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UNITED STATES ARMY

HUMAN FACTORS RESEARCH & DEVELOPMENT

FOURTEENTH ANNUAL CONFERENCE

SPONSOR: CHIEF OF RESEARCH & DEVELOPMENT
DEPARTMENT OF THE ARMY

U. S. ARMY TANK-AUTOMOTIVE COMMAND
WARREN, MICHIGAN

OCTOBER 1968

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20310

CRDBES

SUBJECT: Fourteenth Annual Army Human Factors Research and Development Conference: Foreword and Transmittal

SEE DISTRIBUTION

1. This report is the unclassified record of the 14th Annual Army Human Factors Research and Development Conference held at the US Army Tank-Automotive Command, Warren, Michigan, 23-25 October 1968. The continued annual sponsorship of these conferences and the publication of this report by the Chief of Research and Development, Department of the Army, reconfirms the valuable contribution of the conference to the interchange of information among agencies and personnel concerned with the effectiveness of the US Army soldier, his training, and his equipment in the operational environment. A compendium of current Army human factors research and development work programs is included in the appendices of this report.

2. The conference successfully serves the vital functions of bringing together the diverse elements of the Army's human factors research and development activities and stimulating joint efforts on common problems. This year, the theme of the conference was "Manpower Considerations in the Development Process".

3. The Army's Human Factors Research and Development Committee is to be commended for thoroughly planning and effectively conducting this successful conference. The committee is encouraged to continue its diligent and critical search for more effective means to assure that the Army derives full benefit from the application of the results of research in the psychological and social sciences. Comments regarding this conference may be directed to the Chief of Research and Development, ATTN: Chief, Behavioral Sciences Division, Department of the Army, Washington, D.C. 20310

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

GEORGE M. SNEAD, JR.
Colonel, GS
Director of Army Research

1 Incl
Report

CRDBES
SUBJECT: Fourteenth Annual Army Human Factors Research and Development Conference: Foreword and Transmittal

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- Attendence Roster: See Pages 316-332

REPORT OF THE FOURTEENTH ANNUAL U.S. ARMY HUMAN FACTORS RESEARCH AND DEVELOPMENT CONFERENCE

23-25 October 1968
U.S. Army Tank-Automotive Command
Warren, Michigan

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SESSION I
KEYNOTE SESSION

General Chairman: Lynn E. Baker
U.S. Army Chief Psychologist
Office of the Chief of Research and Development
Department of the Army
Washington, D.C. 20310

1. A. BACKGROUND

References:

a. Conference Report, "Army Human Engineering Conference," The Pentagon, 14-15 December 1955.

b. Report, "Second Annual Army Engineering Psychology Conference," Army Medical Research Lab. Fort Knox, Kentucky, 7-9 November 1956.

c. Report, Third Annual Army Human Factors Engineering Conference," Quartermaster Research and Engineering Command, Natick, Massachusetts, 2-4 October 1957.

d. Report, "Fourth Annual Army Human Factors Engineering Conference," U.S. Army Chemical Center, Maryland, 9-11 September 1958.

e. Report, "Fifth Annual Army Human Factors Engineering Conference," Redstone Arsenal, Alabama, 22-24 September 1959.

f. Report, "Sixth Annual Army Human Factors Engineering Conference," Fort Belvoir, Virginia, 3-6 October 1960.

g. Report, "Seventh Annual Army Human Factors Engineering Conference," University of Michigan, 3-6 October 1961.

h. Report, "Eighth Annual Army Human Factors Engineering Conference," U.S. Army Infantry Center, and U.S Army Infantry School, Fort Benning, Georgia, 16-19 October 1962.

i. Report, "Ninth Annual Army Human Factors Research and Development Conference," Walter Reed Army Medical Center, Washington, D.C. 14-17 October 1963.

j. Report, "Tenth Annual Army Human Factors Research and Development Conference," U.S. Army Aviation Center, Fort Rucker, Alabama, 5-8 October 1964

k. Report, " Eleventh Annual Army Human Factors Research and Development Conference," U.S. Army John F. Kennedy Center for Special Warfare, Fort Bragg, North Carolina, 3-6 October 1965.

l. Report, "Twelfth Annual Army Human Factors Research and Development Conference," U.S. Army Infantry Center, Fort Benning, Georgia, 2-5 October 1966.

m. Report, "Thirteenth Annual Army Human Factors Research and Development Conference," U.S. Army Signal Center and School, Fort Monmouth, New Jersey, 25-27 October 1967.

n. Army Regulation 70-8, Human Factors and Nonmateriel Special Operations Research, dated 19 November 1965.

o. Army Regulation 602-1, Human Factors Engineering Program, dated 4 March 1968.

Sponsorship and Planning of the Conference:

The annual U.S. Army Human Factors Research and Development Conference is sponsored annually by the Chief of Research and Development, (OCRD) Department of the Army. This conference is the Fourteenth in the series. The conference includes programs in all areas of human factors research of interest to the Army.

Previous conferences have been reported in references a through m above.

In accordance with references, planning for the conference, and follow-up of suggestions and recommendations, are accomplished by a U.S. Army Human Factors Research and Development Committee. The committee is composed of representatives of the Chief of Research and Development (Chairman), the Deputy Chief of Staff for Military Operations, Chief of Engineers, The Surgeon General, U.S. Continental Army Command, U.S. Army Combat Development Command, U.S. Army Materiel Command. In addition to the above representation, the committee has been augmented by participants from the Deputy Chief of Staff for Personnel; the U.S. Army Behavioral Science Research Laboratory; the Human Resources Research Office (HumRRO), of the George Washington University; and the Center for Research in Social Systems, the American University.

Purposes of the Conference are:

a. To provide direct exchange of information on human factors research and development among personnel of U.S. Army development agencies and between these and representatives of user agencies and other qualified individuals.

b. To provide recommendations and suggestions to be followed up by the U.S. Army Human Factors Research and Development Committee to assure exploitation of all opportunities for improving the effectiveness of the U.S. Army soldier, his training and his equipment.

c. To provide a conference report which will serve as a useful, authoritative, and complete compendium of current work programs and related information concerning all U.S. Army human factors research and development activities.

Following the invocation by Chaplain (Major) Gasper F. Sirianni, the Conferees were welcomed by Major General Shelton E. Lollis, Commanding General, U.S. Army Tank-Automotive Command. Following the welcoming remarks, General Frank S. Besson, Jr., Command General, U.S. Army Materiel Command, delivered the keynote address. General Besson described the soldier of today and emphasized the need to consider qualitative and quantitative manpower requirements, training requirements, and human performance requirements throughout the life-cycle of materiel development. Lieutenant General Austin W. Betts, Chief of Research and Development, Department of the Army delivered his Sponsors Charge. The charge urged the behavioral and social scientists and others in non-materiel development, tactical doctrine, and manpower management establishments, as well as scientists in materiel development activities to keep each other fully informed and to proceed apace toward the continuing technological advance of the Army as a whole.

The Conference Banquet was held on the evening of 23 October 1968. Dr. S. Rains Wallace, President, American Institutes for Research, presided as the Master of Ceremonies. Dr. Wallace Sinaiko, Institute of Defense Analysis, in his after-dinner address provided interesting and informative sidelights on important but less recognized aspects of the larger world society in which research and development on human factors take place.

Chairman's Summary and Recommendations

The Conference objective remains, as in previous years, the direct exchange of information concerning plans, problems, and accomplishments between the "doers" and the "users" of behavioral science R&D. The theme "Manpower Considerations in the Development Process" refers not solely to the development of materiel, but to the advanced development of the Army as a whole. The behavioral sciences have a vital role to play in assuring that the accomplishment of the AMC materiel development mission will truly achieve advanced technological development of the whole Army, and the assigned leadership responsibilities of the Human Engineering Laboratories for effectuation of AR 602-1 make it a major instrument for this purpose. Similarly, other staff and command agencies, and the research and industrial capabilities represented at this Conference, each has its important role to play in bringing the behavioral sciences to bear vigorously on all manpower considerations in the development of the Army. Conference sessions I and II first set the stage by outlining the generative nature of the Combat Development process, and the AMC plan for implementation of AR 602-1, "Human Factors Engineering Program." These sessions then provided more specific details of human factors inputs to materiel development and the manpower resources constraints within which these inputs are brought to bear. Session III provided a richly detailed review of the development of overseas security operations and of problems and principles of execution of politico-military missions. In session IV our host demonstrated and illustrated advanced mobility problems, trends and concepts; and provided concrete details of the problems encountered in the US/FRG Tank Development Program. In session V ODCSPER described a number of the major technical problems encountered in the development of manpower management: jobs, units, people, and training. FORECAST: Since it has been demonstrated that the process of development of materiel systems is amenable, from the first beginnings, to the active and rational consideration of human factors in system performance; a data bank will be assembled, and require continuous refreshment from new researches, to support manpower considerations in the development process. The Conference adjourned at 1130 hours 25 October 1968.

1B. ADDRESS OF WELCOME

Shelton E. Lollis, Major General, USA
Commanding General
U.S. Army Tank-Automotive Command
Warren, Michigan 48090

The hosting of the 14th Annual Human Factors Conference is an honor for the Army Tank-Automotive Command, and it is my pleasure this morning to welcome you in behalf of TACOM.

To a vehicle design agency, such as ours, the importance of the human factor is an essential element in the success of our product. Every vehicle we build, every piece of equipment we offer for use, demonstrates the importance of the effective application of human factors engineering principles.

Much has been learned about how to make the equipment fit the man; what kind of man will use the equipment; how controls respond to his touch. In the past, the operator's functional effectiveness was no less important than now, but by reason of your scientific interests and by the wealth of knowledge that you have provided, we have a greater appreciation and understanding of the functional man in the system. Our newest vehicle concepts will reflect the results of your studies. The value of your work to our part of the overall technological endeavor cannot be overstated. I hope that our own presentations tomorrow will afford you the opportunity to see how we apply human factors. We also wish to provide you with a more intimate understanding of our present and future needs, and an insight of what we see in the way of future vehicle concepts and trends.

I am sure that, as a result of this conference, many new and valuable contacts will be established between the Army's agencies and with our Industry, and that future exchanges of information may be of benefit to all of us.

Indeed, we all profit richly from this series of annual meetings. I hope that your benefit from this one will be as fruitful as ours.

While you are here, please feel free to call on us for anything that we may do for you to make your visit more rewarding.

It is now my privilege to introduce the Commanding General of the Army Materiel Command, General Frank Besson.

1C. KEYNOTE ADDRESS

Frank S. Besson, Jr., General, USA
Commanding General
U.S. Army Materiel Command
Washington, D.C. 20315

Good Morning.

The theme of this year's conference is concerned with manpower considerations in the materiel development process (Fig. 1). I think this theme is particularly important right now because of the tremendous interest displayed in this subject throughout the Department of Defense. Even more to the point right now is that I am most interested in the subject because we in AMC have responsibility for consideration of manpower throughout the entire life cycle of a weapons system.

When we think of a weapons system, we usually think of an advanced, sophisticated system; such as the Pershing Missile, or the Cheyenne. While systems such as these are all important to our defense effort, we frequently overlook one weapons system that has been with us for a long time. By this I mean that we sometimes forget that man himself (Fig. 2) is frequently the primary component of a weapons system rather than just one of the supporting parts. This is particularly true of the relatively low level armed conflict that we tend to label these days as Counterinsurgency or Internal Defense operations. These wars of ambush, raid, and small unit operations always seem to be fought in primitive, underdeveloped areas of the world. We also find that political considerations and the military situation itself tend to limit the use of our large, general purpose weapons systems. This, of course, brings man into the forefront.

In the primitive, limited war environment, man - more than ever - is the weapons system. This man and his equipment have come a long way since World War I. Back in those days, this was our idea of the well equipped soldier (Fig 3).

We all know, of course, that great strides have been made in the field of weapons development since then. The man who uses the hardware has also been changing (Fig. 4). Let's take a look at the development of the American soldier since World War I.

First of all, he is younger (Fig. 5). These are average ages which mean that there are some older and some younger, but as you can see, with an average age of 20 years and with a minimum draft age of 18, the younger soldiers in Vietnam are close to 19 after training. Thus, the average soldier is some 4 to 5 years younger than in previous wars and there are far fewer about 25. Given the physical demands of a tropical war and the nervous strain associated with a war with no front, the virtues of youth cannot be overemphasized.

He is also better educated (Fig. 6). Unfortunately, our statistics do not differentiate between the Korean level and Vietnam, but in comparison with World War I and II, the trend is clear. There are many advantages associated with a higher educational level but the most obvious is that these soldiers can absorb adequate training in less time, or more importantly, they can be given more training in the same time as was afforded to their predecessors. I will go a little deeper into the importance of this point in a minute or two.

Not only is our soldier of today younger and smarter, he is also bigger (Fig. 7). The size of the soldier generally may be associated with stamina and the amount of equipment and ammunition he can carry. In World War II with the M-1 rifle, the average infantryman carried perhaps 70 to 100 rounds of small arms ammunition. In Vietnam with the light-weight rifle and the lighter ammunition, the soldier will carry sometimes 400 to 500 rounds of ammunition, plus grenades of all kinds, mines, booby traps, night flares, plus his own personal gear and food. In addition, the size of our young men parallels their general health.

The soldier of today is also more confident. This can be attributed to a number of factors. Among the most important of these are that his leaders are more experienced, and he knows that his chances of coming home are better than ever (Fig. 8 and 9). The number of battle deaths is still coming down, and the number of wounded men who later die is at an all time low (Fig. 10 and 11).

So, the picture that emerges from this brief statistical survey is that of a young soldier who is bigger, smarter, healthier, better led, and more confident than ever before.

Tom Tiede of the Newspaper Enterprise Association had another view of the typical American soldier in Vietnam, which I think is well worth repeating here (Fig. 12). As he sees it, the typical soldier over there is 18½ years old, and I quote:

"What a man he is. A pink-cheeked, tousle-haired, tight-muscled fellow who under normal circumstances would be considered by society as half man, half boy, not yet dry behind the ears. But here and now, he is the beardless hope of free man. "Generally he is unmarried and without possessions except for a car at home and a transistor radio here. He listens to rock and roll and 105's.

"..He can break down a rifle in 30 seconds and put it back together again in 29. He can describe the nomenclature of a fragmentation grenade, explain how a machine gun operates, and of course, use either if the need arises.

"He has seen more suffering than he should have in his short life... He will share his water with you if you thirst, break his rations in half if you hunger, split his ammunition if you are fighting for your life.

"He can do the work of two civilians, draw half the pay of one, and find ironic humor in it all. He has learned to use his hands as a weapon and his weapon as his hands.

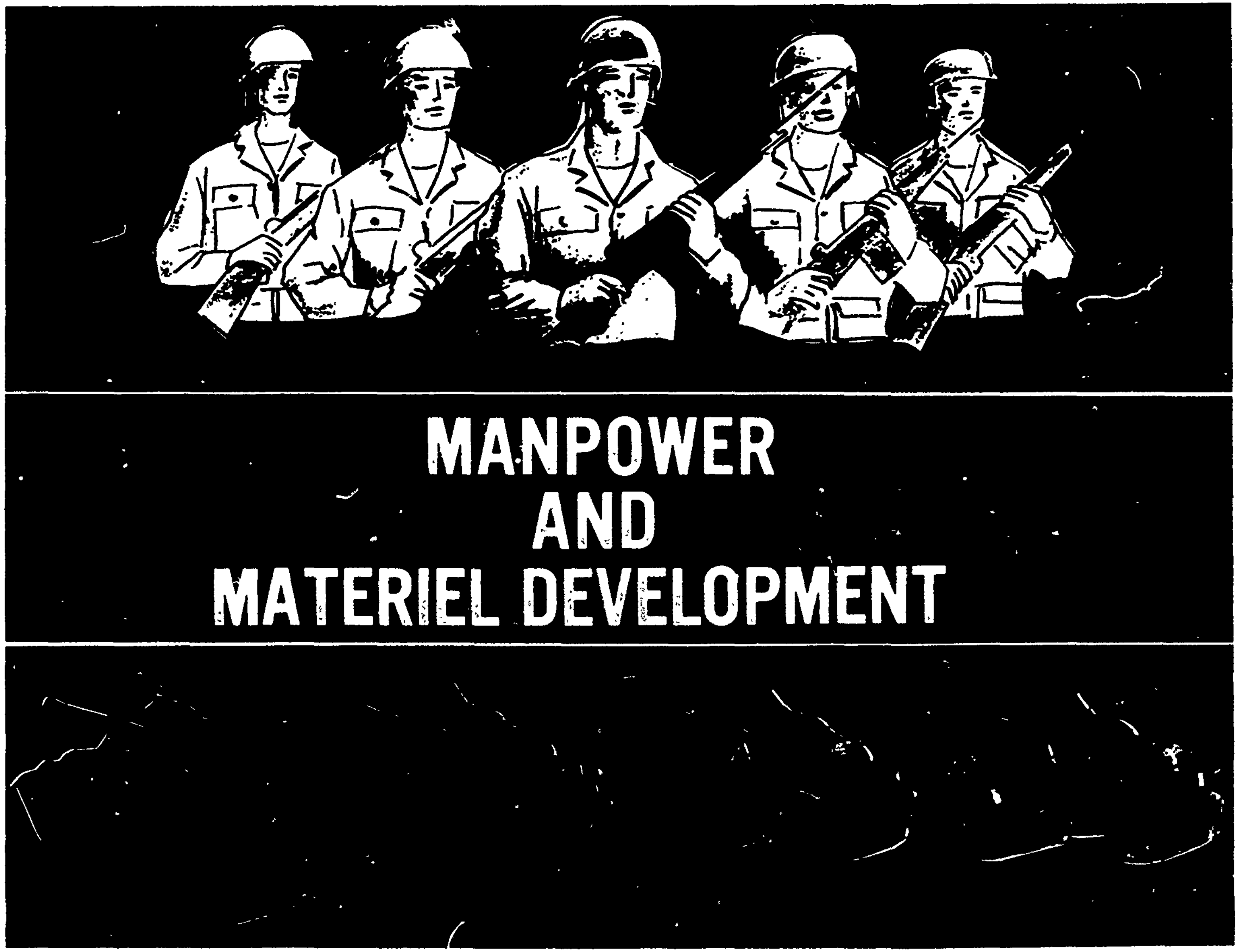

Figure 1.

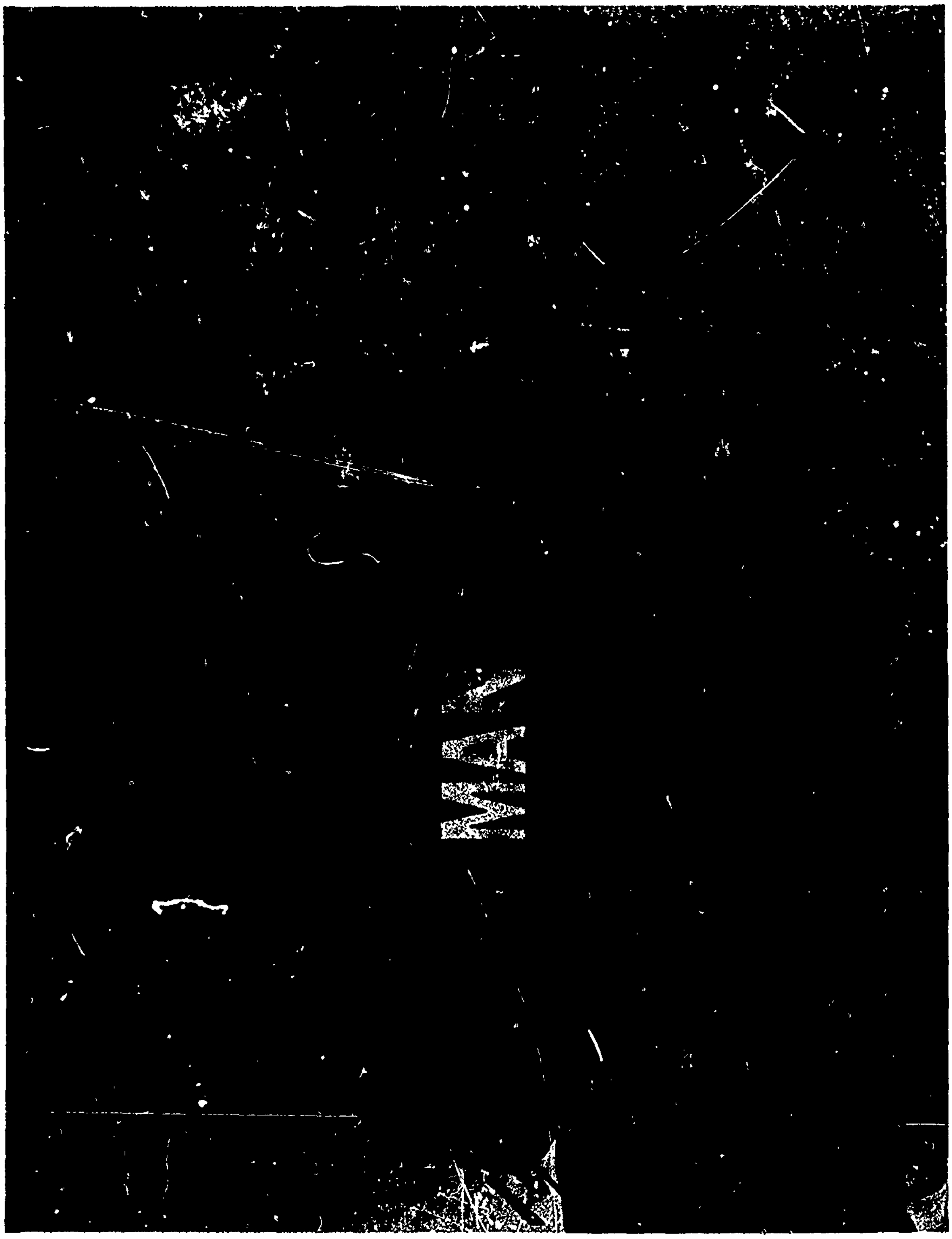

Figure 2.

Figure 3.

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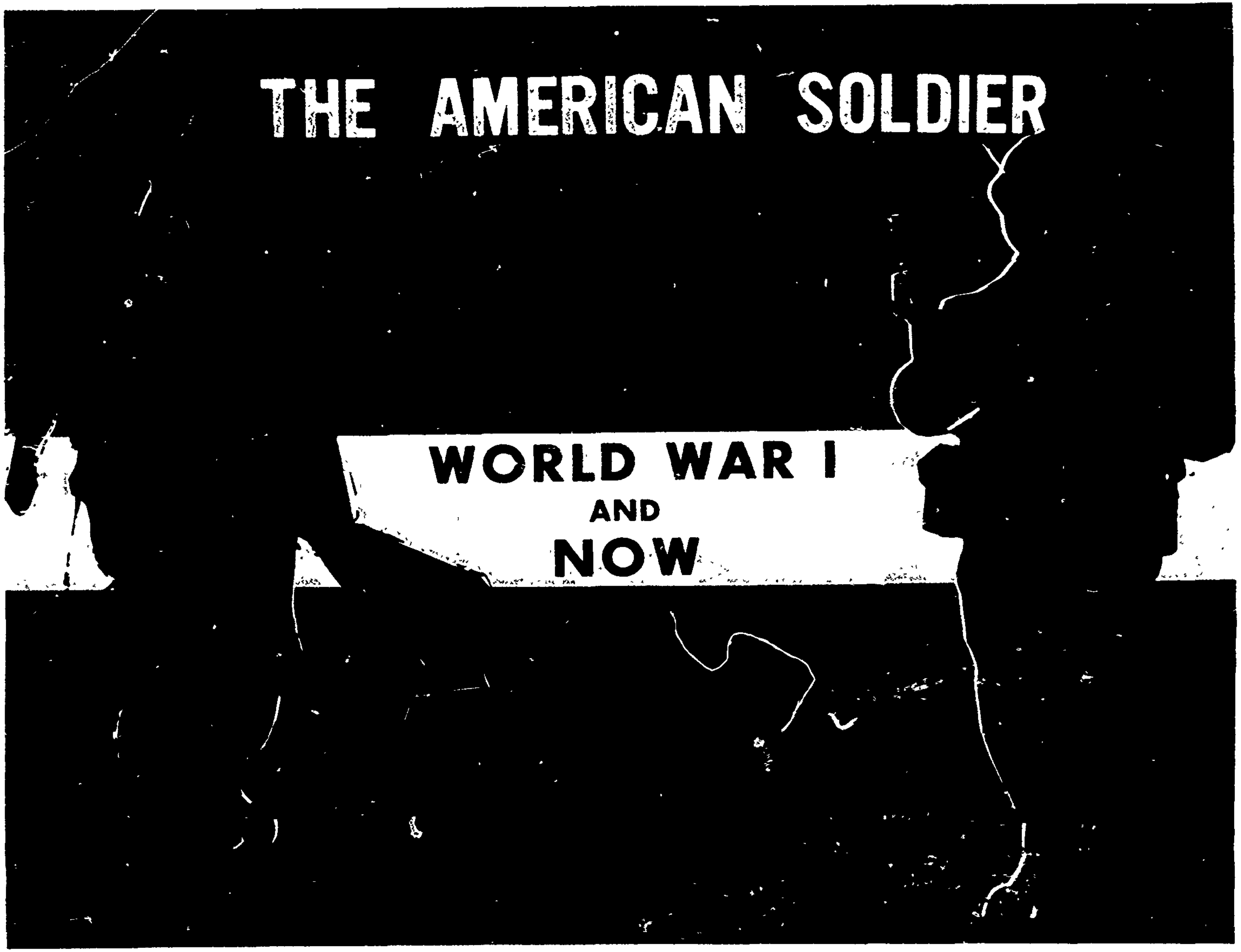


Figure 4.

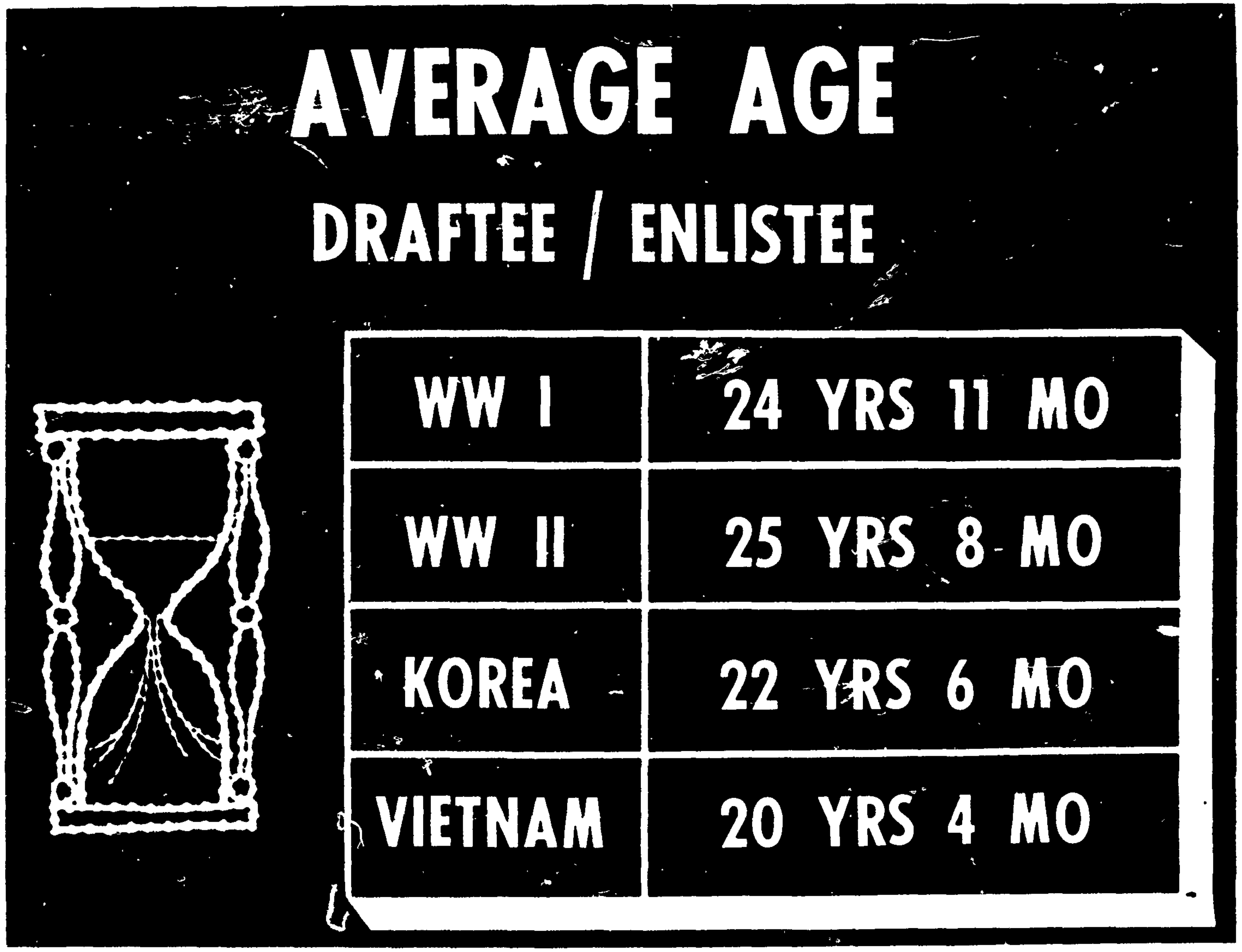

AVERAGE AGE
DRAFTEE / ENLISTEE
WW I
24 YRS 11 MO
WW II
25 YRS 8 MO
KOREA
22 YRS 6 MO
VIETNAM
20 YRS 4 MO

Figure 5.

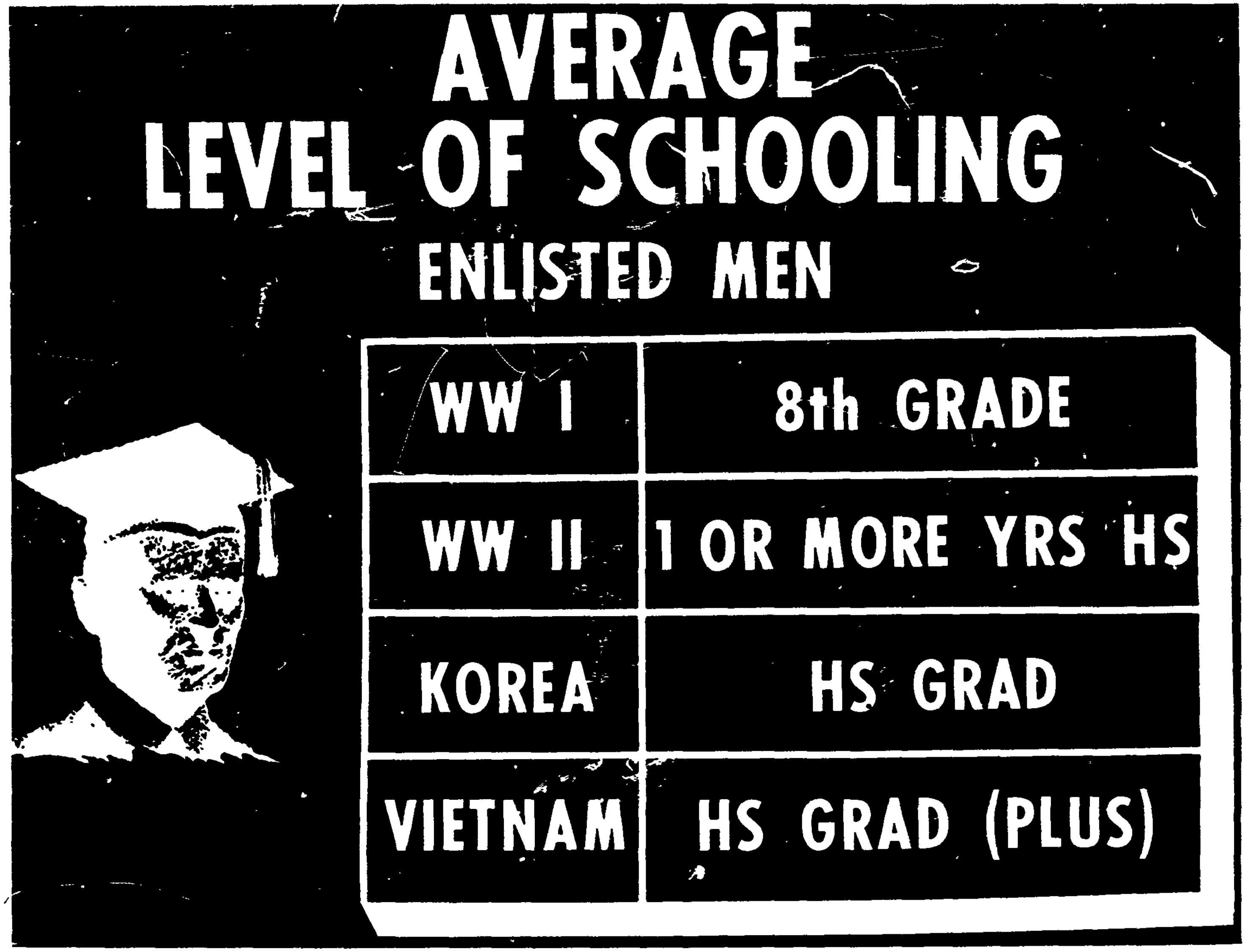
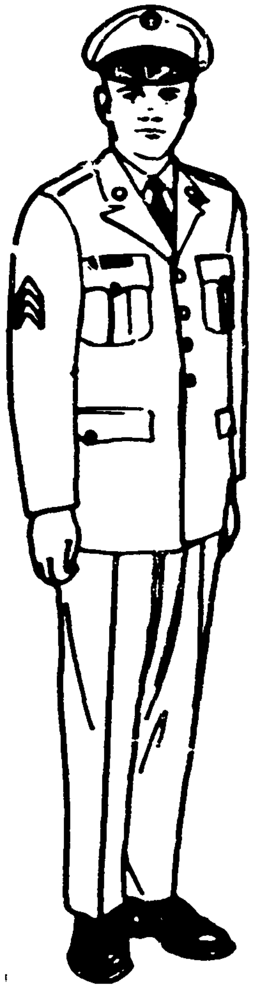

AVERAGE
LEVEL OF SCHOOLING
ENLISTED MEN
WW I
8th GRADE
WW II
1 OR MORE YRS HS
KOREA
HS GRAD
VIETNAM
HS GRAD (PLUS)

Figure 6.

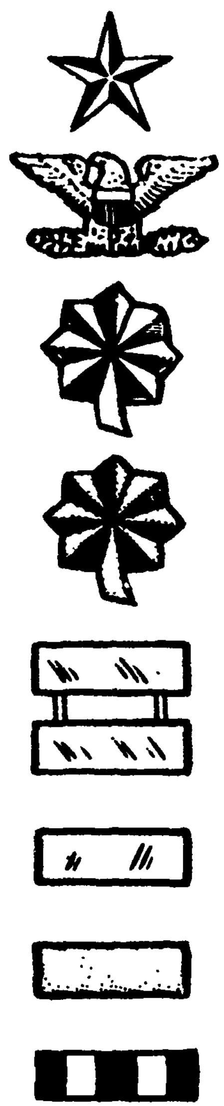
HEIGHT & WEIGHT

AVERAGE



WW I	67.5" / 141.5 lbs
WW II	68.1" / 150.5 lbs
KOREA	68.8" / 155.2 lbs
VIETNAM	68.9" / 158.7 lbs

Figure 7.



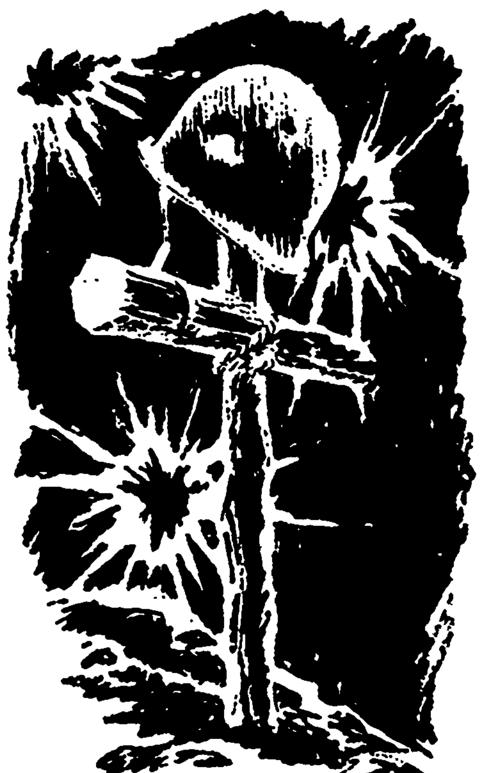
PERCENTAGE OF REGULAR OFFICERS

WW I	5.8%
WW II	2.8%
KOREA	15.6%
VIETNAM	24%

Figure 8.

BATTLE DEATHS

PER 1000 MEN



WW I	47.9 AEF - 1918
WW II	51.9 D-DAY TO VE DAY
KOREA	43.2
VIETNAM	22.6

Figure 10.

PERCENT DIED OF WOUNDS

WW I	8.12%
WW II	4.5%
KOREA	2.5%
VIETNAM	2.4%

Figure 11.

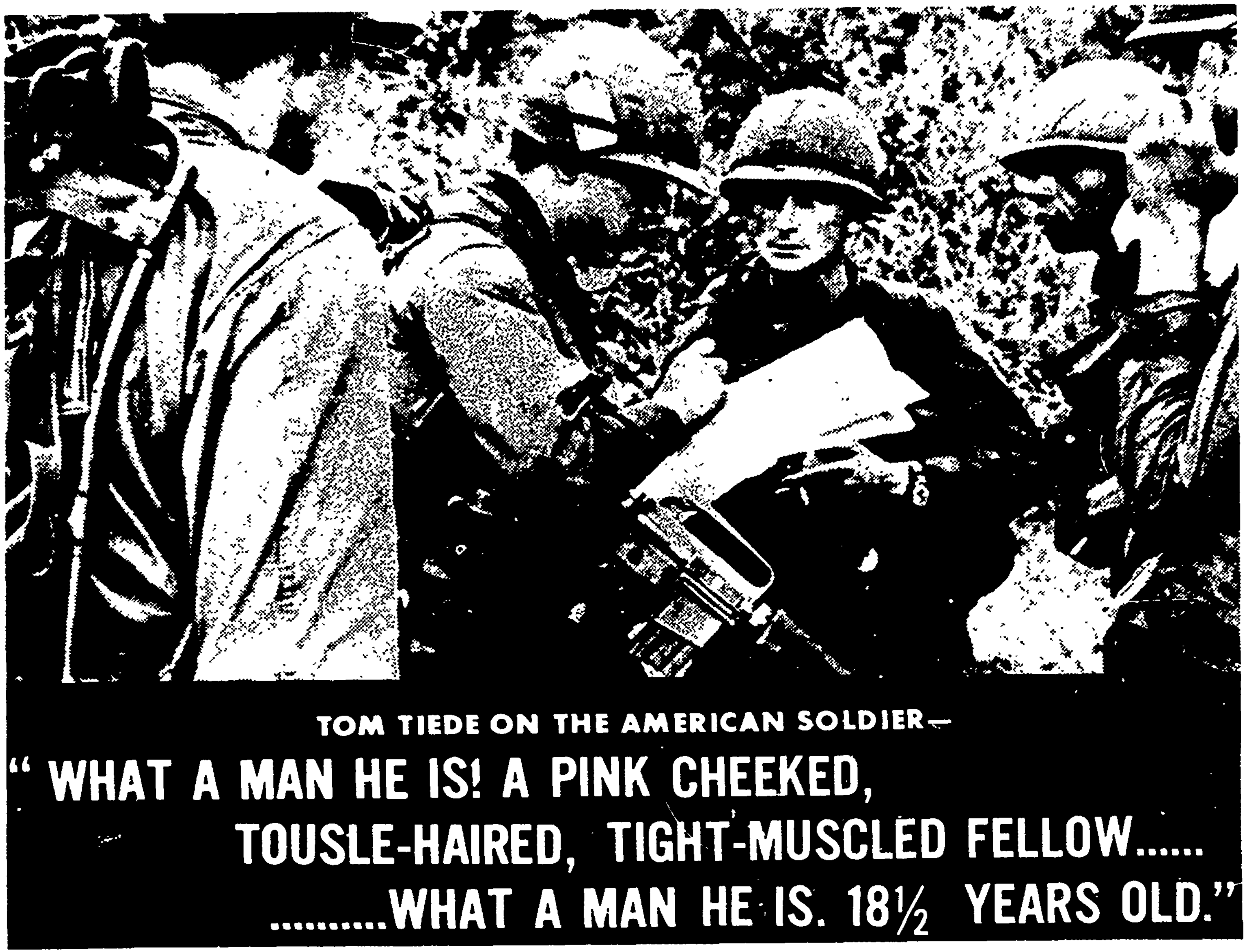

TOM TIEDE ON THE AMERICAN SOLDIER—
" WHAT A MAN HE IS! A PINK CHEEKED,
TOUSLE-HAIRED, TIGHT-MUSCLED FELLOW......
..........WHAT A MAN HE IS. 18½ YEARS OLD."

Figure 12.

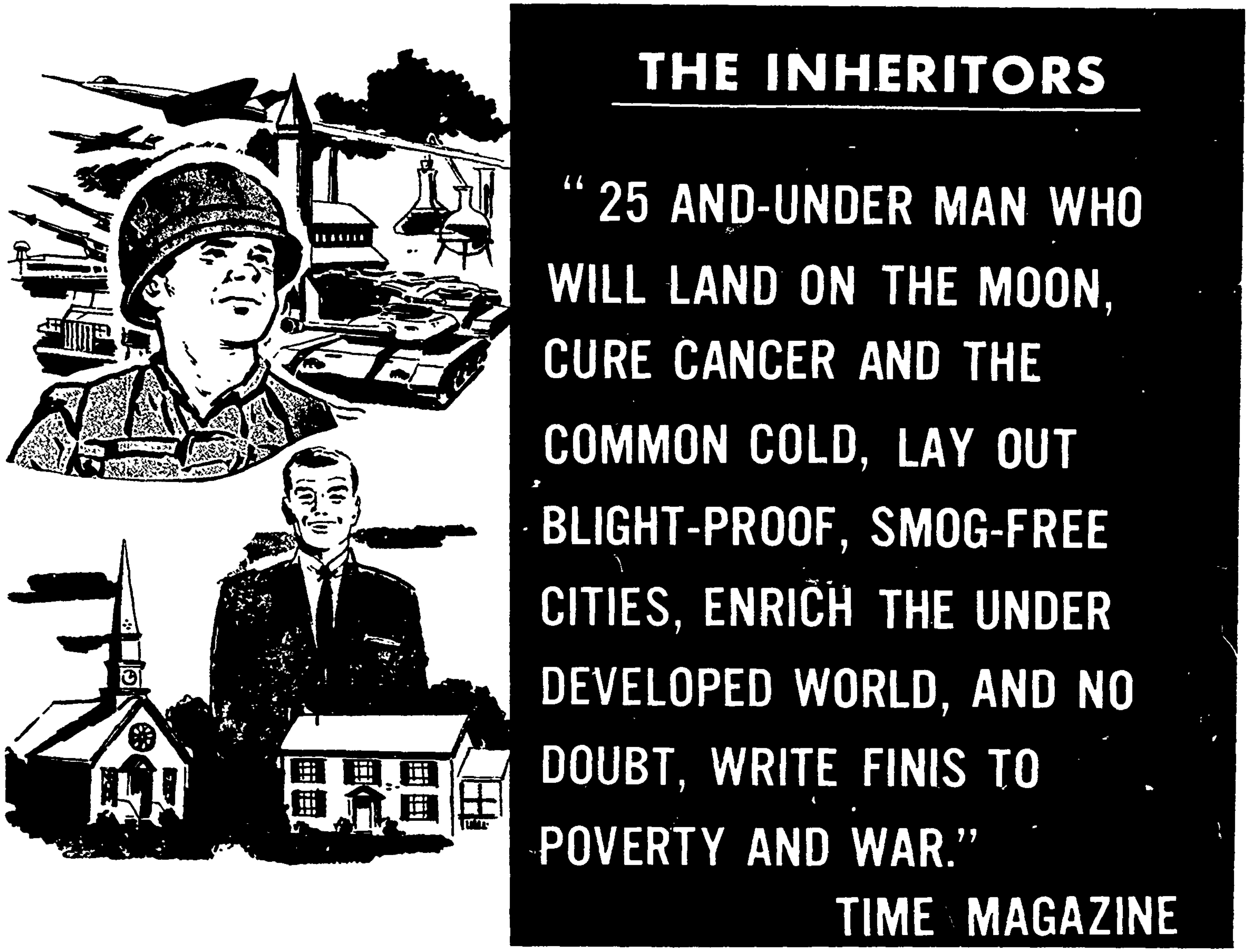

THE INHERITORS
"25 AND-UNDER MAN WHO WILL LAND ON THE MOON, CURE CANCER AND THE COMMON COLD, LAY OUT BLIGHT-PROOF, SMOG-FREE CITIES, ENRICH THE UNDER DEVELOPED WORLD, AND NO DOUBT, WRITE FINIS TO POVERTY AND WAR."
TIME MAGAZINE

Figure 13.

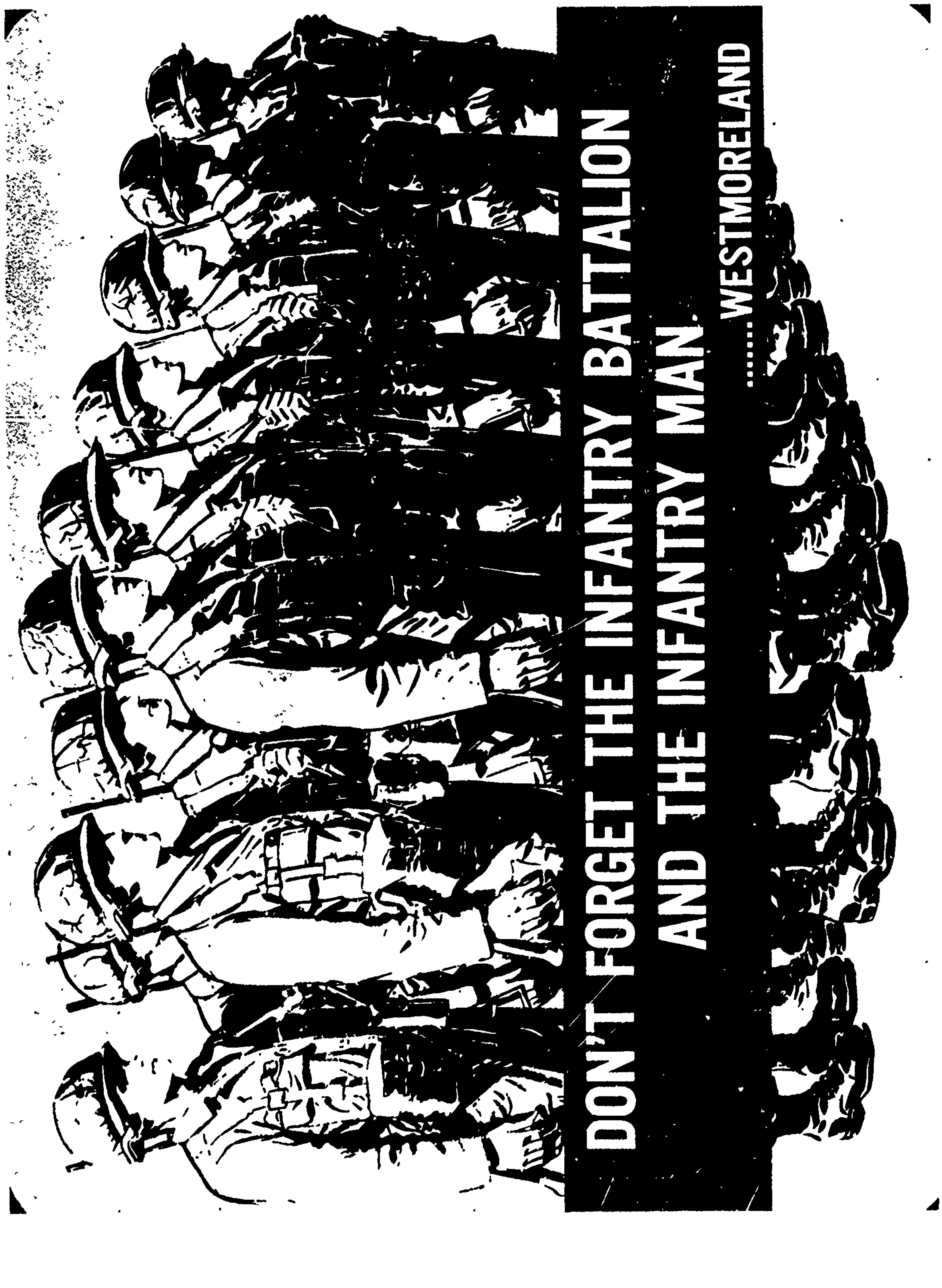

DON'T FORGET THE INFANTRY BATTALION
AND THE INFANTRY MAN.
........WESTMORELAND

Figure 14.

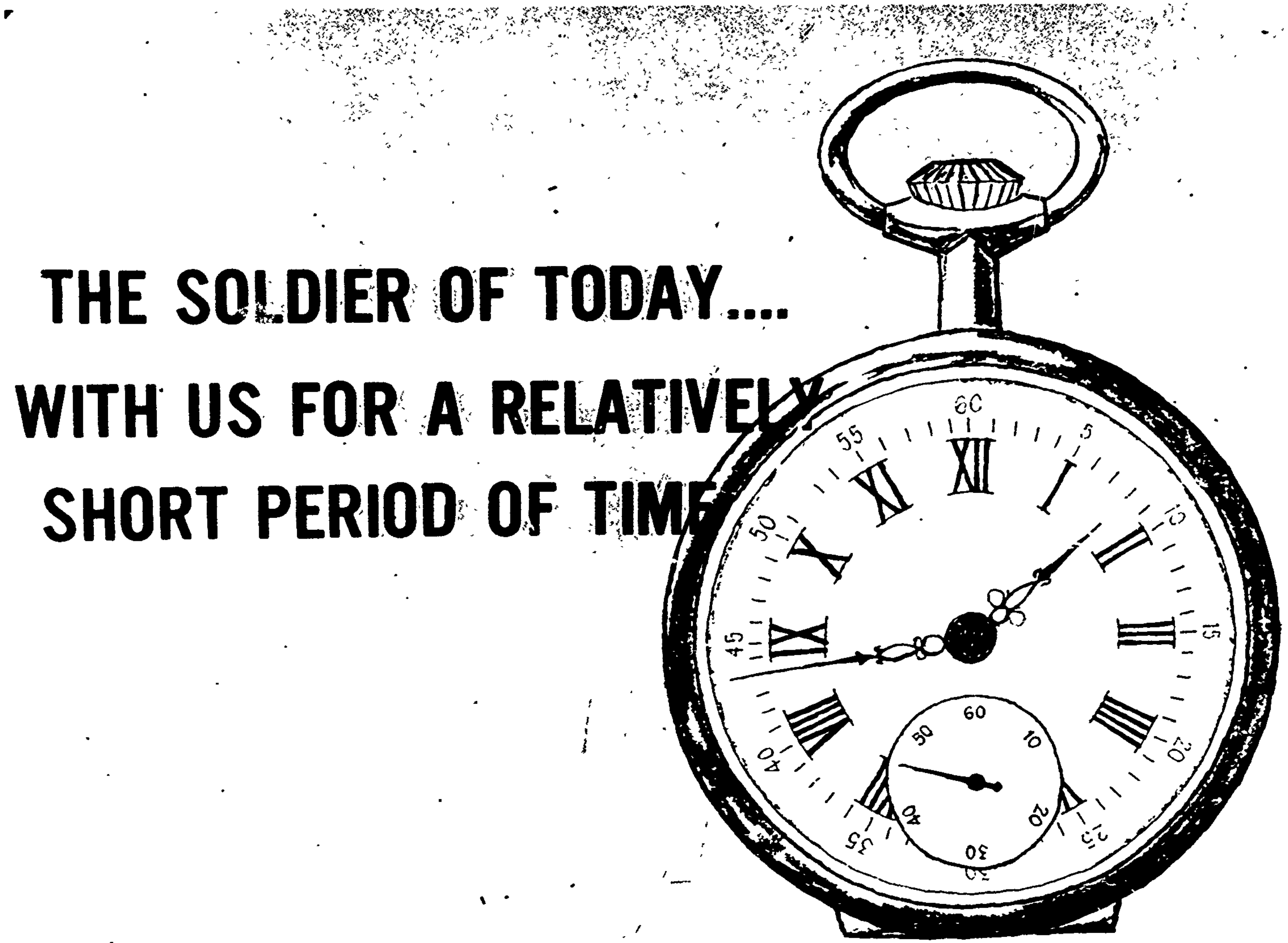

THE SOLDIER OF TODAY....
WITH US FOR A RELATIVEL
SHORT PERIOD OF TIM

Figure 15.

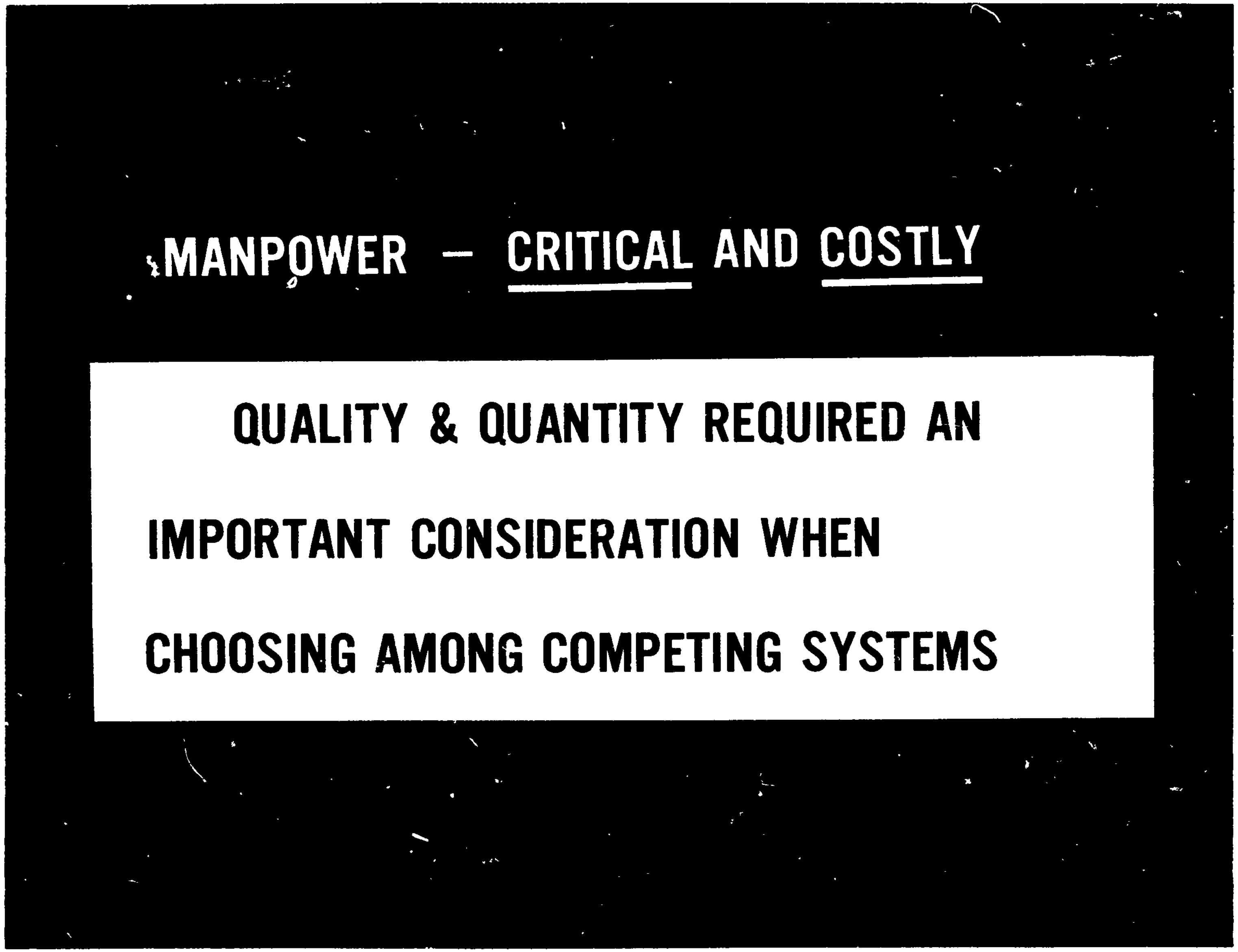

MANPOWER — CRITICAL AND COSTLY
QUALITY & QUANTITY REQUIRED AN
IMPORTANT CONSIDERATION WHEN
CHOOSING AMONG COMPETING SYSTEMS

Figure 16.

Figure 17.

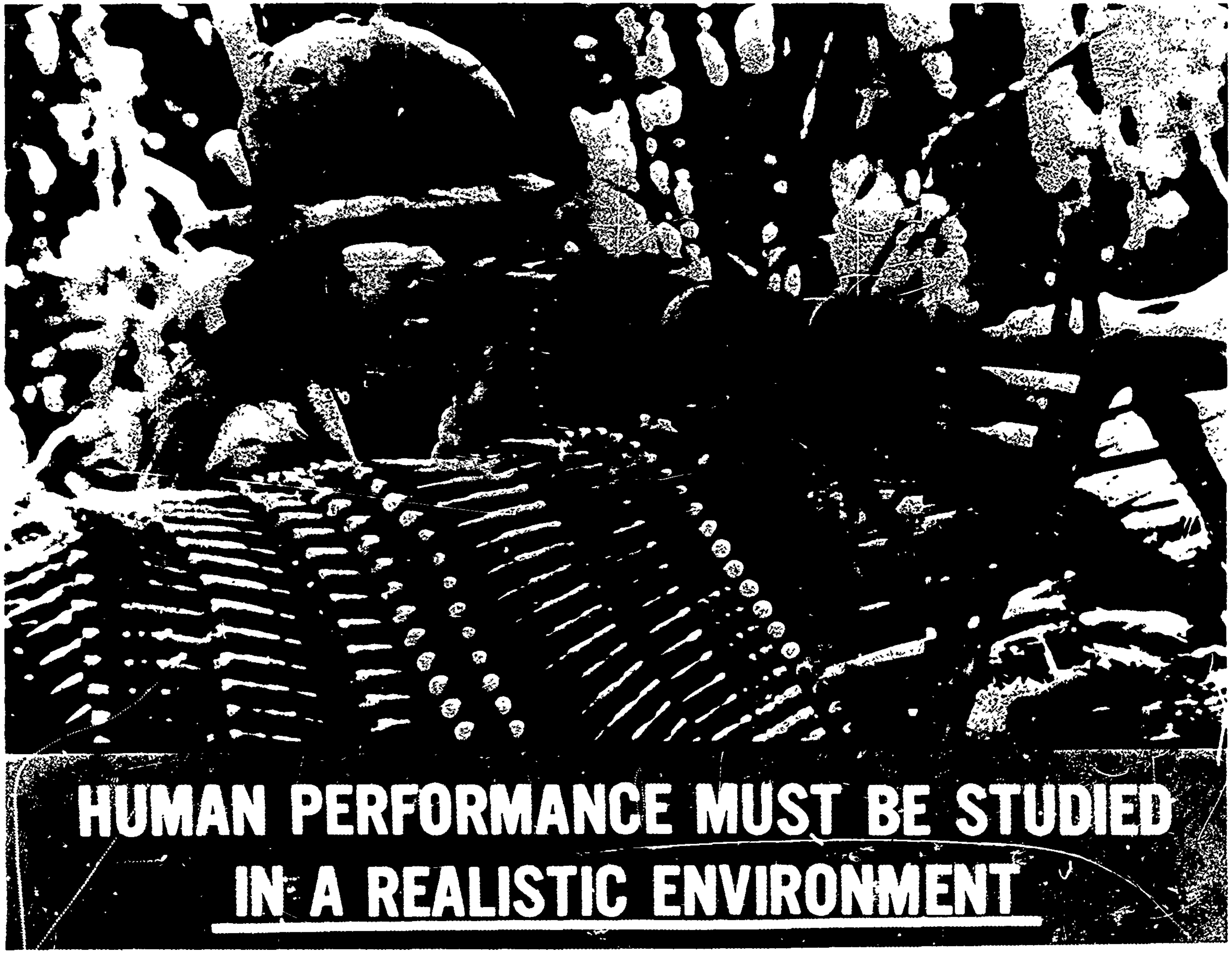

HUMAN PERFORMANCE MUST BE STUDIED
IN A REALISTIC ENVIRONMENT

Figure 18.

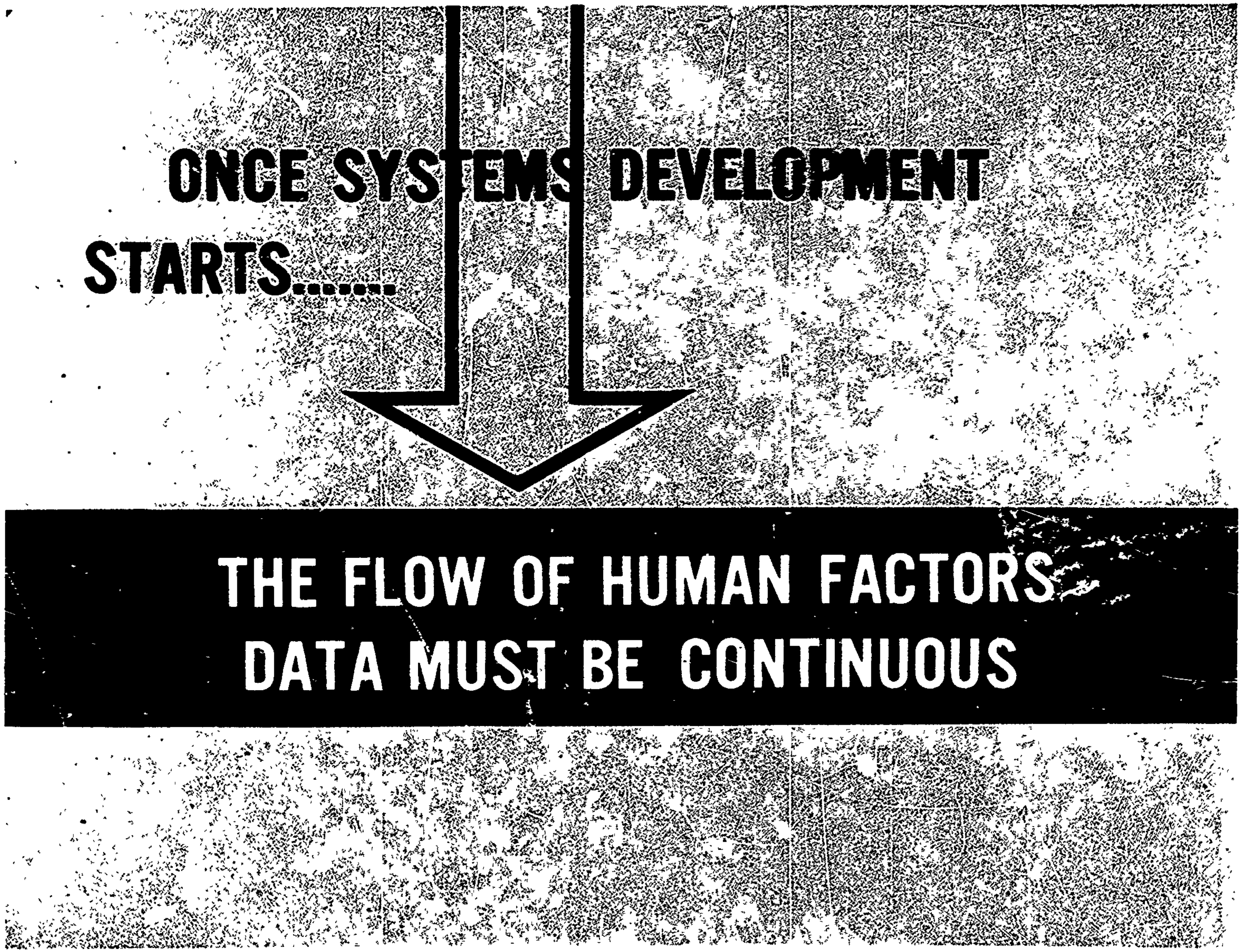

ONCE SYSTEMS DEVELOPMENT
STARTS.......
THE FLOW OF HUMAN FACTORS
DATA MUST BE CONTINUOUS

Figure 19.

OUR GOAL IN

HUMAN FACTORS R&D

RELIABLE LIFE CYCLE COST

& PERFORMANCE DATA

Figure 20.

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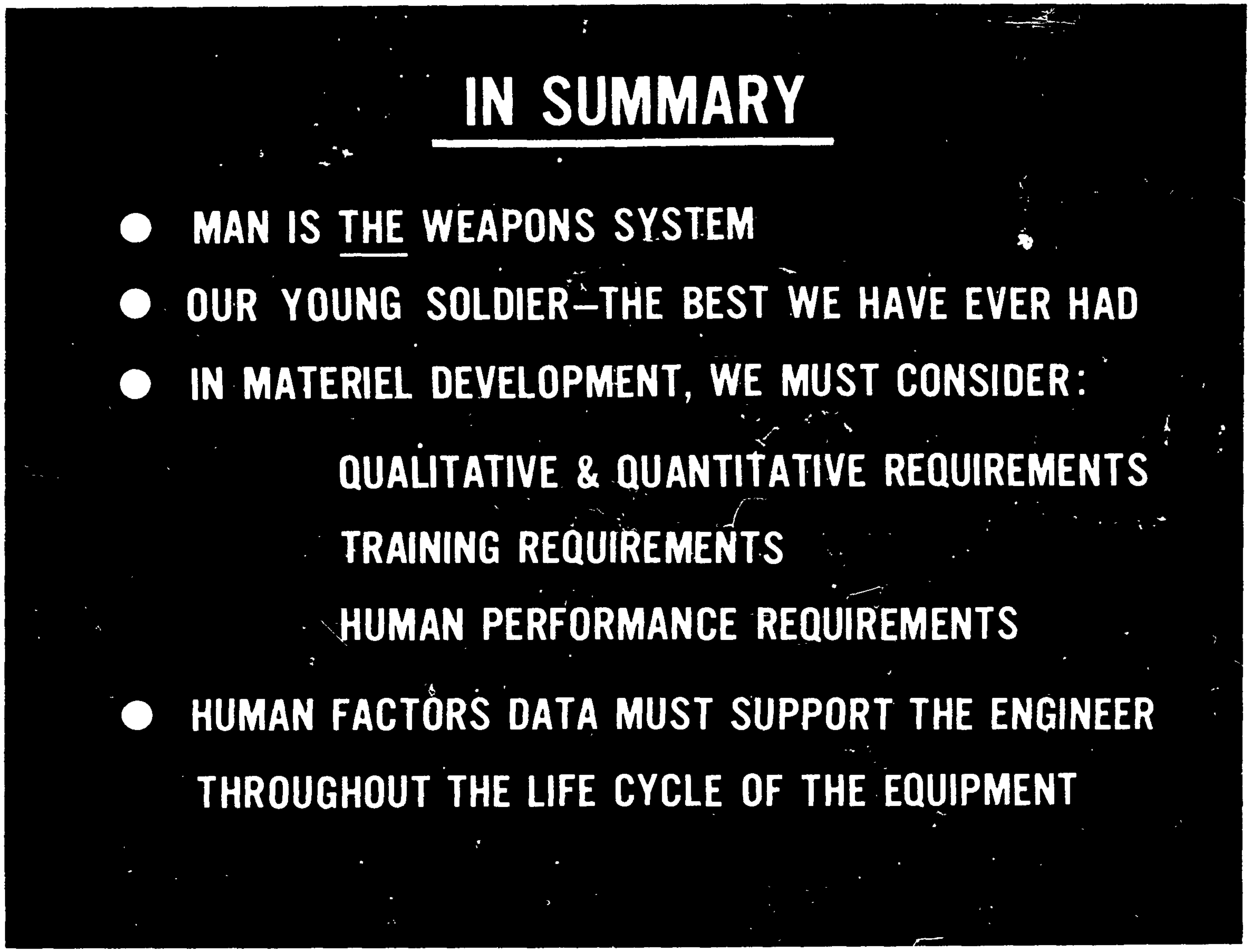
IN SUMMARY
● MAN IS THE WEAPONS SYSTEM
● OUR YOUNG SOLDIER—THE BEST WE HAVE EVER HAD
● IN MATERIEL DEVELOPMENT, WE MUST CONSIDER:
QUALITATIVE & QUANTITATIVE REQUIREMENTS
TRAINING REQUIREMENTS
HUMAN PERFORMANCE REQUIREMENTS
● HUMAN FACTORS DATA MUST SUPPORT THE ENGINEER
THROUGHOUT THE LIFE CYCLE OF THE EQUIPMENT

Figure 21.

He can save a life, or most assuredly take one. What a man he is. 18½ years old."

I must admit that to an old-timer like me, it is difficult to recall the experience of being 18 years old. But the combat soldier's generation is one which TIME Magazine has called "The Inheritors" (Fig. 13). In their Man of the Year for 1966 cover story, they pointed out that it is the "25-and-under man who will land on the moon, cure cancer and the common cold, lay out blight-proof, smog-free cities, enrich the under-developed world and no doubt, write finis to poverty and war."

To do all that, I might add, he will have to be strong, unafraid, and -- most importantly -- a better taxpayer than this father!

This is the picture of the American soldier which we must keep constantly in our minds as we consider the relationships between human factors and materiel development. Our new Chief of Staff, General Westmoreland, is very much concerned with this concept of the soldier himself as <u>the</u> weapons system (Fig. 14). In a recent visit to my headquarters he expressed his concern that in our pursuit of more exotic and sophisticated weapons hardware, we may forget from time to time that the equipping, supporting, and moving of this soldier right here is our real purpose of existence. Let me say right now that I share his concern, and I feel sure that you do too.

I want to go back now, and pick up one point that was mentioned a little earlier - that of the higher educational level of today's soldier (Fig. 15). You will recall that I said he could absorb training at a faster rate than his predecessors, or learn more in the same period of time.

When you consider that this soldier is probably going to stay in the Army for only two years, it is most important that he be taught to use and maintain Army Equipment in a short period of time. We must also consider this when we develop materiel.

As you know, DOD has in the past criticized all the services for not considering manpower aspects in our materiel development programs.

Manpower is a critical and costly commodity (Fig. 16), and must be considered on all proposed materiel system concepts in terms of the number of personnel needed to operate and maintain each competing system concept, and whether appropriately skilled personnel are available in the manpower pool in sufficient numbers to support the system once it gets into the field.

These factors must also be assigned appropriate weights in any simulation processes which may be used to elect from among competing concepts.

Training requirements imposed on the Army by potential weapon systems are another major factor which needs to be considered early in each materiel development program (Fig. 17). We need help here from some of you training experts who can help us estimate the training requirements of competing materiel concepts so that we can convert this information into cost data for comparative system analysis purposes. Thus, training should also be a vital factor in the decision making process of deciding which system concept to select for further development in preference to another concept being proposed.

We must also analyze human performance requirements inherent in a proposed weapons system (Fig. 18). We must determine whether or not physical capabilities of the soldier will be properly used in a proposed system. We must do this not only to be sure that strength and the human senses are appropriately used, but to be sure that the potential for human error is also reduced to the minimum. This contribution of man to system performance must further be studied in a realistic environment. We have to get the dust, heat, mud, noise, blast, smoke, rain, and snow into the equation!

Once we have started development, we need to continually provide human factors data to our designers and provide support to our Project Managers in all areas of manpower considerations (Fig. 19). This must be done in a coordinated manner, however, and I have directed the Human Engineering Laboratories to take the lead in this effort and work out the procedures and methodology to do this effectively. They have considerable experience in working with project managers and I expect them to develop procedures which will permit appropriate inputs from all non-AMC agencies in those areas (training,selection and utilization of personnel, biomedical), where we do not have the needed expertise in the AMC.

What I have tried to indicate is that, hopefully, we will have a program in the Army Materiel Command where inputs from various Army agencies in the fields of training, medical, personnel selection and utilization and other manpower characteristics can be provided early and included in all development programs (Fig. 20). We can help the system analyst by giving him numbers with regard to man's performance which he can use to make better predictions with respect to which particular system to proceed with in development. We propose to develop life cycle cost and performance data on the manpower aspect which can be included by decision makers in deciding the direction of future materiel development.

In summary then, let me remind you once again that the young soldier we have in the field is the best we have ever had (Fig. 21). He is the guy we are in this business to support, and we must keep this constantly in mind.

If we do this, consider his capabilities and his limitations, and take proper note of qualitative manpower requirements, training requirements, and human performance requirements in a realistic environment, we will certainly develop and field the finest in military equipment.

I realize it is easier to say than it is to actually do it, but I feel sure that you will get the job done. Good luck to all of you, and best wishes for the utmost success in your conference. Thank you.

1D. SPONSOR'S CHARGE

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Washington, D.C. 20310

1. The theme of this conference is "Manpower Considerations in the Development Process."

2. Last year in my charge to this conference:

a. I reaffirmed the great value and high priority that the Army places on the support of behavioral and social science technology; and my concern that Army needs for this technological support deserve to be better understood and appreciated in the DOD and the Congress; and

b. I emphasized the necessity that you, the developers as well as the users of that technology, must at all times be acutely aware of the military operational objectives that must be served by research and development in the behavioral and social sciences.

3. This year I desire again to renew that charge and to express my gratification that the Army's needs for behavioral and social science technology are becoming more widely understood and appreciated precisely because, and to the degree that, your work is explicitly directed to support the attainment of stated Army operational objectives.

4. This year, in keeping with the theme "Manpower Considerations in the Development Process" I want to emphasize still another basic guiding principle that must govern your programs of research and development. That principle is simply that both materiel and nonmateriel development must proceed apace as two aspects of a single objective: the continuing technological advance of the Army as a whole.

5. In the Army's behavioral and social science research and development efforts the first of these aspects is concerned with the development of materiel. The record of this conference over the past thirteen years abundantly demonstrates the Army's unswerving will to assure that behavioral science and human factors technology be fully exploited throughout the development of Army weapons and equipment. The record of the next two days in this conference will provide welcome evidence that we continue to make real progress in devising the means to exert that will.

6. The second aspect is con-

cerned with the development of those manpower management and training procedures and tactical doctrines that will assure that each soldier is fully prepared and intelligently led to exploit the power of his weapons and his tactical opportunities. It is essential that these personnel management techniques and doctrines develop apace with materiel development.

7. These two aspects of Army development, the power and adaptability of the materiel and the skill and wisdom of the soldier and his leaders, are inseparable and essential. Each is frustrated without the other. Each requires its own scientific and technological development effort by diverse scientific programs and talents; yet these separate development efforts must be fully informed by and about each other.

8. For this reason I am pleased to note that we have in this conference a broad representation: from industry, the academic scientific community, and the military services; from "user" agencies and development agencies; and from materiel development activities as well as from nonmateriel development, tactical doctrine, and manpower management establishments. I charge each of you in these separate fields to be fully informed and responsive to the scientific objectives and advances of each of the others.

9. The interdependence of all fields of science and technology has been recognized in theory since Aristotle. In practice, however, we have in the past seen separate and disjointed advances producing highly elaborated technologies in some fields while others remain purely academic and research enterprises. In consequence we now see a substantial gap between our capabilities to produce powerful and sophisticated hardware and our capabilities to manage--to plan for, operate, and maintain that hardware.

10. One example of this gap between our hardware systems capabilities and our management system capabilities is given by our limited human capacity to "comprehend" or "deal with" large numbers of contingent events--that is, the kinds of networks of interdependent events that computer programs deal with by means of branching logics or other logic systems.

11. The unaided man, or a small group of men, can comprehend such a set of contingent events only when the number of events in the network is less than some critical number. When the number of events in the network becomes greater than this critical number, as happens in many of our large and complex weapon systems, we must have the help of data processing and other nonmateriel technology if men are to comprehend or deal with the situation in ways that do not depend on blind luck.

12. Thus the speed and precision of six days of Israeli Army operations in the Middle East, quite surely cannot have depended on blind luck. Such speed and precision of massive efforts must depend upon reduction of the gap between the advance of materiel systems capabilities and the nonmateriel technologies of planning, doctrine,communication, and manpower management.

13. The behavioral and social sciences have an important role to play in closing the gap between the advanced stage of development of materiel systems, on the one hand, and the management tools and concepts for their maintenance, use, and deployment, on the other.

14. I charge you to get on with the job.

1E. HUMAN FACTORS AFFECTING THE DEVELOPMENT OF A PARTICULAR WEAPONS SYSTEM: A HYPOTHETICAL EXAMPLE

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INTRODUCTORY SUMMARY

The theme of our conference is "Manpower Considerations in the Development Process." The major thematic materials, in General Besson's keynote address and in the other papers of the conference, stress the importance of considering human factors--orienting our thinking at all times around the soldier himself--in the development of our materiel and management systems.

To tie your thinking to the realistic, down-to-earth problems of hardware design, I propose in this paper to demonstrate by example that:

(a) The process of development of materiel, and especially materiel systems, is amenable from its first beginnings to the active consideration of human factors in system performance; and

(b) A data bank of relevant behavioral science information can be assembled, and needs continuing refreshment from new researches, to support manpower considerations in the development process.

As it always must, our thinking starts with a military operational objective.

THE OPERATIONAL PROBLEM

It is well known that such surface-mobile targets as trucks can be successfully attacked by direct-fire, line-of-sight weapons. It is also well known that even heavily armored targets of the same order of size, notably tanks, can be successfully attacked by such weapons. One important tactical cost of such direct ire, line-of sight attack, however, is that the risk of successful counter-attack is extremely high. Although the rule remains that "the best defense against a tank is a tank," nevertheless, "to fire is to be immediately fired upon."

One sound tactical concept which suggests itself to reduce the risk of successful counterfire is referred to as "shoot-and-scoot." The tactical notion here is to mount the direct-fire, line-of-sight weapon on such a vehicle as will permit quick evasive action; in short, to be somewhere else when the counterfire arrives.

Another equally sound tactical notion would require the development of an indirect fire, or "stand-off" weapon which could attack such tank-sized targets from a distance or from behind a hill or other terrain obstruction offering reduced exposure to enemy action.

Exploring in some detail the "stand-off" weapon concept can provide a realistic example of ways in which human factors must be taken into account from the earliest inception of the concept of development of the weapon.

MAJOR SYSTEM-ELEMENT FUNCTIONS

A system to perform the "stand-off" weapon mission against tanks must include at least the following functional elements:

a. A sensor, be it a man ("forward observer") or a mechanical device to:

(1) detect the target, i.e. distinguish the object of interest, the target, from its background--"I see something that may be what I'm looking for";

(2) recognize the target, i.e. perceive what the general character of the object of interest is--"The something I see is a vehicle"; and

(3) identify the target, i.e. specify the particular class of objects to which the object of interest belongs--"The something I see is not only a vehicle, it is a tank"; and especially to specify whether it is friend or foe--"It is an enemy tank, of such-and-such class (heavy, medium, light, etc.)."

b. A communication channel or net to convey information about the presence and nature of the target, its location if it be stationary and its direction and velocity--hence its likely immediate-future location--if it be moving.

c. A decision function to determine whether or not the target should be fired upon.

d. A controller function to guide the missile to the target location.

These include functions traditionally performed by the forward observer--the man in a forward position at the field of combat action who observes enemy disposition and movements and transmits information to others. He may be on the ground or in some selected elevated position, or he may be airborne to obtain the desired field of-view.

It is clear from the above description of system functions that visual identifier-locater functions will play a critical role in the performance of our "stand-off" system. We can conceive a kamikaze type of pilot to ride the missile and guide it into the target or, less expensively, we can conceive some kind of an electromechanical "eye" (a television camera, for instance) to transmit what it "sees" to a ground controller who guides the weapon. In either case, limits of what a man can perceive and react to in the time available will give the boundary values for the system's capability.

It is also clear that many or all of the major system components necessary to the realization of our described system functions are already in or near the state-of-the-art as far as hardware is concerned.[1]

a. Presently in the inventory, and used in Vietnam and elsewhere, is the short range, direct-fire

LAW (light antitank weapon), such as the recoilless nonwire-guided, shoulder-fired M-72. At longer ranges the Shillelagh missile is gun-launched, wire-guided from a command system in the launching vehicle, and capable of maneuvering in flight to destroy moving targets.

b. The German-French missile HOT is designed to be effective at ranges up to 2½ miles and adaptable to such platforms as helicopters and hovercraft. It senses missile course deviations by an infrared goniometer device which permits the sending of flight-corrective commands via the wire.

c. Other systems are already under consideration or development with greatly enlarged performance capabilities.

SELECTED HUMAN FACTORS: VISION AND COMMUNICATION

One common critical factor in all of these systems and system concepts is the dependence of all optically guided weapon systems on various characteristics of human visual function. This problem has been intensively reviewed for the Army by a Working Group of the Armed Forces--National Research Council Committee on Vision, of which Dr. J. W. Gebhard was chairman.[2] What follows in this paper is liberally adapted for UNCLASSIFIED presentation from that classified (CONFIDENTIAL) study.

In the system configuration in which both the forward observer and the weapon controller are on the ground the problems of visual perception are especially difficult, for we do not know how to measure or predict the ability of a man, or to train him, to judge how a target seen at ground level would look from the point-of-view provided by an airborne missile's "eye."

a. The forward observer may be airborne or on the ground, as may the weapon launching position. Each case presents special problems which may require specific research support of a system design effort.

b. Communication between the observer and the controller will be a critically determining factor in any electro-optical system design, and an essential element of the problem lies in proper performance of their visual tasks by each of these men. The forward observer must translate his view (detection, identification, and recognition) of the target object to the totally different view which will be available to the Controller. He must do this on sunny, cloudy, clear and hazy days, with and against the sun, in summer or winter conditions of foliage or snow backgrounds. Even with a fixed type of countryside, terrain, and climate the infinite variability of backgrounds, lighting, atmospheric effects, and target aspects make it almost mandatory that a coding system be employed to reduce these variables to some smaller, manageable set of signals for voice communication. In addition, visual aids to serve as code keys may be advisable.

c. Target location errors, and their correction, not only lay an additional burden on the observer-controller communication link, but also assist in setting the boundary values for the effective field-of-view of the missile's airborne "eye". Simple geometry tells us, for instance, that a tank moving at 10 knots (310 meters per minute) will amplify a 100 meter observer's error to 930 meters in three minutes. If an airborne "eye" has a field-of-view of, say 28^{o}, this at 1000 meters subtends a ground distance of about 530 meters (which compare with the 930 meter error on the 10-knot tank, above). It is clear that the forward observer's perception, which will never be completely free of error, will be difficult to communicate to the controller both accurately and quickly enough for effective controller performance.

d. The missile controller's task becomes crucial to the success of the system at that moment when the missile arrives at the position from which the forward observer's data leads him to expect to "see" the target. Assuming his expectation is realized and he does "see" the target, then he needs only: (1) verify the missile heading, i.e. recognize check-points in the ground scene, verify the flight path, and apply initial corrections as necessary; (2) navigate the missile, making corrections for e.g., launch errors, crosswinds, etc.; and (3) lock on the target or navigate all the way in.

I have adapted most of the above analysis of a "somewhat hypothetical" example (which is unclassified) for the considerably more extensive and detailed CONFIDENTIAL report of a Working Group of the Armed Forces-NRC Committee on Vision.[2] My purpose is to provide, within the limits permitted by security, a realistic example of the ways in which behavioral science information on human factors can be brought to bear from the earliest concept stages of system design. This brief example by no means exhausts the analytic efforts necessary throughout the development process to assure that the weapon system, when developed, will be "compatible with the abilities and limitations of the men who will operate and maintain it." (AR 70-8 and AR 602-1.)

There was a time, and that not long ago, when many naively thought that we could study the human factors in system performance only after the system was designed and built. It is probably fair to say that our earlier modern approaches to behavioral science in system design primarily involved such after-the-fact design modifications and retrofits. These were not uncommonly called for when the system as realized failed to perform up to presumed theoretical expectations. It cannot be denied that such work can produce useful results, though at greater than optimum cost.

The important thing about the above "somewhat hypothetical" example, however, is that certainly not I nor the Armed Forces-National Research Vision Committee, and probably not you nor anyone else in the world to date, has ever seen the weapon system here referred to. No such system has, to this date, ever been built. Yet is is a certainty that the successful development of such a system must depend either on incredibly good luck or else on careful behavioral science consideration of such human factors as our example illustrates.

AVAILABLE DATA AND FUTURE BEHAVIORAL SCIENCE REQUIREMENTS

Assuming that our incomplete example demonstrates the feasibility and advisability of bringing behavioral science information to bear throughout all stages of system design, what kinds of available data and future behavioral science research may be necessary to round out the picture more fully? What should we have in our data bank? The above cited study by J. W. Gebhard and his AF-NRC Committee Working Group provides, in a number of UNCLASSIFIED paragraphs, useful guidance for answers to such questions as the following:

Question A: Which of the skills

needed by the forward observer and the missile controller can be identified at this early date in such manner that the Army's systems for personnel selection, accession, and distribution can best prepare to fill these positions?

Answer: HumRRO studies[3] have identified direction estimation and terrain contour visualization as critical skills for land navigation on the surface, and have also shown[4] that these skills improve markedly with appropriate training. Part of the problem of communication between the forward observer and the controller concerns adequate briefing and the use of satisfactory maps or photographs of the operational area, and standardized procedures and practice flights will almost certainly be required.[5,6,7,8,9] A study done for ONR[10] has shown that subjects trained in the perspective geometry of movement on television screens located more targets (81% as contrasted with 68%) and located them 3.6 sec. faster than without this training. Thus it appears that trainable and measurable skills of direction estimation, terrain contour visualization and perspective geometry familiarization will be important. In consonance with these studies and other information the Army has already issued a series of training manuals for aerial observers.[11] These could quite probably furnish a basic pattern for the development of selection criteria and training procedures for the forward observer and the controller in the future system.

Question B: What are the major parameters of human target-perception which must be taken into account in drafting design specifications for the future system?

Answer: The problem of visual perception in CR tube imagery involves, as indicated, personnel selection, training, and briefing procedures. It also involves such external variables as target size and shape, contrast and the nature of the surround, atmospheric effects. And finally it involves a large number of characteristics internal to the system under design, such as field-of-view, magnification, resolution, contrast rendition, and many others. Although some studies do exist which treat several of these variables simultaneously, it is a practical impossibility to design a single study which would experimentally control and measure them all. The recommended development program approach in the face of this difficulty is first to define, with increasing precision as the development program progresses, each of the human tasks in the future system, and then to select and treat those variables in simulations or mock-ups and field experiments designed as valid analogues of the operational context of the system's employment.

Points of departure are exemplified by a number of studies already in the literature:

An earlier US Army Behavioral Science Research Laboratory study[12] showed that there was no difference in interpreter performance when vertical views, oblique views, or combinations of these were presented. However, more recent work at the same laboratory[13] has shown that "vertical photos were better for the identification of objects with major dimensions in the horizontal plane, oblique photos for objects with major dimensions in the vertical plane." Moreover, it appears that oblique views are superior to vertical for detecting objects in the background of the scene. A 1959 HumRRO field study of target identification by direct observation from aircraft showed a 30° slant-range angle to be consistently, though only slightly, superior to a 60° angle for both experienced and inexperienced observers. These BESRL and HumRRO findings have obvious relevance to specification of design parameters for a system which will normally be expected to give an oblique view of the target area.

While target size is an obviously important factor, it is difficult to extrapolate from laboratory data on visual acuity to airborne search for tank-sized targets. Six studies cited by Gebhard[2] give mean probabilities of recognition ranging from .74 at 610 meters distance when the visual angle subtended at the eye by a 6-meter target is approximately 34 minutes, to .50 and .60 at 1600 and 2100 meters distance when the visual angle subtended at the eye is 9 to 12 minutes.

Just as the above data give rational points of departure for design studies of slant-range angle and target size parameters, Gebhard's working group study[2] similarly gives suggested points of departure for contrast, target shape, and a number of other system parameters which will affect the performance of the manned future system.

SUMMARY AND CONCLUSIONS

In summary, the somewhat hypothetical example which I have described here clearly demonstrates two important characteristics of manpower considerations in the development process that are of major significance both to the user of weapons and to the behavioral scientist who must participate in the development of such systems:

a. The process of development of materiel systems is amenable, from its first beginnings, to the active and rational consideration of human factors in system performance; and

b. A data bank of relevant behavioral science information can be assembled, and requires continuous refreshment from new researches, to support manpower considerations in the development process.

REFERENCES

1. Heiman, Grover (Assoc. Ed.), "Wire Guided Missiles Challenge Armored Forces of the Seventies." Armed Forces Management, September 1968, pages 50-51.

2. Findley, D. C., Roach, E.G., and Cogan, E.A., "Identification of the Important Skills in Daylight Land Navigation." US Army Armor Human Research Unit, Fort Knox, Ky. HumRRO TR 40, July 1957.

3. Powers, T.R., "Advanced Land Navigation: Development and Evaluation of a Prototype Program of Instruction." US Army Infantry Human Research Unit, Fort Benning, Ga. HumRRO TR 89, April 1964.

4. Dawkins, P.B. "Programmed Instruction and Low Altitude Aerial Observation." US Army Aviation Human Research Unit, Fort Rucker, Ala. Research Report 14, December 1964.

5. Hesson, J.M. and Thomas, F.H., "Training Materials for Aerial Observer Instruction in Basic Visual Skills." US Army Aviation Human Research Unit, Fort Rucker, Alabama. HumRRO TR 80 Supplement, October 1962.

6. Simons, J., "Low-Altitude RECCE/STRIKE Techniques, Problems." Air Force Systems Command, WPAFB, Dayton, Ohio, ASK-TR-67-17, December 1967.

7. Thomas, F.H., "Low-Altitude Aerial Observation: An Experimental Course of Instruction." US Army Aviation Human Research Unit, Fort Rucker, Ala. HumRRO TR-80, October 1962.

8. Thomas, F.H. and Caro, P.W., "Training Research on Low-Altitude Visual Aerial Observation: A Description of Five Field Experiments." US Army Aviation Human Research Unit, Fort Rucker, Ala., RM-8, July 1962.

9. Hagen, W.C., Larue, M.A. and Ozkaptan, H., "Effect of Perspective Geometry Training on Target Area Location." The Martin-Marietta Corporation, Orlando, Florida. OR-8528, October 1966.

10. "Aerial Observer Programmed Text." Department of the Army, Washington, D.C. US Army TM 1-380-1 Through 1-380-6, October 1966.

11. Sadacca, R., Martinekh, H., and Schartz, A.E., "Human Factors Studies Task: Status Report." US Army Personnel Research Office, Washington, D.C. Tech. Resch. Rept 1129, June 1962.

12. Birnbaum, A.H., "Exploratory Study in Interpretation of Vertical and High Oblique Photographs." US Army Personnel Research Office, Washington, D C Tech. Resch. Note 174, June 1966.

13. Whittenberg, J.A , Schreiber A.L., and Richards, B.F., "A Field Test of Visual Detection and Identification for Real and Dummy Targets." US Army Aviation Human-Research Unit, Fort Rucker, Alabama, H5R-TN-59/3-Ce, April 1959.

SESSION 2
HUMAN FACTORS PLANNING RESPONSIBILITIES OF USER AND DEVELOPMENT AGENCIES

General Chairman: Vincent J. McManus, Colonel, USA
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2A. CDC CONSIDERATIONS OF HUMAN FACTORS IN THE COMBAT DEVELOPMENTS PROCESS

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INTRODUCTION

At last year's conference, Mr. Seymour Goldberg of CDC discussed with you the mission, role and organization of the Combat Developments Command and the general relationship between what CDC does and Human Factors Engineering.

Today -- I want to expand upon this relationship and to discuss a reorientation in CDC's thinking with respect to human factors, or behavioral science.

REVIEW OF CDC's MISSION

Perhaps you will recall that the objective of CDC is to provide answers for three basic questions -- now and for periods in the future.

These questions are:

HOW SHOULD THE ARMY FIGHT?
HOW SHOULD THE ARMY BE EQUIPPED?
HOW SHOULD THE ARMY BE ORGANIZED?

The answers to these questions are reflected in the "Products" of the Combat Developments Process (Fig. 1).

The basic products of CDC are studies which address coordinated and integrated answers to each of the three questions for the current time frame and for periods in the future. Studies concerned with future periods are known by the time frames they represent, e.g., Army-70, TASTA-70, CAAS-75, Army-85, and Land Combat System Study-90. The CDC study effort for a single future time period, e.g., 1975 to 1985, consists of three types of studies which differ in degree of specificity and by the order in which they are prepared. The first study is the concept study which addresses answers to the three questions in broad general conceptual terms. The doctrine study covers the answers in more detail and is addressed to combined arms and support aspects of tactical operations. A number of derivative studies, normally one for each arm and service, are then prepared to support the doctrine study.

As output from studies --

--Doctrine, or answers to: How the Army Should Fight?, is provided in Field Manuals developed by CDC.

--Materiel requirements are identified as part of the overall development process. Documents identifying materiel requirements, i.e., QMDO, QMR, SDR, may be derived from the concept, doctrine, or derivative study efforts.

--Answers to the question: How Should the Army be Organized?, are reflected in TOE prepared by CDC. The TOE specifies the units in terms of personnel and equipment necessary to perform given missions according to established doctrine.

CDC's concern and effort in connection with Human Factors has centered largely in the materiel area -- that is as part of the QMDO -- QMR (SDR) Process to recognize Human Factors requirements in materiel development. Or stated another way, we are concerned with the adjustments in materiel design necessary to meet the capabilities and limitations of man.

Additionally, we are concerned at the other end of the materiel development cycle with Qualitative and Quantatitive Personnel Requirements Information or the QQPRI. Or stated another way, we are concerned with the adjustment in human capabilities necessary to meet the requirements of materiel design.

Our concern is generally in accord with responsibilities specified for CDC in AR 602-1 (Fig. 2).

REORIENTATION IN CDC's THINKING

Consideration of Human Factors Engineering in doctrine implies a concern beyond that represented in materiel development.

CDC's reorientation in connection with human factors is largely a matter of emphasis. Where we now answer questions (such as in specifying human factors characteristics for materiel development) we would seek to ask more questions -- and we would ask them of you. Human Factors -- or in a broader sense -- Behavioral Science -- must become more closely associated with the Combat Developments Process.

This association must begin in finding better answers to the first question: HOW SHOULD THE ARMY FIGHT?

Central to this question (and even more basic) is the question: What should the role of man in warfare be?

The answer to the question: How-The-Army-Should-Fight has taken the form of tactics -- tactics which grow out of the roles of man and materiel in warfare.

Historically, however, tactical developments have been based mainly on materield developments which have resulted in extensions of man's own inherent capabilities --

--in Firepower
--in Mobility and
--in Communication

But in reality -- the role of man in warfare has not changed materially in two thousand years.

From the Greek soldier armed with a thrusting spear organized in a phlanx --

To the Roman soldier armed with two throwing spears organized in a legion --

To the American soldier armed with an M-16 organized in a squad --

His role is essentially the same.

Even if one examines the science-fiction writers' visualizations of the future -- take for example the TV series: Star Trek -- you note exotic materiel--in firepower--in mobility and--in communications. But the role of man is much the same as today. This reflects the truth that it is a great deal easier to change the physical world than it is to change the psychological and sociological world, even to envision its change.

But in warfare, man manager man and man managers materiel and for the future we must find and examine alternative answers to the question: What should be the role of man in warfare?

To answer this question -- CDC must first ask you -- the Behavioral Science Research Community -- a number of questions.

In fact we must create a continuous dialogue throughout the Combat Developments Process.

The idea of continuous dialogue between the combat development process and the Behavioral Science Research Community can be illustrated by the use of a slide rule (See Figure 3). The slide represents the Behavioral Science Research Community and the base represents the combat developments process. The groove along and between the slide and the base illustrates the continuous interface which must exist between the Behavioral Science Research Community and the combat development process. The variable positions of the slide with respect to the base illustrate the idea of there not being necessarily a fixed or precise input-output relationship, but rather a continuous interchange of mutual interest, direction and support. The positions reflected in Figure 3 depict the idea of dialogue for mutual support. For any time frame of the future, CDC first develops a concept study which sets forth in very broad conceptual terms how the Army will fight, be equipped, and be organized.

As part of the concept study and basic to the question: How-the-Army-Should-Fight?, CDC must address what will be the role of man in warfare. But to answer this question meaningfully, we must ask what man in the future period will be like. For answers to this question we would turn to the Behavioral Science Research Community for an Environmental Forecast which would develop and support in detail what man in a future period, e.g., 1985, will be like psychologically, sociologically and politically -- what will be his capabilities and limitations. Additionally we must know what are the implications to the Army of man's forecasted limitations and capabilities. Such an enlightened technical forecast would permit CDC to address the concept of man's role in war, in terms of philosophy of command and organization and the man-man and man-materiel concepts for a future land combat system.

The concept study provides not only guidance and concepts for the doctrine and derivative study efforts, but would also provide direction and approach for basic and applied behavioral science research.

The results of the question and answer dialogue reflected in the concept study would prompt formulation of more detailed questions for answer during the development of the doctrine study. In order to flesh-out the concept, the doctrine study will be concerned with the role of man in combat, in combined arms operations and in support. Questions

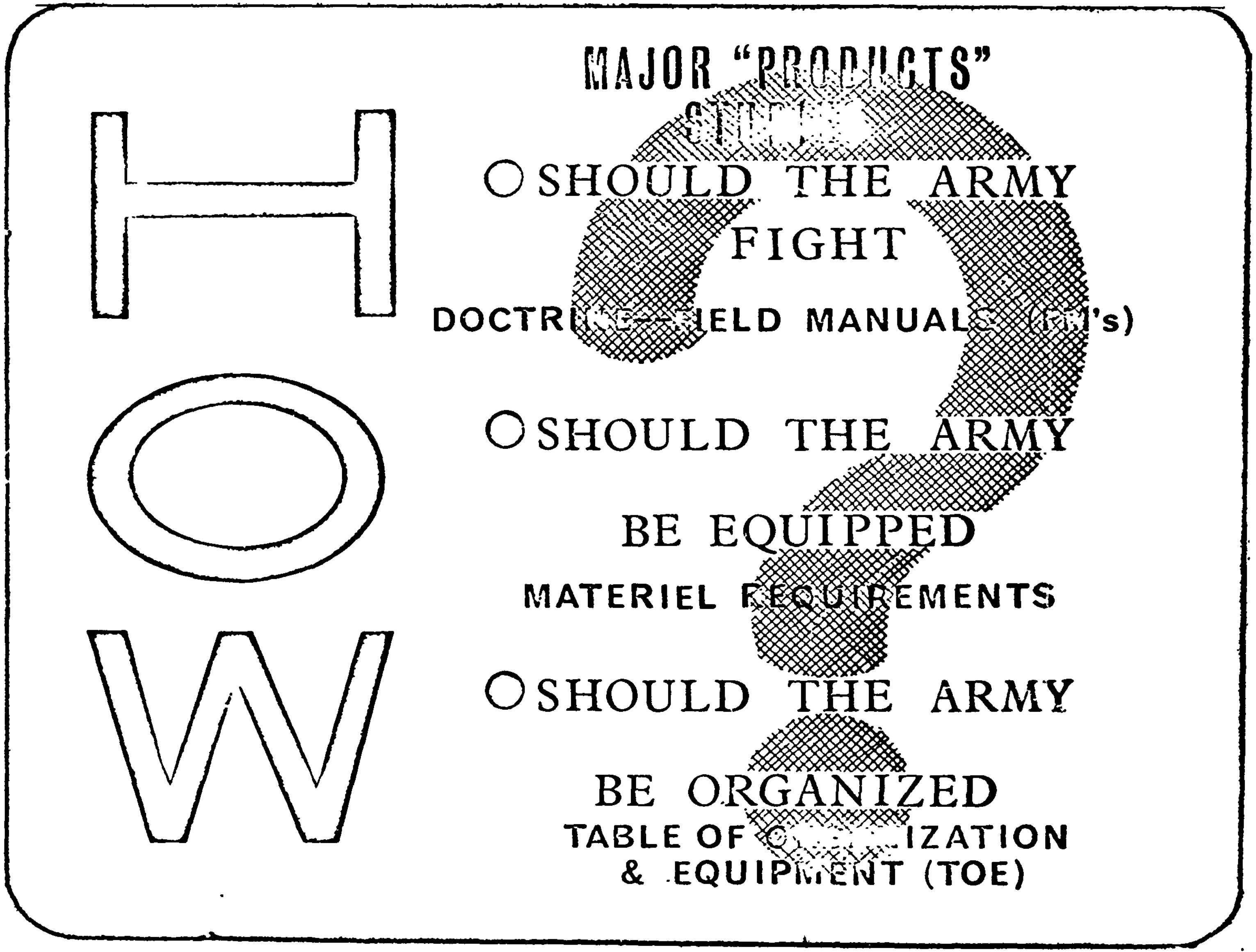
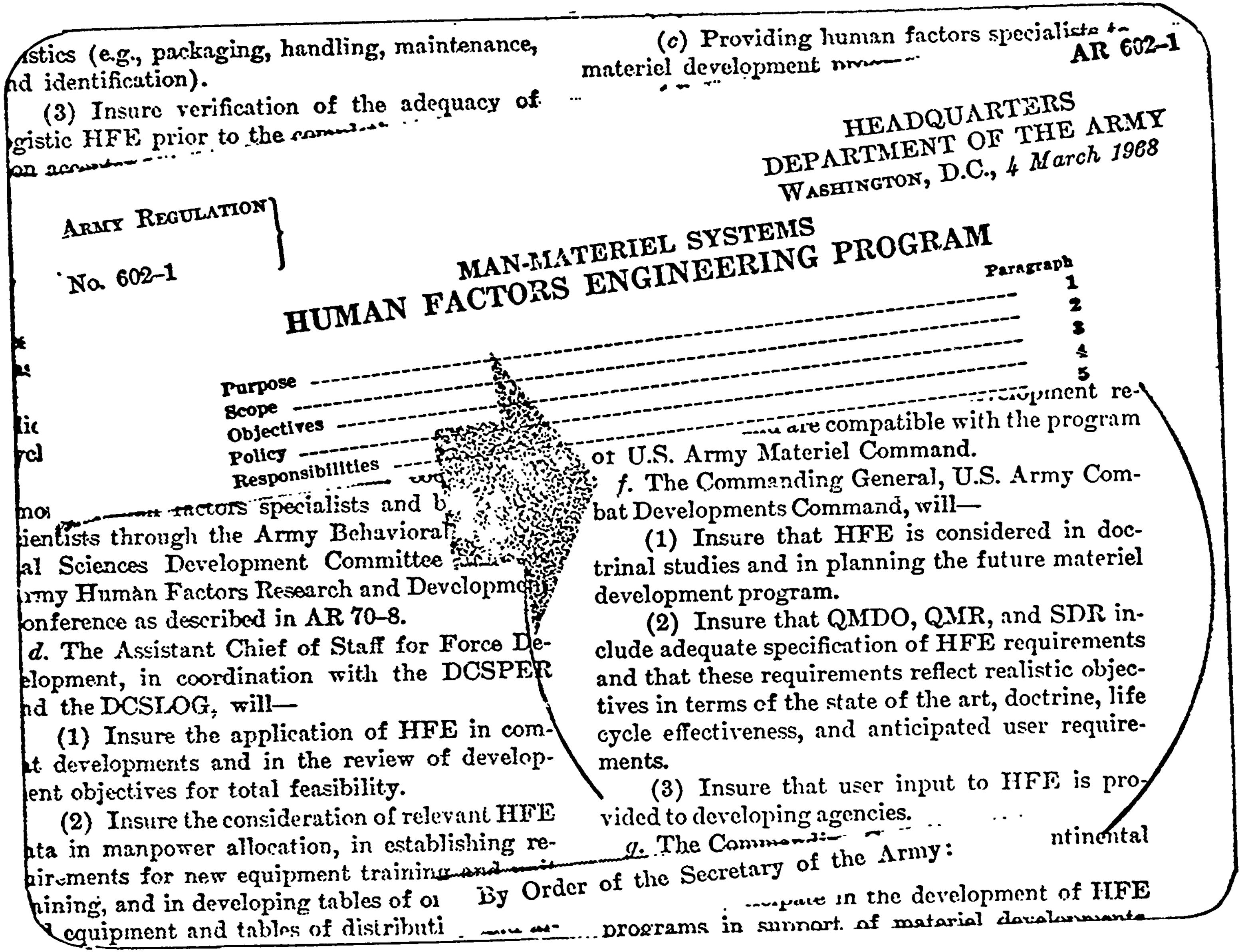


Figure 1.

333-404 O-69—4



AR 602-1
HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 4 March 1968
ARMY REGULATION
No. 602-1
MAN-MATERIEL SYSTEMS
HUMAN FACTORS ENGINEERING PROGRAM
Paragraph
Purpose 1
Scope 2
Objectives 3
Policy 4
Responsibilities 5
stics (e.g., packaging, handling, maintenance,
nd identification).
(3) Insure verification of the adequacy of
gistic HFE prior to the
(c) Providing human factors specialists
materiel development
factors specialists and b
ientists through the Army Behavioral
al Sciences Development Committee
rmy Human Factors Research and Developm
onference as described in AR 70-8.
d. The Assistant Chief of Staff for Force De-
elopment, in coordination with the DCSPER
nd the DCSLOG, will—
(1) Insure the application of HFE in com-
t developments and in the review of develop-
ent objectives for total feasibility.
(2) Insure the consideration of relevant HFE
ta in manpower allocation, in establishing re-
irements for new equipment training
ining, and in developing tables of o
equipment and tables of distributi
are compatible with the program
of U.S. Army Materiel Command.
f. The Commanding General, U.S. Army Com-
bat Developments Command, will—
(1) Insure that HFE is considered in doc-
trinal studies and in planning the future materiel
development program.
(2) Insure that QMDO, QMR, and SDR in-
clude adequate specification of HFE requirements
and that these requirements reflect realistic objec-
tives in terms of the state of the art, doctrine, life
cycle effectiveness, and anticipated user require-
ments.
(3) Insure that user input to HFE is pro-
vided to developing agencies.
g. The Comm
ntinental
in the development of HFE
programs in support of materiel developments
By Order of the Secretary of the Army:

Figure 2.

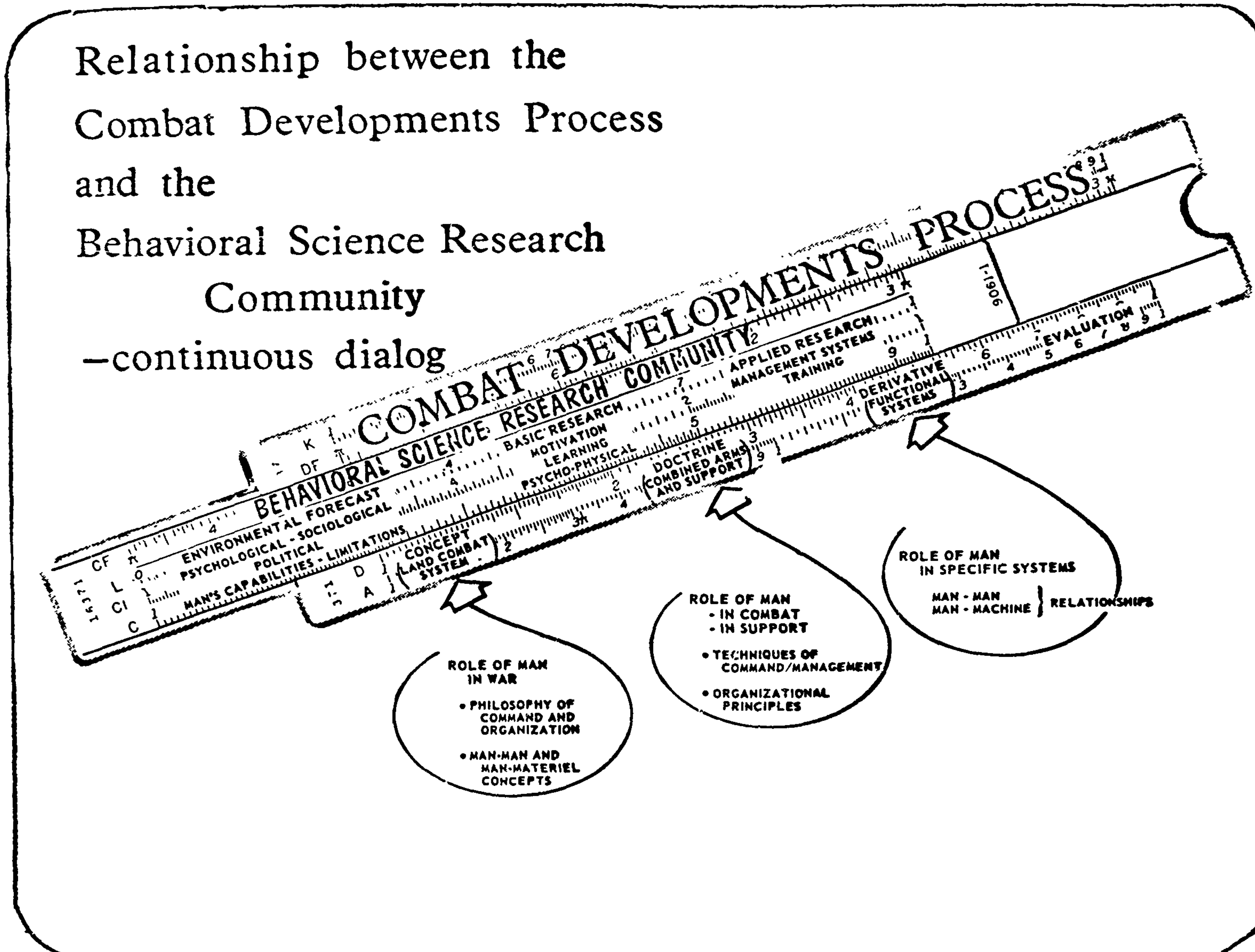

Relationship between the
Combat Developments Process
and the
Behavioral Science Research
Community
—continuous dialog
COMBAT DEVELOPMENTS PROCESS
BEHAVIORAL SCIENCE RESEARCH COMMUNITY
FORECAST
ENVIRONMENTAL - SOCIOLOGICAL
PSYCHOLOGICAL - POLITICAL
MAN'S CAPABILITIES - LIMITATIONS
CONCEPT
LAND COMBAT SYSTEM
BASIC RESEARCH
MOTIVATION
LEARNING
PSYCHO-PHYSICAL
DOCTRINE
COMBINED ARMS AND SUPPORT
APPLIED RESEARCH
MANAGEMENT SYSTEMS
TRAINING
DERIVATIVE
FUNCTIONAL SYSTEMS
EVALUATION
ROLE OF MAN IN WAR
• PHILOSOPHY OF COMMAND AND ORGANIZATION
• MAN-MAN AND MAN-MATERIEL CONCEPTS
ROLE OF MAN
• IN COMBAT
• IN SUPPORT
• TECHNIQUES OF COMMAND/MANAGEMENT
• ORGANIZATIONAL PRINCIPLES
ROLE OF MAN IN SPECIFIC SYSTEMS
MAN - MAN
MAN - MACHINE
RELATIONSHIPS

Figure 3.

appropriate to research in motivation, learning, psychophysical capabilities and limitations of man, etc., would be appropriate for this study phase in order to develop techniques of command and management and organizational principles appropriate for the future period.

The doctrine study would provide direction and approach both for the supporting derivative studies as well as for further research. Derivative studies would address the role of man in specific systems and the development of these studies would pose even more specific questions for research, with emphasis on applied research. Derivative studies which address how each arm or service supports the doctrine study will be concerned with man-man and man-machine relationships in terms of separate systems, e.g., infantry system, maintenance system, air defense system, etc. Research necessary to answer questions for derivative studies would concern management systems, training, and similar subjects.

As the evaluation phase was approached, the slide would move to permit participation by the Behavioral Science Research Community in the evaluation process in order to validate previous research and to develop information for future periods as the process begins a new cycle.

CONCLUSION

Reorientation in CDC's thinking involves an expansion of our consideration of Human Factors Engineering or Behavioral Science throughout the combat development process. We will continue to be concerned with Human Factors in materiel development as we have in the past.

We propose to create a continuous dialogue with the Behavioral Science Research Community and as a result of this dialogue and its incorporation into the combat developments process to provide direction and approach for Behavioral Science Research.

2B. U.S. ARMY MATERIEL COMMAND PLAN FOR IMPLEMENTATION OF AR 602-1

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Embodied within this paper is a draft Army Materiel Command Regulation titled "AMC Human Factors Engineering Program." It clearly delineates the scope, purpose, objectives assignment of specific organization responsibilities, and concept of operation of the AMCHFE Program. The regulation also refers to an AMC HFE Guide titled "Manpower Resources Integration Guide for Army Materiel Development Programs."

The actual presentation consisted of a discussion of the important aspects of the AMC HFE Regulation and the Guide. Especially emphasized, was the specific in-put requirements which will be levied on all other non-AMC Army agencies as part of the attempt to integrate all manpower characteristics into AMC materiel development programs as prescribed in AR 602-1.

AMC HUMAN FACTORS ENGINEERING PROGRAM

Paragraph

1. Purpose. This regulation prescribes the U. S. Army Materiel Command (AMC) human factors engineering (HFE) program, identifies the key elements thereof, and assigns authorities and responsibilities for its promulgation.

2. Scope. This regulation applies to Headquarters, AMC; the Human Engineering Laboratories, Aberdeen Proving Ground, Maryland; AMC major subordinate commands (including subordinate installations and activities), weapon system R&D centers, project managers; and separate installations and activities reporting directly to Headquarters, AMC.

3. Definition. For the purpose of this regulation, the following definition applies:

Human Factors Engineering is defined in AR 602-1, dated 4 March 1968, as a comprehensive technical effort to integrate all manpower characteristics (personnel skills, training implications, behavioral reactions, human performance, anthropometric data, and biomedical factors) into all Army systems.

4. General. a. The AMC human factors engineering program begins with human factors research of both basic and applied nature, extends through participation in system analysis studies and preparation of qualitative materiel requirements (QMR), small development requirements (SDR), or other research and development project authority document; progresses through design, testing, production, use and reconditioning phases; and ends only when the item is dropped from the supply system.

b. Human factors engineering includes--

(1) That part of system analysis that determines man's role in a man-materiel system.

(2) Selection, definition, and development of man-materiel interface characteristics, workspace layout and work environment conducive to effective and efficient performance under expected use conditions.

(3) Determining the needs for, and then developing and evaluating job procedures, performance aids, and training devices, aids, equipment, and publications.

(4) Providing basic man-machine task sequence data used to describe, develop, and assess the feasibility of the human performance required in a man-materiel system.

(5) Developing equipment which permits effective man-equipment interaction under special limitations in the training time, aptitudes, skills, or physical standards.

(6) Determining number and kinds of military and civilian personnel needed in a man-materiel system for cost effectiveness analyses when evaluating various design concepts and for subsequent personnel planning, and providing the data needed for modifying current MOS or establishing new MOS required by new equipment, doctrine, or organization.

(7) Assessing the training burden which competing materiel design concepts may impose on the Army.

(8) Developing the information needed for new or revised training plans, courses, or programs of instruction as required by new or modified materiel, doctrine, or organization.

(9) Assessing HFE as described above by evaluating the man-equipment combination.

5. Objectives.

The AMC human factors engineering program has as its objectives:

a. The integration of human performance into system design to achieve the most effective, efficient, and reliable man-equipment combination under use conditions.

b. To insure that materiel is developed so that the human tasks involved in operating, maintaining, and supplying the Army's equipment and weapons do not exceed the capabilities of the manpower resources available to the Army.

c. To insure that training on specific equipment is feasible, effective, sufficient, necessary, and integrated into the Army training program.

d. To improve control of total life cycle costs of man-materiel systems by assuring consideration, early in the materiel life cycle, of the cost of manpower resources and training for alternative systems.

e. To reduce skill levels, training, and manpower required by equipment.

f. To develop human performance data, integrate it with system performance data, determine new performance requirements, evaluate personnel feasibility, and provide for the timely development of the necessary trained manpower resources.

g. To insure that systems safety engineering is considered.

h. To provide data for the development of technical manuals, training manuals, field manuals, and other technical publications and insure that the use of these publications does not require aptitudes, education, or training beyond that required to perform the tasks they describe.

i. To apply HFE concepts and current education technology to design and development of training devices.

6. Assignment of Responsibilities.

a. The Director of Development and Engineering is responsible for the staff supervision and coordination of that portion of the AMC HFE program pertaining to the integration of manpower characteristics into materiel development. In addition, he is responsible for:

(1) Developing and promulgating AMC policies concerning manpower characteristic integration into materiel development starting with draft QMR's and SDR's and continuing through the entire item life cycle.

(2) Responsible for development of coordinated policies and procedures for the systematic interchange of information among AMC, DCSPER, USCONARC, OPO, and CDC concerning the HFE program associated with materiel development as described in AR 602-1, dated 4 March 68.

b. The Director of Personnel and Training, AMC will exercise staff supervision over that portion of the AMC HFE program pertaining to manpower characteristics integration insofar as future military training implications and development of training devices and materiel are concerned.

c. Project Managers established by the Commanding General, AMC are responsible for tasking the Human Engineering Laboratories or subordinate command HFE units for HFE support as described in AR 602-1, dated 4 Mar 68, and AR 70-17, dated 19 Jan 68.

d. The Human Engineering Laboratories, Aberdeen Proving Ground, Md. are assigned the following mission and functions:

(1) Serves as the AMC field coordinating agency to assure the complete integration of all manpower characteristics (personnel skills, training implications, behavioral reactions, human performance, anthropometric data, and biomedical factors) into all AMC materiel development programs.

(2) Develops HFE guides, standards, procedures, and specifications and provides technical coordination in the field of human factors engineering as required in AR 602-1, dated 4 March 1968.

(3) Assures that AMC materiel evolved conforms with the capabilities and limitations of the fully equipped soldier to operate and maintain the materiel in its operational environment consistent with tactical requirements and logistic capabilities.

(4). Provides human factors specialists support to Project Managers as required in AR 70-17, dated 19 January 1968, and AR 602-1, dated 4 Mar 68.

(5) Conducts basic research, human factors research and engineering, methodological research in order to derive data and new methods necessary for effective integration of all manpower characteristics into materiel development.

(6) Obtains human factors support from other Army agencies such as OPO, DCSPER, CDC, USCONARC, OTSG, OCRD, DCSLOG, ACSFOR, etc., insofar as inputs from these agencies into AMC materiel development programs are concerned.

(7) Participates in all in-process reviews conducted by AMC development agencies and project managers.

(8) Maintains liaison with Department of Defense and other Department of Army human factors research and engineering agencies.

(9) Maintains long-range basic research and human factors engineering research programs related to future Army weapon systems and devices as approved by the Deputy for Research and Laboratories, AMC.

(10) Provides human factors engineering training for all Army agencies and Project Managers.

(11) Establishes and operates a manpower characteristics data bank which is responsive to changing AMC materiel development needs.

(12) Reviews all QMDO's and QMR's being staffed by the AMC and provides appropriate comments on the human factors aspects involved.

(13) Performs such special duties as directed by the Deputy for Research and Laboratories, AMC.

e. The Commander of each major AMC subordinate command and weapon system R&D Center is responsible, in the execution of his mission, for assuring that the materiel evolved during the concept, development, design, production, and test phases conforms with the capabilities and limitations of the fully equipped soldier to operate and maintain the item in its operational environment consistent with tactical and logistical requirements including the integration of all manpower characteristics into materiel development programs as described in AR 602-1, Man-Materiel Systems, Human Factors Engineering Program.

f. The Commander of each AMC major subordinate command, weapon system R&D Center, and the Commander of Natick Laboratories will establish a human factors engineering element at the staff level of his headquarters and, as desired, at installations and activities reporting directly to him to perform the following functions:

(1) Provide human factors engineering support to project managers and materiel development contractors as described in approved AMC HFE procedures, guides, and standards.

(2) Insure the inclusion of human factors engineering requirements when contracts for materiel are initiated or modified through the utilization of Standards and MIL-H Standards and Specifications, and maintain contact with contractors to insure effective implementation of the AMC human factors engineering program.

(3) Identify the human factors problems as early as possible in the materiel development stages.

(4) Conducts such in-house engineering studies and applied research as are necessary to supply specific human factors engineering data for the prototype systems and components under development or modification. Subordinate command HFE Units will not develop research capabilities which duplicate those available at the Human Engineering Laboratories without prior AMC headquarters approval.

(5) Maintain liaison with the prospective user of each item under development to insure early recognition of operational and maintenance problems. This includes the gathering of information pertinent to the eventual training of operators and maintenance personnel.

(6) Assist in preparing AMC's evaluation plan of materiel insofar as human factors engineering is concerned.

(7) In-Process Reviews. The Human Engineering Laboratories will be invited by AMC subordinate command commanders and R&D Centers to participate in all in-process reviews.

7. Concept of Operation. AMC major subordinate command and weapon system R&D Center HFE elements will provide appropriate human factors input into all locally staffed QMDO's and QMR's as indicated in AR 602-1 and approved AMC HFE procedures and guides. The HFE elements will also provide human factors engineering support to all component materiel development projects being promulgated by the respective major subordinate command or materiel R&D center.

Utilizing an AMC approved Guide, titled "Manpower Resources Integration Guide for Army materiel Development Programs", detailed procedures and methods will be devised to insure the integration of manpower characteristics into all phases of the life cycle of materiel. This AMC Guide presently covers only the development cycle from inception to the point where the first unit is equipped with the item. Human Factors Engineering teams will be formed either at the HEL or at appropriate major subordinate commands, augmented by liaison personnel from other agencies such as USCONARC, DCSPER, CDC, etc., for each project managed item. This will be done at the time the PMO charter is written. In conjunction with the office of the PM, the team will plan the detailed HFE plan for each project utilizing the "Manpower Resources Integration Guide" as a general reference document. Final plans will vary depending on the nature and type of development project involved.

This plan will be included in the System Development Plan (SDP) and Project Master Plan (PMP) as described in AR 70-17, dated 19 January 1968. Manpower resources integration effort will then be provided to the PMO throughout the development phase as specified in these approved plans by the HFE teams. The Project Manager is, as with all other supporting functions, the final authority for execution of all tasks associated with the project.

8. References:

a. AR 602-1, AR 70-17, AR 70-8 and AR 705-5.

b. AMCR 11-16, AMCR 11-26, AMCR 11-27, AMCR 350-6, AMCR 350-12, AMCR 70-5, AMCR 700-15, AMCR 10-4, AMCR 70-1.

2C. USCONARC TRAINING REQUIREMENTS INTERFACE WITH CDC AND AMC IN THE DEVELOPMENT PROCESS

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Fort Monroe, Virginia 22351

Gentlemen:

I will present USCONARC training requirements interface with CDC and AMC - in the sense of human factors planning responsibilities of trainer/user during the life cycle of the development process.

DEVELOPMENT PROCESS

The development process has been ably and lucidly described by Mr. M. S. Baird, Jr., USACDC, during his presentation, "CDC Considerations of Human Factors in the Combat Development Process", and Dr. J. D. Weisz, USAMC, when he portrayed "US Army Materiel Command Plan for Implementation of AR 602-1 (Human Factors Engineering Program)".

Both presentations brought out - at long last - that human factors will influence not only the utility development of equipment and weapons systems, but will significantly impress the very concept formulation.

From the USCONARC point of view, a major breakthrough has in fact occurred - for it is in the earliest stages of the development of any system when thoughts of training and training preparations must begin - to achieve the least costly, most effective, and timely training program, and the most usable and supportable from the soldiers' viewpoints.

INTERFACE WITH CDC AND AMC

As part of the conference proceedings, you will receive a commentary describing in detail the various instances during the management of the development cycle when USCONARC interfaces, not only with AMC and CDC, but DA as well. Thus - my presentation will disclose some of the influences which provide the basis for USCONARC considerations during the development process.

Probably the most significant of the interfacings occur during the five or six Systems Status Evaluations (SSE), for these are the major decision points in the life cycle of the development when intelligent anticipation and knowledgeable objectivity will exert maximum influence.

Prior to the conduct of each Systems Status Evaluation, USCONARC evaluates and assesses development accomplishments in all areas affecting personnel and training, from the standpoint of timeliness and adequacy. The position thus developed is presented at the Systems Status Evaluation proceedings.

In the past, such influence by USCONARC was expressed only on invitation by some astute developer, but only infrequently. Examples exist today to indict such casual consideration of human factors in the development of new hardware. For example - during the development of the M60 Tank, HumRRO (Human Resources Research Office) Division

Number 2 at Fort Knox was asked by the Armor School to conduct a human factors analysis for the troop test, which was being conducted during the first production run. The results of this analysis indicated over 150 deficiencies; 64 were so serious that they led to an immediate re-engineering and retrofit.

In other words - what are USCONARC's human factors planning responsibilities in the development process?

Stated briefly - USCONARC human factors planning responsibilities are that of trainer/user.

In amplification, USCONARC participates in combat developments and materiel developments which concern individual and unit training - and provides advice and assistance and direct support to the Commanding Generals of the United States Materiel Command and United States Combat Developments Command in these areas. This includes relevant participation in formulation and review of doctrinal and organizational matters, materiel objectives and requirements, review of materiel test and evaluation plans and reports, "in-process" reviews, systems status evaluations, and support of confirmatory and troop tests.

We may say, then, that the role of USCONARC as trainer/user during the course of interface with AMC and CDC is that of human performance development - the objective of which is to promote the acquisition of equipment/weapons/systems that can be effectively operated, maintained, and supported by, readily trainable average troops.

With this objective in mind, what are some of the elements that comprise the human performance development of the training concept?

Let's take, for example, the "United States Approach to Training System Development for the Main Battle Tank-1970" as reported by Dr. D. F. Haggard, Director of Research, HumRRO Division Number 1 (Armor), Fort Knox, Kentucky. What I have to say about the MBT-70 program may serve as a brief prelude to more detailed coverage by the Project Manager's staff of the Automotive/Tank Command during Session IV, Thursday.

HUMAN FACTORS DATA BASE

The initial objective of human performance development is to obtain a human factors data base (see Figure 1).

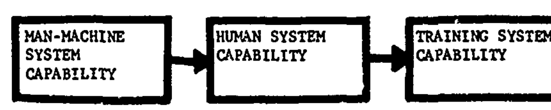

Figure 1. Analyses for Obtaining a Human Factors Data Base.

Man-Machine System Analysis

A man-machine system analysis determines whether the design and location of equipment components allows the human operator to perform the job tasks required.

Human System Analysis

A human system analysis determines whether the task can be performed by an experienced skilled man at the standard of speed, accuracy and reliability that is required.

Training System Analysis

A training system analysis determines whether we can train an initially inexperienced, low skill man to perform the task to this same standard within the administrative limitations of training time and cost.

From this brief description of the human factors cycle emerges two information requirements common to all activities (see Figure 2).

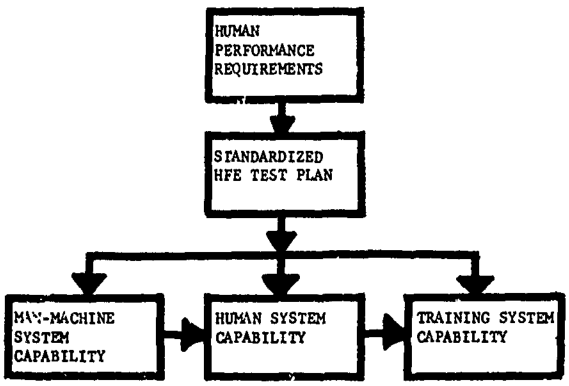

Figure 2. Information Requirements.

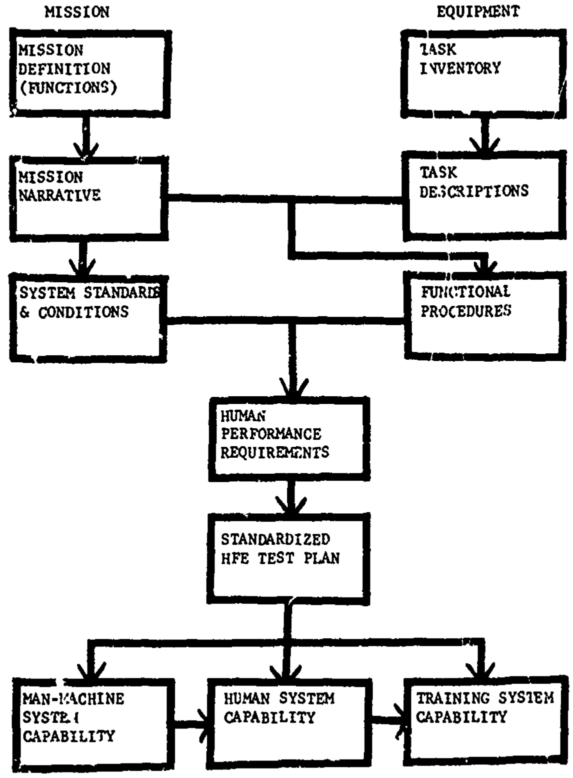

Figure 3. Human Factors Data Base.

Human Performance Requirements

These requirements are derived from statements of the tasks that must be performed by the crew and mechanic, the conditions under which these tasks will be performed, and the standards for man-machine system performance that are imposed by the tactics proposed.

Standardized Human Factors Test Plan

If the results of investigations are to be useful in later phases of the cycle, they must be based on common conditions, methods, and measures.

The human performance requirements are derived from two sources: a Mission Analysis and an Equipment Analysis (see Figure 3).

Mission Analysis

A mission analysis of the tactical plans for the system provides the general functions that will be required; the standards, or minimum levels, of performance; and the environmental conditions related to performance.

Equipment Analysis

An equipment analysis provides the specific job tasks that must be performed by the human in the system, a description of the activities required to complete each task, and the procedures showing relations between tasks and within mission functions.

The mission analysis is based on the expected battlefield day and provides a description of the way in which a single weapon system is to be used. It first specifies the seven general tactical functions that will be required: maintenance, mission preparation, advance guard, defense, offense, retrograde, and revert to reserve. It then specifies twelve weapons system functions that underlie these tactical functions: navigation, tank control, general surveillance, communications, systems monitoring, target evaluation, target data storage, weapons control, target damage assessment, return to readiness, and rendezvous. This tactics and weapons system information is then integrated along the battlefield day time line to provide a definition of overall mission functions.

Next, a detailed elaboration of the mission description; the mission narrative, added the specific environmental conditions that would affect functions at each point along a mission time line. Conditions such as target types and ranges, ambient and artificial illumination prevailing, are examples.

For the information of the conferees, at the present time, the Human Engineering Laboratory is consolidating the mission functions and conditions that are common across this mission time line for the Main Battle Tank-1970.

With regard to the equipment analysis, an equipment-oriented inventory of tasks required for crew operation and maintenance of the equipment must be initiated during the prototype phase. For example, this inventory for the Main Battle Tank-1970 is being periodically updated to keep it current with equipment development; a similar inventory for mechanic tasks is in progress.

The crew tasks are assigned to a crew position, and, within that position, to each of the functional categories that are provided by the mission analysis. From the equipment and information available, a step-by-step description is written of how each task is accomplished. Within each description is included (a) a data source code number which states the source of the information. As the source number increases, then confidence in the accuracy of the information decreases; (b) the task steps are listed in the order in which they would be performed and each step includes the equipment input, the human activity as a response to that input, and the indication results from that activity; (c) finally, any clarifying remarks with regard to that step or task are listed. These include references to similar steps, prerequisite steps, and safety precautions as well as general knowledge that should be considered.

The mission and task analyses are then combined to state the procedures that had to be performed to operate and maintain the equipment system so as to accomplish the mission functions. These functional procedures are stated as performance units and a flow diagram of the order in which the required tasks are to be performed for that unit, is given. For example - as one of the performance units, gunnery is stated as firing the main weapon from the gunner's station (see Figure 4). The flow diagram for this unit gives the tasks that are required, the order in which they are to be performed, and any interaction that occurs between crew members.

PERFORMANCE UNIT -

Firing Main Weapon from Gunner's Station

SYSTEM VARIABLES -

Target Movement, Platform Movement, Terrain, Weather

SYSTEM STANDARDS -

Time, Accuracy, Reliability

PERFORMANCE STANDARDS -

Time, Rate of Response, Sequence Accuracy, Solution Accuracy, Consistency

PERFORMANCE VARIABLES -

Combat Stress, Fatigue, G-Forces

Figure 4. Performance Unit

For each performance unit, lists of conditions, or system variables, are obtained that will affect system performance (e.g., target movement, platform movement, terrain, weather, and other such influences). At the same time, the system standards are obtained that state what level of performance must be attained by the complete man-machine system. This information is collected from available planning and joint requirements documents.

At present, as you know, many of the standards for system performance are not stated in any available document. Nor are many of them recorded for systems now in the field. In addition, the standards available are usually "estimated" or "hoped-for" values. During the process, it may not be possible to factually conclude whether or not it is possible to attain these standards with the equipment that is being built.

For these reasons, most of the standards will have to be determined, or validated, during the development and engineering tests. During these tests, the system capability will have to be determined with the equipment that is provided and using experienced, highly skilled operators and mechanics. That is, what are the upper limits of system performance that can be attained with this equipment?

With the present lack of information on most system performance standards, the major problem is to delimit the performance areas that appear to be the most critical for system functioning.

As these standards are obtained, the human performance requirements for the system can be stated. First, the standards and conditions for each task in the function sequence are laid out. From this information it can be determined where human performance is vital, and what degree of proficiency must be attained with this performance, to determine if the system standard is to be met - and, of course, the related question, "Is the standard/condition set unrealistically too high?" (see Figure 5).

HUMAN PERFORMANCE STANDARD

.81 Missile Hit Probability =
.90 (Equipment Reliability) x X(Gunner Tracking Reliability)

Gunner Tracking Reliability = .90

Figure 5. Human Performance Standard.

For example, let us assume that missile hit probability must be 81 percent. If the tracking equipment reliability is found to be 90 percent, we can state the human performance standard as 90 percent time on target.

In this way, the human performance requirements can be derived for each performance unit. Also, the conditions which may affect, or change, this performance must be determined (see Figure 4) and related to this problem; what changes can be made in the human or equipment systems to lessen, or negate, the effects of these conditions. Here, some of the information should already be available in the research literature or in the experience of the people involved. But again, it is obvious that much additional research will be needed.

This, then, is the status of development of the human performance requirements that will be needed. These human performance requirements will have to be updated somewhat as the equipment and tactical development proceeds. The ever-present problem lies in the area of systems standards and conditions and the variables that will directly affect human performance within this system, and any system.

From the standpoint of USCONARC training requirements, these are the human performance data to be provided by AMC, but influenced by CDC and USCONARC.

With this background, let us explore the development and evaluation of the training system. That is, to examine the concepts (see Figure 6) for training methods and materials that will be needed for developing training programs; for example, the Main Battle Tank-1970.

PURPOSE

Provide	Training Methods Concepts Training Materials Concepts
To	Training Program Developers
For	Operator Training User Maintenance Training

Figure 6 Concepts for Training Methods and Materials

The approach (see Figure 7) is divided into three related phases that parallel the equipment development cycle. If this approach is successful, tested training programs will be available coincident with the requirement to initiate training.

As you can see, much of the task analysis for the Main Battle Tank-1970 has been completed (dark block). This is a provision of the statements of human performance requirements discussed earlier. Most of the actual training research is just beginning. So what follows concerns the procedures and planing for completing this training analysis.

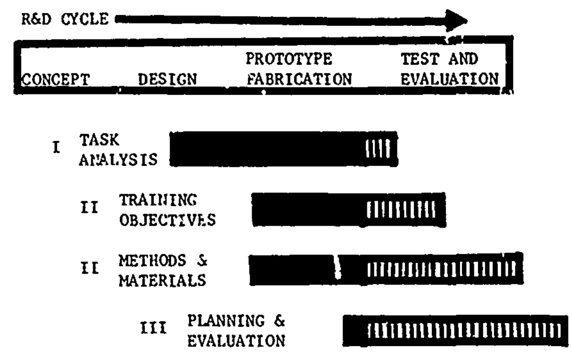

Figure 7. Approach and Schedule

For training, the first concern is with the training objective (see Figure 8). This objective is based on the human performance standard that has been specified by the man-machine system functions and limited by the environmental conditions.

BASIS FOR TRAINING OBJECTIVES

1. Man-Machine System Functions
2. Environmental Conditions
3. Human Performance Standard

Figure 8. Basis for Training Objectives

It is hoped that through training, the human knowledges and skills that are necessary to attain the system standards can be developed. But the part of the standards that will be provided through scheduled training will be further limited by a training concept. The administrative restrictions of the training concept determine how training will be provided, where it will be

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provided, and to what extent it will be provided. A preliminary training concept was developed to guide the research work. This concept assumes that (see Figure 9):

1. Whenever possible, training programs must be integrated for all armor vehicles in the system during the 1970's. This will insure that excessive training time will not accumulate from a series of separate training programs on related items of equipment. This means integrating the requirements for at least the M551 Sheridan and the M60A1E2.

2. Because of the complexity of new equipment, training will have to provide qualification proficiency for crew positions.

3. Due to the new extended-range weapons and nuclear battlefield capabilities and tactics, simulation of targets, terrain, and environmental conditions in training may be required.

TRAINING CONCEPT

1. Integrated Training (M551, M60A1E2)
2. Trainee Qualification
3. Increased Simulation

Figure 9. Training Concept.

Based on the human performance standards and this training concept (see Figure 10), the training objective will be stated, the knowledge and skill requirements for this objective will be analyzed, and the necessary training methods and materials will be selected or developed. The available material has enabled the writing of the training objectives for the functions that appear to be unique to the Main Battle Tank-1970.

Those common to all, or at least several vehicles, and for which common training could be provided (for example, communications procedures or guidance and control equipment tests); those involving common content but differing in the levels of proficiency needed (such as tracking moving targets for conventional or missile firing); and those with only transitional changes (such as tracking with different types of controls or difference sighting systems).

TRAINING ANALYSIS

1. Performance Standard + Training Concept
2. Training Objective
3. Knowledge and Skill Requirements
4. Training Methods and Materials
5. Training [illegible]gram
6. Training T[illegible]t

Figure 10. Training Analysis.

For the common and transitional objectives, studies of training methods, time and materials can be completed with available equipment. A few such studies have already been completed; one for computer training and several for missile firing training. For unique objectives, work will have to be accomplished with simulated equipment and conditions or wait for pilot vehicles. Apparatus is now being constructed to simulate training in discriminating the multiple returns from the laser rangefinder stadia.

Some of the [illegible]k on the Shillelagh missile system illustrates these three steps. The objective for the gunnery function we discussed earlier, firing the main weapon from the gunner's station, is stated at 16.0. One skill enabling the gunner to attain this objective is stated as 16.5. For both, we have specified preliminary training standards. Final standards will be stated once an Army training concept has been adopted.

In analyzing this skill it was determined that gunner tracking proficiency required in missile firing at a moving target must be considered as a sequence of actions. These actions vary in type and in the quality required. This sequence consists of (see Figure 11): (a) the relatively gross track that must be established before firing; (b) firing the weapon; (c) holding the established tracking rate and direction during obscuration; (d) adjustment after obscuration to correct for target directional change and accumulated error in the initial tracking rate; and (e) establishing a smooth and consistent tracking rate until the missile hits the target. From this diagram are defined two tracking requirements.

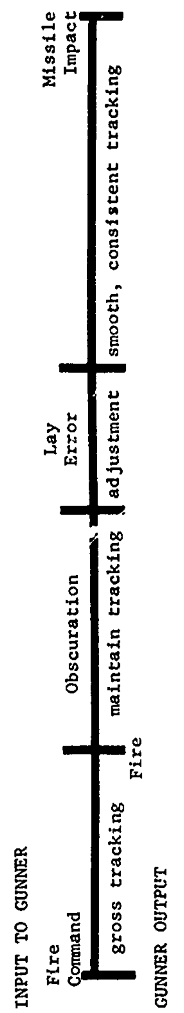

Figure 11. Missile Firing at Moving Target.

The first is to establish a gross rate of tracing before firing and to maintain this rate during obscuration. After obscuration clears, discrepancies between the line-of-sight and the target are noted and the gunner makes an immediate adjustment to bring the sight reticle back onto the target. Considering the relatively long periods of obscuration resulting from firing the Shillelagh missile, and the 1-2 seconds that were found to be required for relaying on the target, this segment of the task would appear to encompass the requirements for engaging short and medium-range targets.

The second tracking requirement occurs after the post-obscuration adjustment, or relay. From this point on, the gunner must maintain the appropriate rate of track, and, as the target range increases, he must become increasingly consistent in maintenance of the rate. This is a finer degree of tracking consistency than that which is required in the first segment and the requirement increases directly with target range. The time period for which this smooth tracking must be maintained depends upon the distance to the target (see Figure 12). The allowable fluctuations in this tracking depend upon the visual angle to the target, i.e., apparent target size, which becomes smaller with increasing target distance. Thus as target range is increased, the requirement for fine tracking skill and for maintaining consistency over long time periods is also increased.

Also, we would expect this latter type of tracking skill to be easily disrupted by sudden or unexpected changes in the environmental conditions. One of these conditions is provided by the missile flare suddenly appearing in the gunner's sight and spiraling around his focal point.

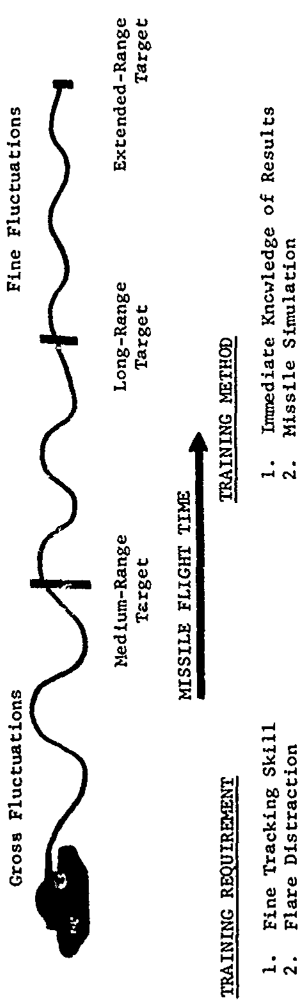

Figure 12. Fire Sequence.

Several earlier studies indicated that the short-range, gross tracking skill was being attained during present training which involves dry-firing and conventional round firing. But fine, continuous tracking skill was not being attained during this type of training. Also, simply warning the gunner to disregard the missile flare was not effective. With respect to this analysis, two probably new training requirements were stated: (a) the need for obtaining very fine tracking skills, and (b) the need for decreasing the distraction from the missile flare.

Some of the problems in using conventional rounds to meet the missile requirement were that conventional round firing allowed the gunner to ambush the target and that it did not give him any knowledge of his tracking performance until round impact. It was proposed that a method be used to give the gunner and instructor a continuous knowledge of tracking accuracy. Also, to provide experience in disregarding the missile flare simulation of the missile flare characteristics was proposed - to use a training device that would also provide a continuous, immediate record of gunner tracking accuracy.

To test this training device method, reference was made to the performance standard as demonstrated by well-trained experienced gunners and gunners who had attained a very high level of fine tracking skill but who had not previously experienced the missile flare. It was found that two missile firings were required to acquaint the gunner with missile flare distraction effects (see Figure 13).

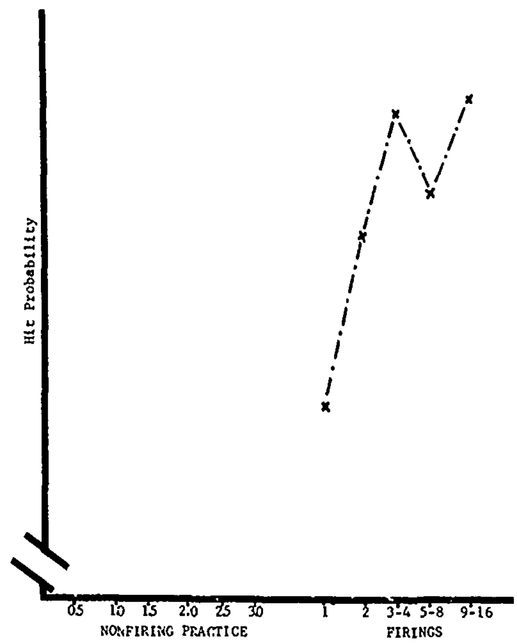

Figure 13. Missile Firing by Experienced Gunners.

After these two firings, the expert gunner was at the performance standard. Next, it was determined that without the training device method, new gunners required three hours of tracking practice and the same two missiles to attain this standard (see Figure 14).

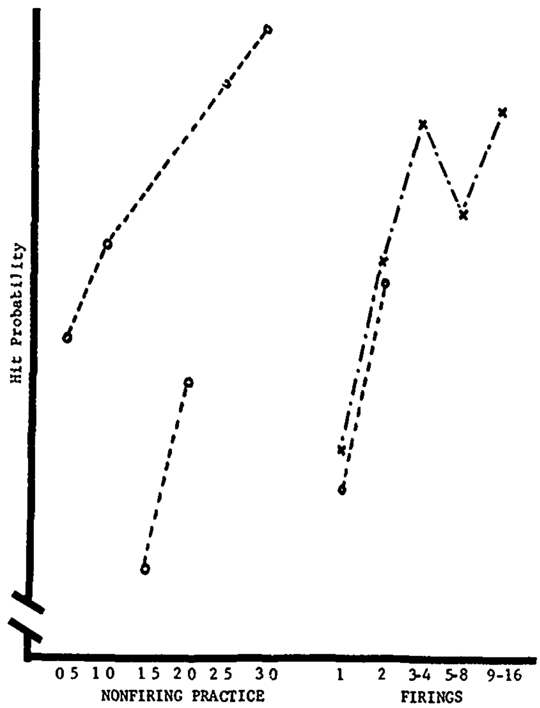

Figure 14. Missile Firing by New Gunners w/o Tng Device

Finally, with the training device, new gunners could develop tracking skill with less practice due to the knowledge of results, and could begin actual missile firing at the standard, due to the missile flare simulation during training (see Figure 15).

This procedure of analyzing the knowledge and skill requirements for each training objective, determining the most efficient training methods for attaining these requirements, and testing the implementation of these methods will be followed for each objective for the Main Battle Tank-1970 (see Figure 11).

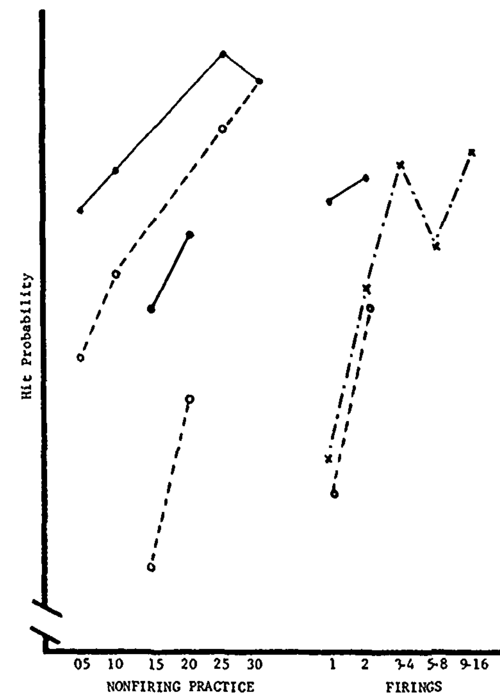

Figure 15. Missile Firing by New Gunners w/Tng Device.

The final phase of this work requires constructing a training program which uses the training methods stipulated and then evaluating the efficiency and effectiveness of this program. Program construction is now being coordinated with the Armor School and they have agreed to conduct an evaluation test with a minimum number of trainees (see Figure 7). Coordinating evaluation of on-the-job training methods is being accomplished using the transition training that will be given to service test personnel at the Armor and Engineer Board. The general plan of evaluation for both is contained in the United States Plan of Test for Service Test of the Main Battle Tank-1970.

The specific procedures and measures that will be used during these evaluations will be based on the standardized test that the Human Engineering Laboratory is developing. Within the requirements for training evaluation, the course, conditions and measures that are being constructed at Aberdeen are being paralleled. This is required to determine the effectiveness of training in relation to the upper level of human capability with this system. This procedure will also allow determination as to where the measured performance of highly qualified test personnel may not give realistic estimates of actual performance in the field. Both comparisons will allow improvement of equipment, training, and tactics.

SUPPLEMENT[1]

INTERRELATIONSHIP - USCONARC AS TRAINER/USER WITH CDC AND AMC

Purpose

This supplement is prepared to support and amplify the oral presentation, "USCONARC Training Requirements Interface with CDC, AMC, and DA Staff".

Background

More than two years ago, the Army initiated an effort to improve procedures, coordination, and management of materiel systems under development. The effort evolved from recognized shortcomings from the Brown Board, SATE Study, the "Committee of Four", and others that pinpointed problems. The Chief of Staff approved many of the recommendations of these studies. As a result, DA has made a complete review of all Army Regulations concerning research and development. This review has caused six new AR's to be written, seven to be revised, and the development of a pamphlet and model entitled "Life Cycle Management".

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1. Less Flow Chart

The Life Cycle Management Model for Army developmental systems illustrates graphically the interrelationship that exists between CDC, AMC, CONARC and DA staffs for a particular system. It identifies and relates key activities in the process, and provides a guide for disciplined project management.

The spread sheet attached (omitted) portrays the interrelationship between CDC, AMC and DA staffs.

The following comments are keyed numerically to the model. The top section shows events which are the responsibility of CDC. The next line down is DA. Next is AMC, and CONARC activities are shown on the bottom line. The entire process is logically divided into four phases:

1. Concept Formulation
2. Contract Definition
3. Development and Production
4. Operations and Disposal

The end of each phase is highlighted by a heavy vertical line. The events for which CONARC is responsible (bottom line) have been outlined, showing as well, AMC, CDC and DA association with CONARC activities. The five major decision points - systems status evaluations - are highlighted by heavier shading.

The following briefly takes you through the chart, concentrating on issues of CONARC interest. Numbers identified with ( ) refer to like indications annotated to the flow chart[2]. Numbers within (( )) refer to block numbers as described in the inclosure to AR 11-25.

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2. Model refers to flow chart published with AR 11-25, annotated to describe USCONARC participation and areas of interest.

Where no number appears within (( )), interface with USCONARC was not prescribed, but will appear in revisions of AR 11-25.

As a result of participation in Army concept studies (1), USCONARC reviews and comments (2) (( )) on proposed qualitative materiel development objectives (3) ((15)). These documents trigger engineering feasibility studies, cost/effectiveness exercises necessary to complete concept formulation.

USCONARC participation (4) (( )) in this is required in determining personnel and skill requirements (5) ((34)) and a rough Basis of Issue plan (6) ((35)).

By this time, a hardware concept has evolved and proposed Qualitative Materiel Requirements (7) ((40)) are prepared with USCONARC input and review (8) (( )).

If a major system is involved, a DA System Staff Officer will be appointed at this time and a DA System Manager Charter will be prepared (9) ((43)).

The DA-approved charter will task the System Manager, the DA staff and major subordinate commands with specific responsibilities in continuing the development.

At about this time the developer drafts a Systems Development Plan and a Program Change Request (10) (( )).

These develop into formal Systems Development Plans called SDPs and Program Change Requests called PCRs (11) ((47)), and require USCONARC planning, requirements and cost inputs (12) ((46)) along with any other data called for in the charter.

Near the end, contract definition command positions (13) ((50)) are developed and the first Systems Status Evaluation is conducted (14) ((52)). If the results are favorable, the SDP and PCR are forwarded to DOD for approval to proceed into contract definition. This is required only above certain thresholds; $10M in RDT&E or $300M in procurement of equipment and missiles, Army, otherwise DA approves.

Contract definition begins with a request for proposals (15) ((60)) from industry, source evaluation, and selection. Contracts are awarded and the various technical development and management plans are evaluated (16) ((74)).

The foregoing results in development of command positions again (17) ((78,79)) and the second Systems Status Evaluation (18) ((81)). This, in effect, is approval or disapproval of the basic technical approach and management plan that will govern the development and production phase if the project is to be continued.

Assuming continuation, USCONARC, CDC and AMC then submit required data packages (19) ((86)) to DA. The sum of these is the final Qualitative Materiel Requirement including other goods and services to be contracted for and developed (20) ((81)). USCONARC's required data package would include requirements for Task and Skill Analysis, systems-peculiar training equipment, technical literature, New Equipment Training, and any other item or service it needs.

After approval to proceed into development and production, USCONARC and others submit estimated requirements for facilities (21) ((95)) including Military Construction (Army) for systems evaluation.

In the case of USCONARC, this would involve only that needed for confirmatory tests or others in support of AMC or CDC testing.

The next formal input is visualized as rather detailed participation (22) ((107)) and input during preparation of the Project Manager's Master Plan and Schedule which will become, in effect, a Master Milestone Schedule. This has been a weak area in the past.

The next activity is very important and intended to remedy past failures. This requires very early CDC action on unit structure and Basis of Issue (23) ((116)), and AMC/USCONARC action on maintenance requirements (24) ((112,113)) which includes operator functions. This soon evolves into a Maintenance Support Plan and Quantitative and Qualitative Personnel Requirements Information (25) ((117)). This is intended to force OPO to make at least a tentative Military Occupational Specialty (MOS) decision (26) ((119)) in order to permit realistic planning by USCONARC. This will, for example, support Military Construction (Army) submissions.

In the next major action, USCONARC submits its portion of the Advanced Individual Training (AIT) plan for depots, test/evaluation personnel, key instructors, staff planners and overseas commands, and publishes the plan for DA approval (28) ((126)). DA approval at this time is important in that it will enable all concerned to provision for future requirements.

USCONARC inputs to the various development acceptance tests (29) ((134)) may be large or small, but ordinarily would concern tests to validate the Task and Skill Analysis, Qualitative and Quantitative Personnel Requirement Information, Advanced Individual Training Plan, and Military Occupational Specialty decisions.

The prototype review (30) ((139)) and results of the engineer design tests are part of the development acceptance tests just mentioned. This results in development of additional command positions (31) ((140,142)) and a prototype System Status Evaluation (32) ((144)). If program continuation is approved, New Equipment Training begins (33) ((147)) for staff planners and others who will become involved later.

By this time, refinement of Maintenance Support Plans, maintenance literature (34) ((150)), and, e.g., Qualitative and Quantitative Personnel Requirement Information, should be possible. This, combined with refined Tables of Equipment and Basis of Issue data (35) ((151)) will enable DA to make final decisions on these issues (36) ((158)) and prepare the Army materiel program, Equipment Distribution Planning Studies and Army Force Development Plan (37) ((162,165)).

At this time, and prior to, award of a production contract (38) ((178)) another System Status Evaluation considers not only materiel development aspects, but all others such as Tables of Equipment, Basis of Issue, Army Materiel and Force Development Plans, and Training Plans. Program failures beyond this point are extremely expensive.

Engineer and Service Tests will have been runing continuously since prototype production (39) ((139)). Ordinarily, many hardware changes will have been made including those on first production run items. First edition Field Manuals and Technical Manuals and Basis of

Issue will be available (40) ((180,183,185)). All this is considered at the production validation System Status Evaluation (41) ((192)). Ideally, this results in a recommendation for type classification - Standard A (42) ((195)).

Beyond this point, there is little new in the system. USCONARC gets its training devices and equipment (43) ((199)) and begins resident training (44) ((205)). Units are equipped (45) ((211)) and begin training.

The draft model was reviewed and commented on recently by HQS, USCONARC. The principal recommendations for changes proposed by USCONARC are as follows:

First, change the designation of USCONARC on the model from "trainer" to "trainer/user", as shown.

Second, add the three blocks identified on this chart as (2) (( )), (4) (( )), and (8) (( )). USCONARC participation at these points is provided for in the pamphlet text; it also should appear on the model.

Third, change the Qualitative Materiel Requirements description data (19) ((86)) to require inclusion of USCONARC Small Development Requirements on training devices as an integral part of the item or system development package.

Fourth, include all available data on system-peculiar training devices in the proposed Qualitative Materiel Requirements (7) ((40)).

Fifth, expand response to charter (12) ((46)) to include submission of special training ammunition, targets, Military Construction (Army), end-items for training and Small Development Requirements for non-system peculiar training devices. The test, as is, mentions only training aids and devices.

Sixth, modify service test objective, (X) upper right, to include acceptability of systems-peculiar training devices, special tools and test equipment.

Lastly, expand input to program schedule (22) ((107)) to include training devices and end-item delivery; technical data requirements; cost estimates; all training milestones; Military Construction (Army) submissions and other timing data on modified Tables of Equipment, modified Tables of Distribution and Allowances, common Tables of Allowances, Technical Bulletins and Supply Bulletins.

In conclusion, there is no doubt that the new procedures represent a step in the right direction. In the past, USCONARC often had to work in the dark. Now, USCONARC's ability to remain cognizant of systems developments and to influence them appropriately will be improved significantly. Further, USCONARC now has specific and exact authority for certain actions which previously were permissive.

SUMMARY

Human factors development cycles must begin and proceed in phase with the equipment development cycle in order to provide, for the trainer, the human factors data base he needs. Provided such a human factors data base, the trainer concurrently assesses training requirements and institutes timely planning and preparing of methods and materials to ensure safe and reliable operation, maintenance and support of the equipment at the time it is placed into the hands of the troops.

We now have a system which is calculated to achieve such an objective. However, the organization of effort to accomplish the objective is not in full phase with the concept, at the present time. Much more needs to be done, but the movement is in the right direction.

The approach to the training requirements problem as described for the development of a training system for the Main Battle Tank-1970 is the first application of a complete human factors approach to any Army system. However, to make progress, it was necessary for contract researchers to pioneer; for example - planning the procedures, performance objectives and measurement standards - sometimes as USCONARC, and at times doing what management charts have ascribed to CDC or AMC. This was done in collaboration with CDC and AMC and USCONARC.

Out of this effort emerged a partial basis for several new AR's and it has provided AMC with task descriptions which are being used as an example for other developments. But there also emerged a clear demonstration to us of areas where our ability in application may be much less than the ease of our discussion of them, and a clear identification of areas where future research is needed to make the USCONARC, CDC, AMC interface more effectively responsive to meet training requirements on a timely, economical basis.

In closing:

Where we join - is shown in this rather busy illustration (see Figure 16).

What we are to do - is covered in published and emerging regulations.

How well we do - is dependent upon imagination, industry, and most of all, timely inputs.

ABSTRACT

USCONARC training requirements interface with CDC and AMC is an orderly progression from concept formulation to end of operations and disposal of equipment - during the life cycle of the development process. The regulated early consideration and derivation of human performance requirements provides a substantive data base for human engineering evaluations, performance capability tests and training methods and material studies - a prerequisite for effective training system development and evaluation. Gaps may exist in this orderly management array - gaps in the man-machine criteria objectives, performance variables, measurement standards and training methods and media selection. Future research must fill these gaps.

SESSION 2A
HUMAN FACTORS INPUTS TO MATERIEL DEVELOPMENT

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2A(1). PLANNING FOR HUMAN FACTORS ENGINEERING

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As a technical effort, human factors engineering has attempted to apply knowledge of human behavior to the design of man-machine systems in order to increase the overall effectiveness of the systems. Thus we concerned ourselves with display-control, compatibility, reduction of workload, equipment layout, habitability, lighting, and so on.

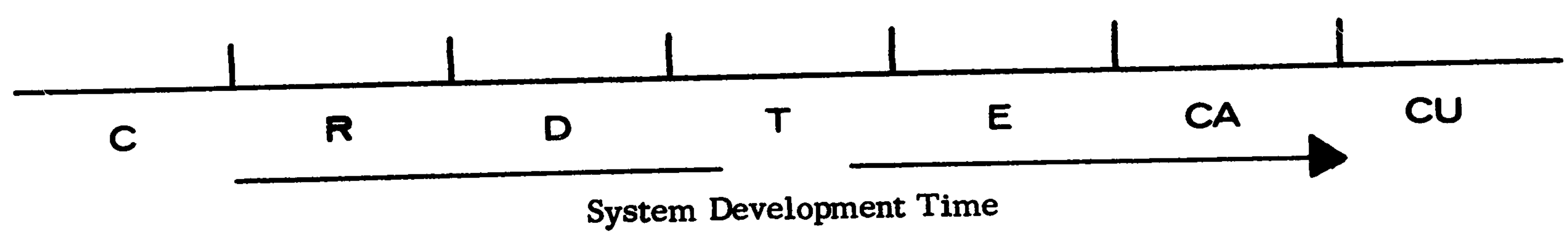
With all due respect to our fond hopes and verbalizations concerning the importance of human factors engineering, our contributions have met with varying degrees of success. Successful we have been--but relative to what is truly required of a human factors engineering effort, we apparently have some shortcomings.

As one looks back at the history of human factors engineering, it appears to have been a predominantly bipolar effort. On one pole of the dimension we have had detailed participation in actual hardware developments through consultations and evaluations. It is here that we were running trying to keep up with hardware development schedules and complained of insufficient amounts of time. We, however, got the job done. On the other pole of the dimension we were performing research which was behaviorally and psychologically oriented. Some of this research translated directly to systems application, while the rest provided background expertise and future reference material.

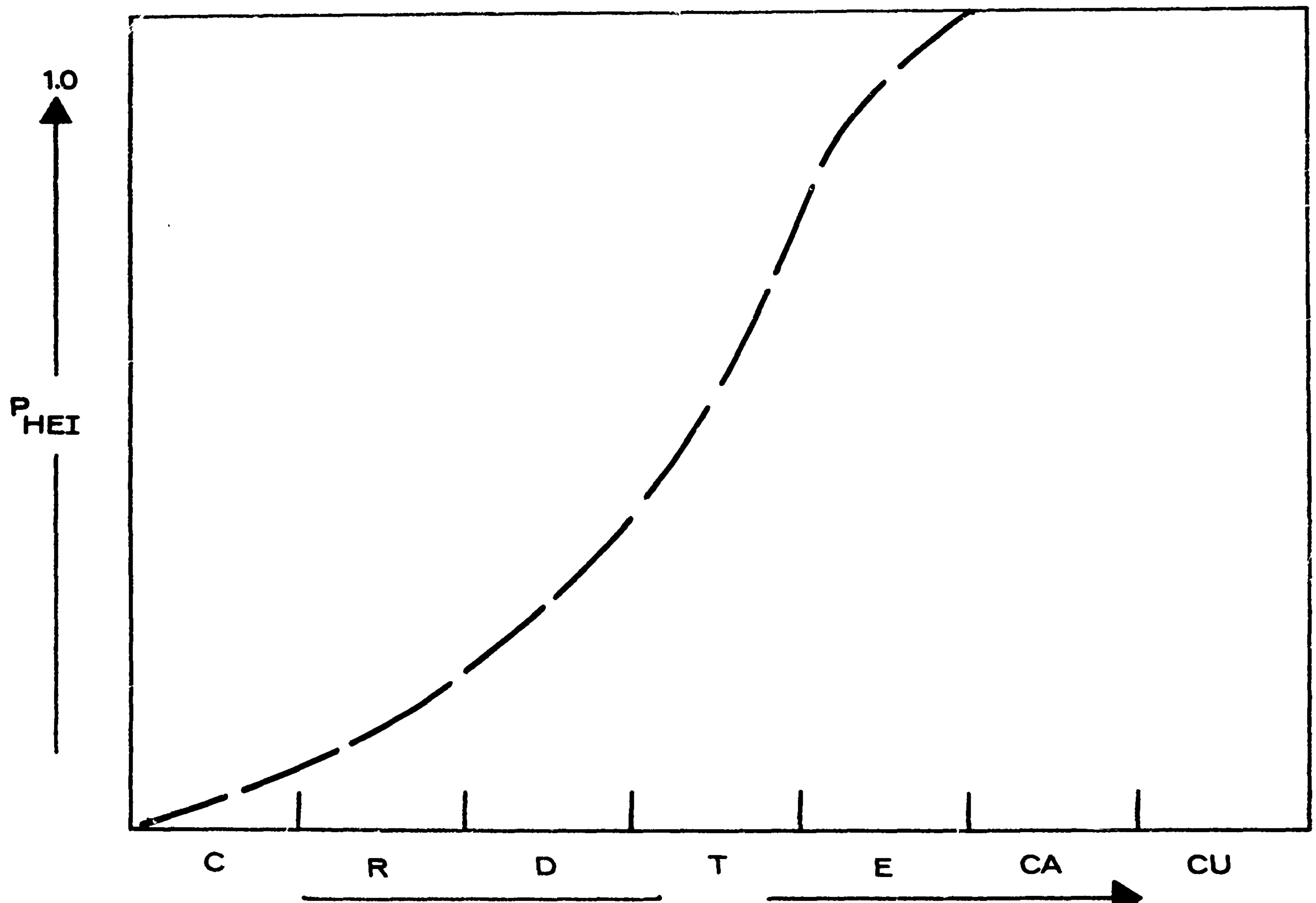
We have said that human factors engineering has met with varying degrees of success, and we have attempted to analyze the reasons for success or the lack of success. Any analysis of success is somewhat subjective, but I would like to propose the following:

In Slide 1 we have depicted the system development cycle as beginning with concepts, followed by research, development, test, evaluation, field acceptance, and utilization.

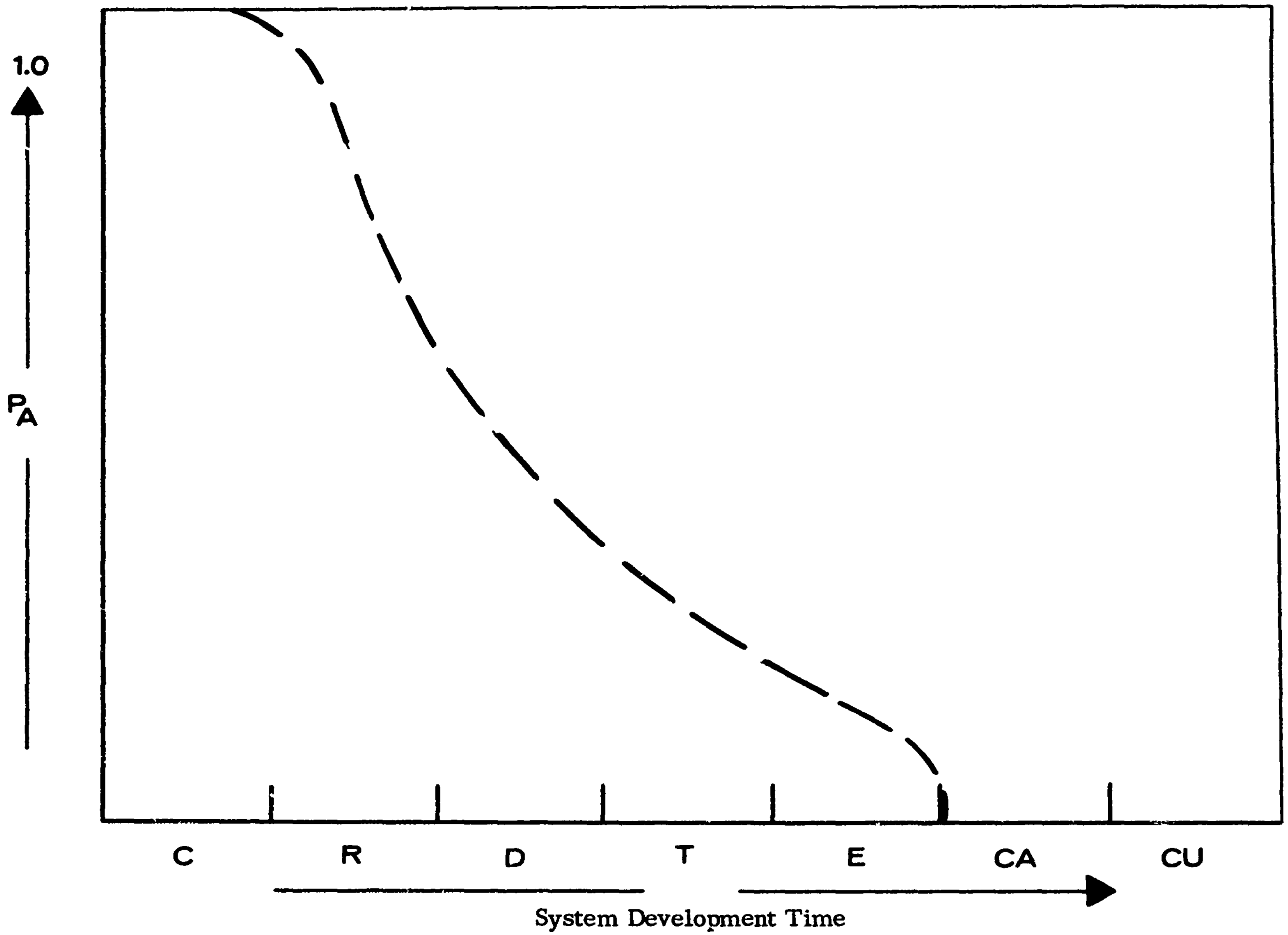
Now we have found, and you will find intuitively acceptable, that the



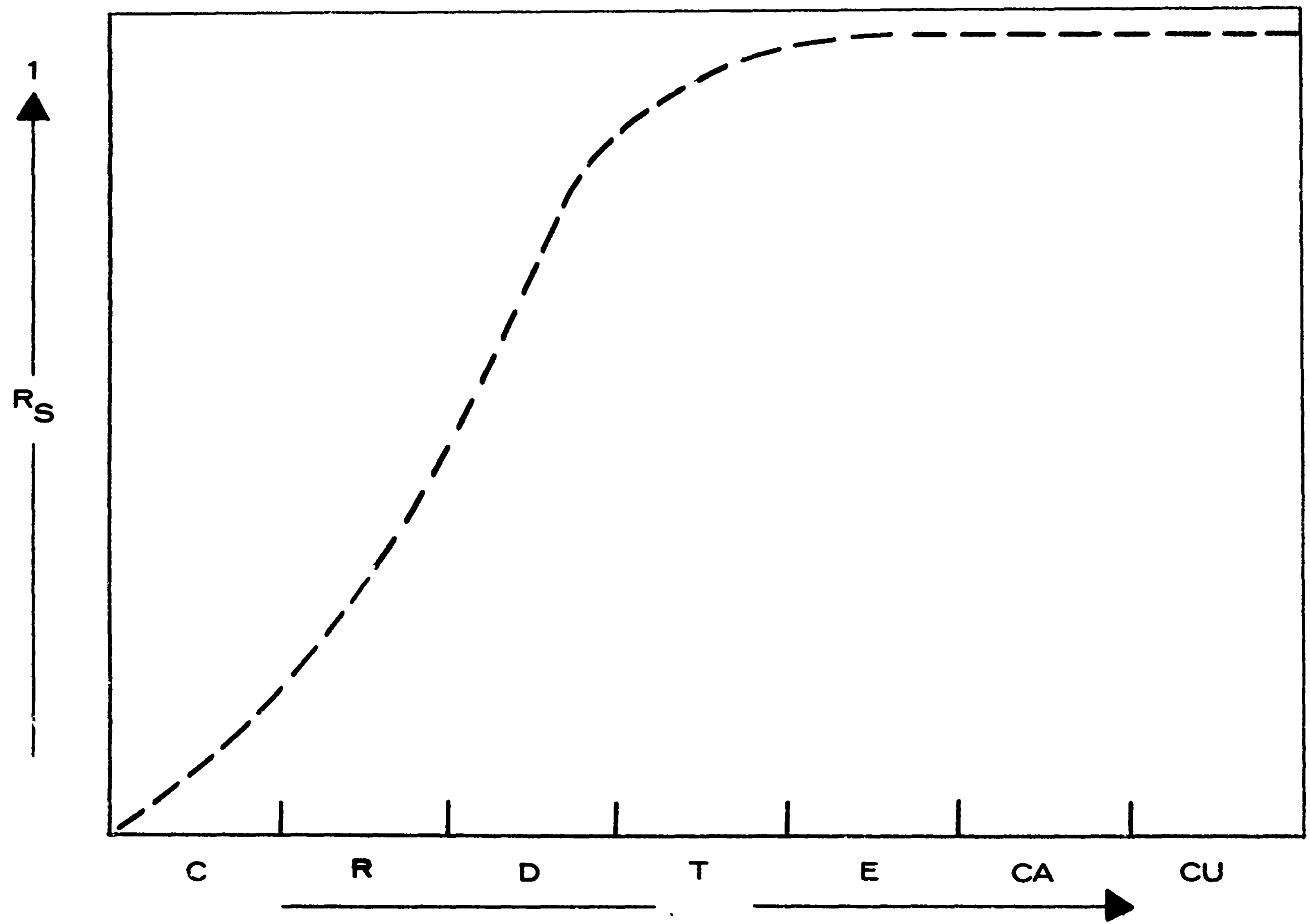
Slide 1



System Development Time
Slide 2

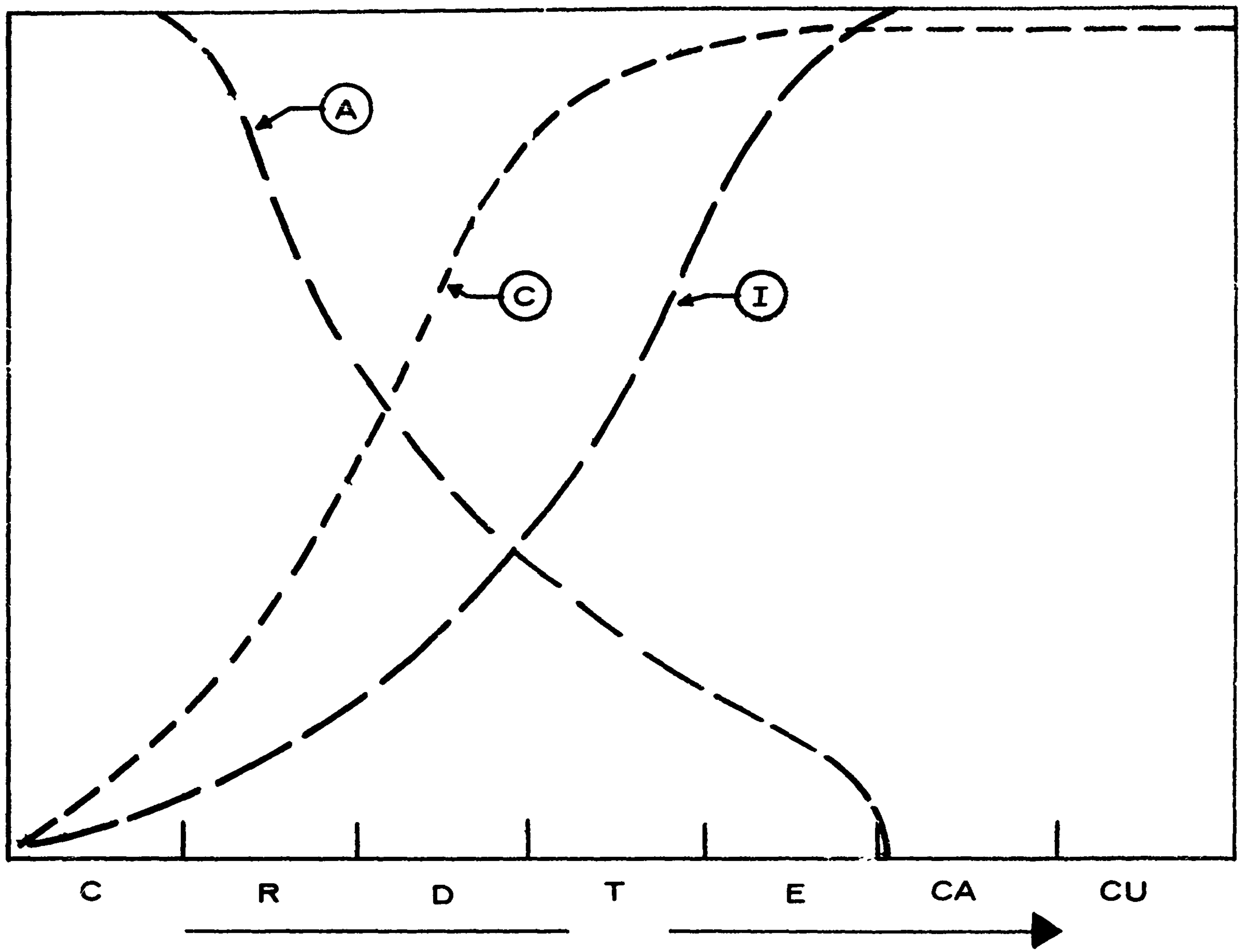


Slide 3



System Development Time

Slide 4



System Development Time
Slide 5

probability of making human factors inputs in terms of changes or improvements to the system follows some function like the one shown in Slide 2. The reason for this relationship is obviously one gets smarter as a function of time and it is easier to establish actual or potential problem areas as the system takes shape. Slide 3, however, shows a probability-of-acceptance curve. The explanation of this curve is quite obvious. During the initial formative stages of a system when the degrees of freedom for action are high, any good idea or data inputs are well accepted and implemented. However, as the degrees of freedom are reduced by virtue of previous hardware decisions or the hardware is in final design, the probability of acceptance is reduced because of its potential redesign implications.

There is obviously a corollary curve associated with the probability-of-acceptance curve, and that is a cost-of-acceptance curve which is shown in Slide 4. The relationship is now fairly explicit and it must be recognized that this relationship is not peculiar to human factors engineering; maybe we are merely the latest to rediscover the relationship.

One might say that what we accomplish in human factors engineering is more a function of when we try to accomplish it rather than what we try to accomplish.

Let me expand on this for a moment. How many times have human engineers reviewed a component or components and found some incompatibility in the man interface and, when reported, received a polite "If you are so smart, where were you when we made the design decisions?" This implies the human engineer was not in early enough.

Of even greater import is when a deficiency is found and the statement is made: "Gee, I'm glad you pointed that out. We will pick it up in the next redesign."

The last little example takes the form of "Maybe we can overcome that problem by selecting better people or training our personnel better."

If we superimpose Slides 2, 3 and 4, we see the total relationship. It is significant to note that a project manager may not be established until some point beyond where the acceptance and cost curves cross.

The consensus of the field is consistent with our analysis of success; namely, that the earlier the inputs, the greater is the likelihood of acceptance. The question becomes one of what is 'early?'

'Early' must, of necessity, be interpreted in terms of systems planning rather than systems development. While there is much applied research to be accomplished during development, development as such implies building or putting together a system of components.

If one reviews the nature of systems planning and development, one will find numerous documents

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which fall out into a neat framework. To limit the list, one can start with OCO's, QMDO's, ADO's, and QMR's. Each of these documents has its own bit of magic but, more important, each has a projected time base. For example, the OCO is a very broad, general statement of Operational Capability Objectives projected into the future. The QMDO is a DA military need for developing new materiel, the feasibility or specific definition of which cannot be sufficiently determined to permit the establishment of a QMR.

Because of the nature of feasibility, QMDO's address materiel objectives in a period of 12 to 20 years prior to the date that the Army is to be equipped. The QMDO, therefore, encompasses the following categories: research in the 6.1 category; 6.2 exploratory development, and 6.3 advanced development.

It should be obvious about now that <u>early</u> with respect to systems development means <u>QMDO.</u>

Now the QMDO system has been in existence for quite some time; however, its value has apparently been somewhat questionable to the operating elements. To this extent, AMC has initiated a comprehensive program known as QMDO planning and under the careful guidance of Mr. Lewis Roepke QMDO planning is becoming a formalized reality. Just what is QMDO planning and what is its relationship to human factors engineering?

QMDO planning in its simplest form is an explicit attempt to chart the alternative scientific and technological accomplishments necessary to meet the stated objectives within the stated time frame.

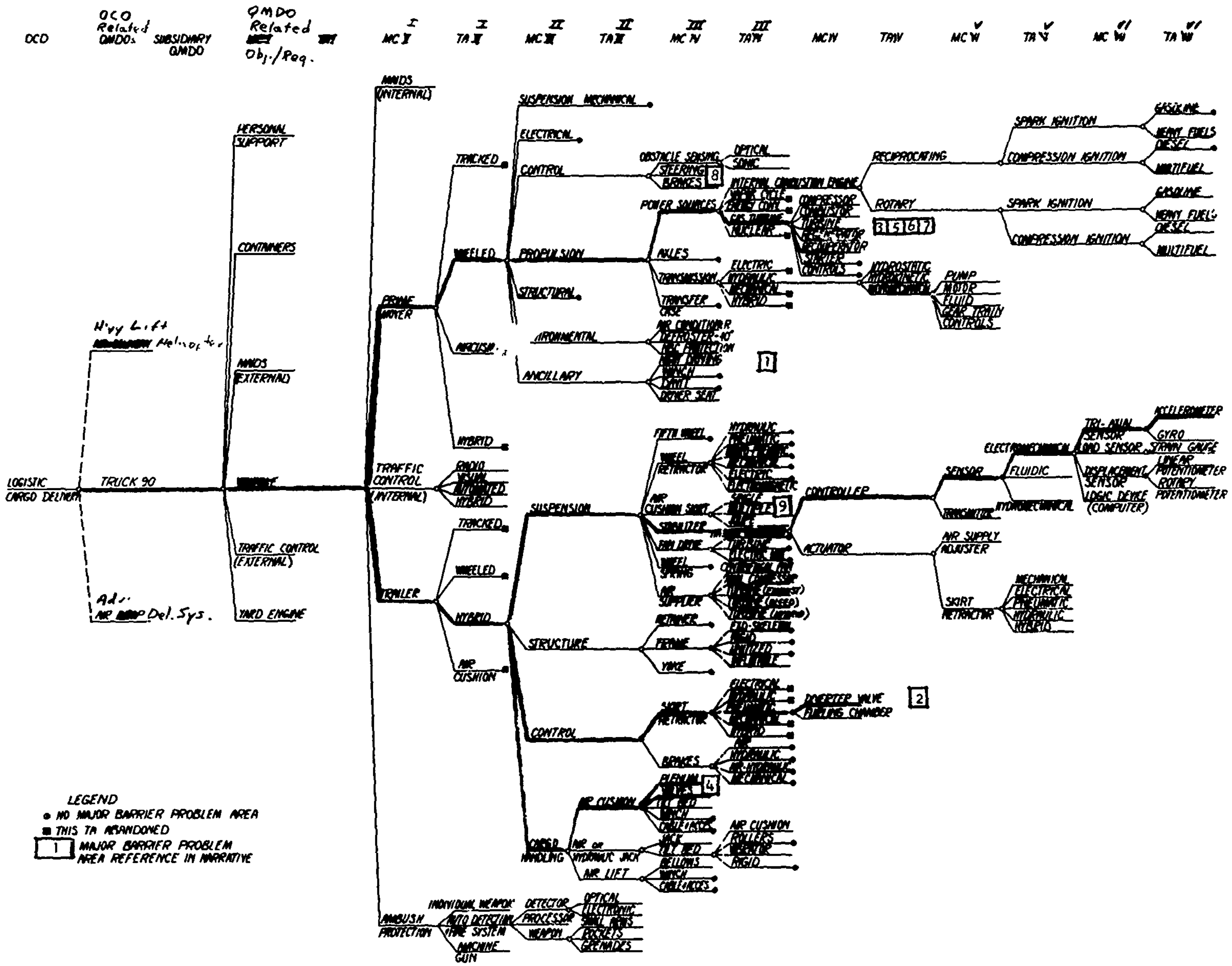
This statement obviously implies scientific and technological forecasting and an associated probability-of-success statement for each of the alternatives.

I would like to show you a task chart of a straw man QMDO plan which was developed for heuristic purposes at a recently held QMDO planning seminar. The straw man QMDO was for a "Military Cargo Line Haul Carrier System (Truck 90." Extracted from the straw man QMDO are the following statements:

"Future operations of fighting units require greater supply tonnage to the field army as compared to present-day operations. Truck 90 will provide the required transport of bulk cargo with minimum personnel and equipment. Existing systems cannot achieve the high rate of supply due to their limited capabilities, maintainability, mobility, and excessive requirements for manpower."

"Limited off-road mobility is required to by-pass severely damaged road sections."

"Truck 90 shall have an endurance capability of at least 1,000 miles without resupply. It shall operate under all weather and night conditions as indicated by the table above. Reduced vehicle signatures


OCO
OCO Related QMDOs
SUBSIDIARY QMDO
QMDO Related Obj./Req.
MC I
TA I
MC II
TA II
MC III
TA III
MC IV
TA IV
MC V
TA V
MC VI
TA VI
LOGISTIC CARGO DELIVERY
TRUCK 90
Hvy Lift Helicopter
Air Del. Sys.
PERSONAL SUPPORT
CONTAINERS
AMMOS (EXTERNAL)
TRAFFIC CONTROL (EXTERNAL)
YARD ENGINE
AMMOS (INTERNAL)
PRIME MOVER
TRAFFIC CONTROL (INTERNAL)
TRAILER
AMBUSH PROTECTION
TRACKED
WHEELED
HYBRID
AIR CUSHION
SUSPENSION MECHANICAL
ELECTRICAL
CONTROL
PROPULSION
STRUCTURAL
ANCILLARY
SUSPENSION
STRUCTURE
CARGO HANDLING
OBSTACLE SENSING
STEERING
BRAKES
POWER SOURCES
AXLES
TRANSMISSION
TRANSFER CASE
OPTICAL
SONIC
INTERNAL COMBUSTION ENGINE
NUCLEAR
ELECTRIC
HYDRAULIC
MECHANICAL
RECIPROCATING
ROTARY
SPARK IGNITION
COMPRESSION IGNITION
GASOLINE
HEAVY FUELS DIESEL
MULTIFUEL
HYDROSTATIC
PUMP
MOTOR
FLUID
GEAR TRAIN
CONTROLS
FIFTH WHEEL
WHEEL RETRACTOR
AIR CUSHION SKIRT
STABILIZER
WHEEL SPRING
AIR SUPPLIER
RETAINER
FRAME
YOKE
SKIRT RETRACTOR
PLENUM
AIR LIFT
CONTROLLER
ACTUATOR
SENSOR
TRANSMITTER
ELECTROMECHANICAL
FLUIDIC
HYDROMECHANICAL
TRI-AXIAL SENSOR
RND SENSOR
DISPLACEMENT SENSOR
LOGIC DEVICE (COMPUTER)
ACCELEROMETER
GYRO
STRAIN GAUGE
LINEAR POTENTIOMETER
ROTARY POTENTIOMETER
AIR SUPPLY ADJUSTER
SKIRT RETRACTOR
MECHANICAL
ELECTRICAL
PNEUMATIC
HYDRAULIC
HYBRID
DIVERTER VALVE
FUELING CHAMBER
AIR CUSHION
ROLLERS
RIGID
BELLOWS
WINCH
INDIVIDUAL WEAPON
AUTO DETECTION
FIRE SYSTEM
MACHINE GUN
DETECTOR
PROCESSOR
WEAPON
OPTICAL
ELECTRONIC
SMALL ARMS
ROCKETS
GRENADES
1
2
3 5 6 7
4
8
9
LEGEND
NO MAJOR BARRIER PROBLEM AREA
THIS TA ABANDONED
MAJOR BARRIER PROBLEM AREA REFERENCE IN NARRATIVE

Task Chart

consistent with detection capabilities and camouflage requirements of 1990 are required, e.g., electromagnetic radiation, including infrared, ultraviolet, and acoustics."

"Each Truck 90 cargo carrier will require no more than a two-man crew consisting of a driver and co-driver. In addition to operating the carrier, the crew will operate the carrier's cargo-handling equipment and perform driver maintenance functions."

"Protection of crew against nuclear fall-out, biological and chemical contamination while driving and when performing emergency driver maintenance is necessary. Protection against ambush is required. Communication for traffic control is needed."

The task chart of the materiel approaches is shown in Slide 3.

What are the implications for human factors engineering, given the approaches taken? I might suggest the following:

1. The alertness requirements for a two-man crew with the implied workload are very high for a 22-hour period.

A program on long-term alertness would have to be conducted to determine:

(1) age and personality factors,

(2) antifatigue drugs, and

(3) personnel recovery rates following long-term performance.

2. The implied complexity of the on-board equipment requires high skill levels.

a. What are the predicted available skill levels for the 1990 time frame?

b. What training would have to be instituted to assure availability of skill levels?

3. What kinds of information and controls are required to operate a hybrid wheeled/air-cushion vehicle? What are the human factors requirements for loading and unloading? Exo-skeleton?

We could go to any level of analysis we choose to develop the problems and investigations required to solve the Truck 90 problem. The important thing to note is that it is here that human factors engineering starts by an in-depth analysis of what the potential barriers are which will require solution for the preparation of an ADO or a QMR. The idealistic goal is that if all barriers are overcome, the concept under investigation can become a system reality in the time frame required rather than eat up valuable development time to investigate solutions to problems.

During the successful accomplishment of a QMDO program a great deal of technical data and information will have been accumulated on both barrier and non-barrier problems. These technical information points and data provide a base for three related activities. First, it provides a statement of feasibility for the generation of the QMR; second, it provides the basis for a technical data package in support of Requests for Proposals from industrial sources; and third, it provides a partial base for the assessment of the industrial proposals.

Industrial proposals are evaluated by convening a source selection committee consisting of specialists from each of the different areas required by the system in question.

For those of you who have participated in source selection activities, you will recall a single contractor's submission consists of many volumes, one for each of the major aspects of the system, such as propulsion, powerpack, configuration, etc. Oftentimes there is a volume on human factors engineering which, after a fashion, says 'Yes, we will do it.' Our own personal experience with proposal evaluation is that apparently proposal generators do not know the full requirements of human factors engineering or we have not requested the collation of all necessary inputs to the human factors engineering volume. This statement stems from the fact that human factors engineering evaluators literally have to review most volumes of the proposal to get an idea of the contractor's approach to human factors engineering. Often a control volume will contain more human factors engineering information and data than the human factors engineering volume itself. The requirements underlying the generation of proposals is continually changing for the better and we will hear more of this in the next paper. However, to continue with source selection activities, more detailed attention must be given to the allocation of evaluation points to human factors engineering. As you all probably know, evaluations are conducted on a point score basis and each of the contributing aspects are assigned a percentage of the total point value. In the past human factors engineering has been allocated from 5% to 10% of the total. This percentage value should be raised to approximately 25% because of the importance and ramifications of total human factors engineering involvement. This degree of assessment would force contractors to look at human factors engineering in detail as the one consolidating feature of a proposal rather than merely indicate that something will be done. We have also found that the contractor who submits a good human factors engineering volume

1. puts forth a totally integrated package;

2. places all interrelated components and their functions in perspective; and

3. indicates the contractor knows the man-in-the-system concept as opposed to the man-adapting-to-the-system concept.

Following the selection of a contractor, the emphasis shifts to that of supporting the Project Manager's Office 'if there is one' in terms of

1. developing an overall human factors engineering system integration plan to insure the inclusion of all related human factors engineering and biomedical data and information into development;

2. development of a comprehensive human factors engineering test plan to operationally assess the first prototype against human factors engineering inputs; and

3. to generate training inputs required to develop the manning level for the first operationally equipped units.

2A(2). PMO SUPPORT—HFE STANDARDS AND SPECIFICATIONS, CONTRACT MONITORING

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INTRODUCTION

The topics for Session IIA, "Human Factors Engineering Inputs to Materiel Development," are arranged in the chronology of the development cycle and could be considered simply as: "Determining HFE Requirements," "Buying HFE," and "Testing HFE." This paper will consider the second of these HFE activities from four viewpoints:

a. The general HFE sequence during Contract Definition and full scale Engineering Development,

b. The development of regulatory, contractual, and management innovations of the past ten years which now provide the tools and constraints for buying HFE,

c. HFE contract monitoring methodology, job aids, and products, and

d. A brief look at the scope of HFE during acquisition of future Army systems.

TODAY'S HFE SEQUENCE

To summarize the inputs of HFE into Contract Definition and subsequent development, primarily from the viewpoint of a program manager's human factors specialist, we shall assume that a concept has developed through the QMDO and QMR stages, as discussed in the previous paper, and that Contract Definition has been authorized.

Contract Definition

At the outset of Contract Definition, HFE inputs to the RFP must be prepared. Relevant specifications, studies, documentation, management requirements, and design criteria must be delineated for HFE. The technical requirement is examined in detail and appropriate inputs made where HFE attention is needed for consideration of potentially critical tasks, where deviation from standard HFE criteria may be required, or where other special treatment of HFE aspects of system requirements is warranted. Where appropriate, a summary of pertinent HFE requirements, objectives, and explanations is prepared for use at a bidders' conference.

At this point, prospective contractors would review requirements, establish a human factors staff for the program, review system description and available engineering documentation, verify and expand HFE analyses, perform selected trade-off studies, identify definition trade-off requirements in the HFE area, perform initial training devices studies, verify and expand the system description and prepare a HFE Program Plan for inclusion in the proposal.

These proposals are then evaluated to determine the degree to which the engineering approaches and planned HFE effort efficiently and effectively reflect stated requirements. Results of these evaluations are submitted to the Source Selection Evaluation Board preparatory to contractor selection for the subsequent definition phase.

Contractor HFE activities during this next phase include conduct of trade-off studies; development of design requirements for operations and maintenance end items (with special attention to critical functions); preparation of development descriptions; updating of design requirements for operation functions, operation end items, maintenance functions, maintenance end items, and facilities; and participation in design review efforts. HFE participation should be included in identification of high risk areas and long lead-time items, and in In-Process Reviews of system requirements and system design. During this phase, refinements of such HFE functions as analyzing information flow and processing, estimating potential operator/maintainer processing capabilities, allocating functions, identifying equipment, analyzing tasks to identify critical human performance requirements, and in general, any other HFE efforts required to define preliminary system and subsystem design, are performed. The HFE program plan is refined to reflect a systematic implementation of the technical effort proposed as an outgrowth of this definition phase.

The proposals for engineering development are subsequently subjected to an in-depth HFE evaluation by the procuring activity. Envisioned design approaches are assessed from the HFE viewpoint. The HFE Program Plans are carefully evaluated against a common yardstick and are also analyzed with respect to the proposed schedule, design effort, study effort, testing and general approaches portrayed elsewhere within the proposals to which the HFE Program Plans apply. Related functional areas are reviewed to insure that a coordinated HFE effort is planned; the proposed master schedule is examined to determine that HFE milestones are an integrated portion of the total development effort; development descriptions are reviewed to ascertain that HFE criteria and the results of analytic efforts are reflected therein; and assistance is furnished other members of the evaluation team where HFE data is required to support evaluations in such areas as system effectiveness, maintainability, GSE, reliability, and safety engineering.

To supplement the skills of the program manager's HFE personnel, specialists from such organizations as the Human Engineering Laboratories are frequently called upon to assist in the evaluation as a member of the HFE team where their unique skills in special HFE areas can be brought to bear upon the total evaluation. Additionally, technical inputs from representatives of user, personnel, and training agencies (among others) are integrated into the HFE evaluation. At the conclusion of this effort, recommendations are submitted, a development baseline is established, and documentation is updated preparatory to full scale development authorization.

Engineering Development

By this time HFE responsibility is assigned to a member of the program manager's staff, to one or more HFE specialists employed at the major subordinate command where the program manager is located, to specialists at the Human Engineering Laboratories, or a combination of these depending upon the complexity of the system and specialized areas involved. Also by this time, coordination will have been made with counterpart personnel of agencies having pertinent interests in the HFE aspects of the program -- Army Natick Laboratories, Army Environmental Hygiene Agency, user agency and appropriate personnel and training specialists.

After engineering development contract award, the contemporary program manager's HFE specialist or team must continue evaluations of preliminary system and subsystem designs; studies; mockup and simulation efforts; detail designs of equipment, work environment, facilities, and operating procedures; testing; and any other system development actions required to implement the approved HFE program plan submitted by the contractor.

The hundreds of HFE-related management and system engineering events which take place during contract definition and engineering development are well summarized in detail in the "Manpower Resources Integration Guide for Army Materiel Development Programs," (1) adapted by HEL from SDC TM-2908/000/01 (2) prepared for the Army Research Office by the System Development Corporation. Consequently, we shall not trace each detailed step in which HFE is involved during definition and development, but shall turn our attention to the development of regulatory, contractual, and management innovations of the past ten years which now furnish the tools and constraints for buying HFE.

DEVELOPING TODAYS HFE PRACTICES

The 1950's

Ten to fifteen years ago, the scope of human factors specialists working for a commodity command was indeed a narrow one when contracts for weapon systems development were initiated and monitored. In most instances, only the minimum human factors engineering requirement contained in the Ordnance Procurement Instruction (3) was inserted into the contract technical requirement. This standard HFE requirement, or contract clause, was so brief that it can be stated here to portray the simplicity of specifying HFE ten years ago:

"The contractor agrees that in the performance of the research and development work called for, he will subject all equipment design and developments to human factors engineering by qualified human factors engineers."

"a. The human factors engineering will include but not be limited to a consideration of each of the following (where applicable) in terms of the intellectual, physical, and psychomotor capabilities of the intended user." (Ten examples, such as communication, workspace layout, and control-display relationships, followed.)

"b. During the earliest possible state of development, the contractor agrees to prepare functional mock-up(s) of the item(s) envisioned. These mockups will provide the basis for determining the related human factors engineering problems, and will include a complete system evaluation by the contractor. Indicated improvements will be incorporated into the system prior to the design of prototypes."

"c. Progress reports and final reports will include human factors engineering as a separate topic. The reports are to indicate the methods of study, the problems uncovered, and the corrective measures taken."

Today's Practices

While this simple contract clause may have sufficed for prescribing HFE requirements of the late 1950's, events of the following ten years radically changed program management techniques, types of contracts, data management, scheduling methods, the general system engineering process, and the scope of human factors engineering. Human factors specialists of the procuring activities now find that they must have some conversance with these other functional areas if an HFE program is to be effectively integrated into the framework of other disciplines and contemporary management techniques being employed to develop complex systems -- even simple systems for that matter.

Requirements for human engineering of equipment designs have been replaced by requirements for human factors engineering of total systems, including consideration of their operating and maintenance procedures, as well as training, skill level, and manning implications. The Army no longer asks solely for subjecting designs to HFE by "qualified" human factors engineers, but for a comprehensive program to integrate HFE into the total development program through system engineering analysis, detail design, and test and evaluation, and asks the contractor to propose his own plan for accomplishing this effort.

The Army no longer merely lists in system development contracts representative areas of intellectual, physical and psychomotor capabilities of the intended user which design should consider, but specifies human engineering and life support criteria -- quantified and system-pertinent where possible -- for design application.

The Army no longer prescribes HFE analysis solely in terms of general considerations and mock-up studies, but in terms of functional allocation, information flow and processing, potential operator/maintainer processing capabilities, equipment identification, gross and refined analyses of tasks, preliminary system and subsystem design, studies, and dynamic simulation, among others.

The two-sentence documentation requirement used ten years ago to acquire progress and final reports has been replaced by availability of concise requirements for HFE in equipment detail design drawings, equipment operating procedures and specifications. In addition, an HFE category in the Army's Authorized Data List (4) covers all HFE documentation which can be required of a contractor. Supplementing this HFE documentation, products resulting from a number of training data items (Category 14) are used in conjunction with HFE actions.

The human factors specialist of ten years ago might well be puzzled, for example, to learn that his relatively compact contract clause would not even suffice for a contract definition request for proposals (RFP), which must now include results of prior HFE studies, an indication of criteria against which proposals will be evaluated, outline of plans for program management (including management of HFE), HFE milestones in PERT networks, HFE program requirements and specific design criteria for both contract definition and engineering development, HFE documentation required during contract definition and engineering development, and other factors such as interrelationships of HFE with reliability, maintainability, safety engineering. Additionally, he will see that he must review and identify specifications, standards, and guidance documents and indicate any planned deviations, examine proposed incentive features desired in the proposal for engineering development, and participate in planning the format and content of the proposal package for engineering development.

The changes between "HFE - 1959" and "HFE - 1968" just noted did not occur simultaneously, but evolved as a series of management methodology, contractual, handbook, and regulatory requirement innovations. Figure 1 portrays the development of these changes against a broad time base showing how the last ten years have systematized acquiring HFE during materiel development.

1958 - 1960

In 1959, a procuring activity's HFE specialist could lean on only two devices -- the approved HFE contract clause of OPI 7-381.2 and his charter contained in OCTI 200-1-59 (5). This charter, "Human Factors Engineering in Ordnance Materiel Research, Development, and Evaluation" prescribed that he be located at the staff level to "monitor, stress and enforce the application of HFE" as his sole assignment, as a collateral responsibility, or as a member of a group. Other than maintaining liaison with such groups as the Human Engineering Laboratories and users of mission items, he was responsible for assuring that each materiel contract contained the approved human factors engineering contract clause, previously described.

Perhaps the Signal Corps HFE specialist was somewhat more fortunate, being armed with a commodity command specification for Signal Corps equipment. This specification, SCL 1787, "Human Factors Engineering for Signal Corps Systems and Equipment," (6) can be considered as one of the pioneering efforts in the Army to systematically specify for contractors the requirements for HFE program efforts and data in materiel development programs. This specification included requirements for an HFE Design Plan, Operator Decision Diagrams, Link Analyses, and HFE Progress Reports reflecting installation, operation, and maintenance performance time data, and operational procedures, among others. While this specification prescribed no HFE design criteria, a list of guidance publications was included and consisted of 6 technical reports, 2 handbooks, 2 textbooks, and a bibliography. It is interesting to note that most of the handbooks, referenced by this specification, evolved into a major portion of the "Human Engineering Guide for Equipment Designers" (7) published four years later under sponsorship of the Joint Services.

Toward the end of the 1958 - 60 period, the utilization of PERT (Program Evaluation and Review Technique) offered a means of systematically time-phasing HFE actions and milestones into overall system development programs during planning stages. Furthermore, it offered a means of determining specific HFE review items during any projected point in the network and highlighting potential HFE road-

ITEM	1958-1960	1961-1962	1963-1964	1965-1966	1967-1968
Regulatory	-OCTI 200-1-59 -OPI 7-381	-AMCR 70-1 -AMCR 10-4			AR 602-1
Mgt Techniques	PERT	-Proj Mgt -Incentive Contr	-Contract Definition	-Configuration Mgt -Auth Data List	
HFE Specifications	SCL-1787		-MIS-10017 -MIL-H-46819		MIL-H-46855
HFE Standards		ABMA-STD-434	MIL-STD-1248		MIL-STD-1472
HFE Handbooks		-HEL STD S-1-63 -Joint Svc Guide	HEL STD S-2-64	-HEL STD S-3-65 -HEL STD S-6-66	HEL STD S-7-67

Figure 1. DEVELOPING TODAY'S HFE METHODS

blocks which might otherwise have gone unnoticed. Timely updating of PERT networks furnished the HFE monitor (and contractor) a valuable tool to assess HFE progress in relation to the overall development program and to remain abreast of HFE actions and requirements.

1961 - 1962

The following two years (1961 - 1962) saw the development and utilization of ABMA-STD-434, "Missile Systems Human Factors Engineering Criteria," (8) a commodity-command document which stated very basic HFE requirements against which equipment could be designed and the designs assessed. This document was an outgrowth of material contained in technical reports then being considered for incorporation into the "Joint Services Guide" and from ABMA-XPD-844 (9), the HFE design criteria prepared for use on PERSHING by the Martin Company. In addition to standardizing certain elements of HFE design practice, ABMA-STD-434 saved considerable time and effort which would otherwise have been spent determining basic dimensional workspace, environmental workspace and "knob and dial" requirements for system design. Perhaps the most obvious shortcoming of this standard was its limited applicability to the large missile systems of the preparing agency.

Four other innovations arising during the latter part of the 1961-62 time frame included the advent of the Project Manager concept with the establishment of AMC; emphasis on fixed price and incentive contracting rather than "cost-plus" contracts; and promulgation of AMC Regulations 70-1 (10) and 10-4 (11), delineating responsibilities of major subordinate commands and project managers, and those of the US Army Human Engineering Laboratories (now expanded from one to three laboratories) for implementing HFE.

The departure from cost-plus contracts necessarily placed responsibilities on program management to specify HFE requirements as completely as possible prior to contracting. Here then, was a further step in advancing HFE consideration to as early a point in the development cycle as possible. From the early 1950's to this time, the concentration of HFE effort moved from equipment evaluation, to earlier design evaluation, to still earlier preliminary design evaluation. Setting system HFE requirements and doing considerable "homework" prior to contracting was therefore a natural transition of HFE emphasis.

AMCR 70-1 placed responsibility for HFE directly upon the Project Manager and chartered the major subordinate command HFE groups to support program efforts as team members. The previous requirement to "monitor, stress, and enforce" the application of HFE from the staff level was replaced by responsibilities to identify HFE problems and requirements early in the development cycle, to prepare contractual requirements, perform study efforts, and participate in in-process reviews. AMCR 10-4 placed the resources of HEL behind the major subordinate commands to supplement efforts where the capabilities of that organization could best be brought to bear.

1963 - 1964

The period 1963 - 1964 saw the AMC HFE specialist acquire many other tools to facilitate his participation in system development programs.

The advent of Contract Definition offered a means of incorporating HFE requirements into system development well before contracts for engineering development were released and provided a period of time where a comprehensive, analytic look could be taken at HFE implications of alternative system design approaches.

The "Human Engineering Guide to Equipment Design," sponsored by the Joint Services, was published, thereby offering an extensive, authoritative source of HFE design data to supplement the mandatory HFE requirements of specifications and standards.

The Human Engineering Laboratories published HEL-STD-S-1-63 (12), which standardized the design maximum steady-state noise levels and established uniform requirements for noise levels as a function of communication to be utilized.

The Army Missile Command promulgated MIS-10017, "Human Factors Engineering in Development of Missile Systems" (13), which defined requirements for applying HFE to RDT&E of Army missile systems and specified both HFE program and data requirements. Requirements for HFE in system engineering analysis, selection, definition and detail design, and the test and evaluation program were stipulated. This document was subsequently revised as MIL-H-46819 (14).

ABMA-STD-434 was revised and released as MIL-STD-1248 "Missile Systems Human Factors Engineering Criteria" (15).

The Human Engineering Laboratories published HEL STD S-2-64, "Human Factors Engineering Design Standard for Vehicle Fighting Compartments" (16), marking the initiation of a series of HFE design guidance documents applicable to specific commodity lines.

1965 - 1966

Developments of 1965 - 1966 further contributed to the "tool-chest" for integrating HFE into weapon system programs.

A configuration management program was developed. This furnished a means of including HFE into system and development descriptions, specifying quantified HFE data peculiar to the system being developed, and a medium of recording end-item pertinent HFE requirements prior to engineering development.

AR 700-51 was published and included the Army Authorized Data List consisting of convenient-to-use, sheet-formatted HFE data items that could be specified for contractual delivery. Category 15 of this list contained HFE data items. Other items of a general nature having an HFE implication were now available in other categories.

HEL standards for Missile Systems and Related Equipment (17) and Wheeled Vehicles (18), respectively, were published, thereby increasing the coverage of design guidance handbooks to two more specific commodity lines.

1967 - 1968

HFE innovations of 1967 - 1968, bringing us up to the current time, included a new Army Regulation on HFE (19), a Joint Services Specification for Human Engineering (20), a Joint Services Standard for Human Engineering (21), and an HFE design handbook for Communication Systems (22).

a. Promulgation of AR 602-1

vastly expanded the scope of HFE through its redefinition as "a comprehensive technical effort to integrate <u>all</u> manpower characteristics (personnel skills, training implications, behavioral reactions, human performance, anthropometric data, and biomedical factors) into all Army Systems." Furthermore, it channels inputs from cognizant Army agencies into an integrated program to include materiel design and development, logistic systems design, personnel and training implications, and total life cycle cost control of man-materiel systems.

b. The Department of Defense Human Factors and Standardization Programs teamed up to develop a single military specification and a single military standard to supersede over eight similar documents used by the three services for prescribing human engineering program and design criteria requirements. These consolidation efforts represented consideration of thousands of comments in addition to the eight limited-coordination documents which were superseded. There were 12 Army, seven Navy, and four Air Force Review Activities. Two industry groups and NASA also participated in the consolidation efforts. In addition to reducing the number of human engineering documents in the defense standardization program from eight to two, efficient utilization of human engineering requirements and criteria is enhanced through contractor familiarity with these requirements irrespective of application or service.

c. Finally, HEL STD S-7-67, "Human Factors Engineering Design Standard for Communication Systems" was published.

HFE MANAGEMENT/CONTRACT MONITORING JOB AIDS

HFE Requirements

While the program manager's human factors specialist must consider many more facets of the system development process than his counterpart of ten years ago did, he does have considerably more aids available to do the job efficiently and effectively. He may make use of a Joint Services military specification to prescribe HFE program requirements, a 175-page Joint Services military standard to prescribe minimum HFE design requirements, and a series of handbooks issued by the Human Engineering Laboratories to provide supplementary design and HFE data related to the commodity line being developed. Finally, he may prescribe contractor HFE data requirements by entering any of a number of Authorized Data List items on a convenient-to-use form DD 1423, which is made a part of the contract. The Authorized HFE Data Items are included, in sheet format, as a part of AR 700-51 and may be utilized without change merely by referencing the data item number and listing supplementary information (such as copies required, when required, distribution, purposes, etc.). He is free to delete any portion of an HFE data item which is not applicable to the program at hand or where the use of the data item is limited.

HFE Monitorship through Data

HFE documentation options available to remain abreast of HFE progress consist of:

HFE Program Plan

Control, Display, Communication, and Environmental Workspace

Planning Data

Operator/Maintainer Taskload Analyses

Analysis of Critical Tasks for Information Systems/Subsystems

HFE Design Approach Documents

HFE Test Program Plan, implementing documents, and Test Reports

Periodic Progress Reports

Final Report

Data, in categories other than HFE, submitted by the contractor, are also reviewed for their reflection of the HFE effort and approved HFE design criteria. Examples of these data items include equipment detail design drawings, performance and design specifications, operational and maintenance procedures, test and study reports, reliability, maintainability and safety engineering documentation, and system schedules. Within each of these categories, significant data is available for use by the HFE monitor. For example, equipment detail design drawings reflect panel layouts, overall workspace layouts, communication systems, controls, and other items important to system operation and maintenance by human operators.

HFE Monitoring through Doing

But these are only documentation review paths to HFE monitorship. Other techniques are equally necessary and include participation in in-process reviews, witnessing tests, maintaining direct contact with contractor HFE counterparts, independently analyzing critical system functions, participating in meetings with the contractor, and remaining abreast of developments in program functional areas other than HFE. The emphasis placed on these and other "doing" tasks will strongly affect the value of the documentation previously described.

A Two-Way Street

The HFE contract monitor's job, however, is not solely the one-way street pictured above. He should be in a position to respond to the contractor's requests for HFE and related data that has as its source the work performed by in-house laboratories; to assist in furnishing any documentation required by the contractor to do the job he has planned and which is referenced by system specifications; and to make the contractor aware of any new reports or developments which can enable him to consider solutions of HFE problems on a broad base. The program manager's HFE specialist must also be in a position to furnish inputs to other groups supporting the program manager such as personnel, training, safety engineering, reliability and maintainability. Products of HFE analyses and evaluations may be required by these other interests. For example, estimates of potential operator/maintainer processing capabilities, identification of critical human performance areas, and preliminary operating procedures have personnel and training implications, while results of time studies have maintainability implications. Similarly critical task error rates, disclosed by simulation or experimentation and gross task error rates disclosed by other tests or analyses may have reliability implications.

Testing

When time for final testing comes, the HFE Program will hopefully have enhanced the system's capability to meet or exceed requirements. The program manager's HFE specialist has available to him for "communicating" with the HFE Test and Evaluation Program, similar tools as were used during analysis and design, and include: the HFE Program Plan; the HFE Test Program Plan; Test Plans; participation in or witnessing of tests; general HFE criteria and essential system performance requirements which can be used as yardsticks; and test reports. HFE in the test phase of materiel development will be covered in the following paper and will not be touched on further here.

HFE TEN YEARS FROM NOW

Changes of the Last Ten Years

We have seen that, if the program manager's HFE specialist of ten years ago were to visit us today and ask, "What has happened in the last ten years to change my approach, charter, tools, and methods so extensively?", we could answer -- "Many things with which the HFE practioner should be acquainted to take full advantage of all the opportunities available to make inputs into a development program." We could also answer by stating that the following happened:

a. Emphasis on fixed price and incentive contracting

b. PERT

c. Uniform tri-service human engineering requirements

d. Uniform tri-service human engineering design criteria

e. Uniform contractor data items

f. HFE handbooks for design of specific commodities

g. Configuration management

h. Project Management concept

i. Contract Definition

j. Expansion of the scope of HFE

Changes of the Next Ten Years

If we were to go ten years into the future and ask the same question which the HFE practioner of ten years ago was pictured as asking today, we hopefully could point out a neat package of such innovations as:

a. A personnel cost-data bank.

b. A personnel skill/availability data bank.

c. Uniform computational methods for quantifying effectiveness of system personnel components.

d. A "top" DOD human factors specification and standard for integrating ALL manpower factors into development programs, supplemented by a comprehensive document structure addressing such subordinate areas as human engineering, personnel requirements, training, biomedical factors, cost control, and effectiveness measurement.

e. A Joint Services Authorized Data List consolidating all HFE information requirements for system acquisition.

f. More mutual dependency between human engineering, personnel selection, training, biomedical, hardware and software design, and test agencies.

g. More "homework" in the QMDO and QMR stages of system development to better prepare HFE programs for subsequent contract definition and development phases (or their

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equivalents ten years hence).

Significant Milestones

AR 602-1, previously mentioned, forms one of the charters upon which these and other HFE improvements can be built. Each of these anticipated innovations has been an open door for HFE to more effectively participate as a fully-integrated entity in system development efforts. While they will place some burden upon HFE to become conversant with new technical and management concepts and methods, the opportunity is worth the price; the results are worth the effort.

REFERENCES

(1) US Army Human Engineering Laboratories, Manpower Resources Integration Guide for Army Materiel Development Programs, May 1968.

(2) System Development Corporation, System/Project Management Procedures for Integrated Management of the Human Factors (Personnel Related) Aspects of Army System Management, SDC TM-2908/000/01, 27 July 1966.

(3) Department of the Army, Human Factors Engineering Contract Clause, Ordnance Procurement Instruction 7-381.2, Change 15, 18 June 1959.

(4) Headquarters, Department of the Army, Improved Management and Determination of Requirements for Procurement of Technical Data and Information, AR 700-51, August 1966.

(5) Department of the Army, Human Factors Engineering in Ordnance Materiel Research, Development, and Evaluation, Ordnance Corps Technical Instruction 200-1-59, 8 January 1959.

(6) US Army Signal Corps, Human Factors Engineering for Signal Corps Systems and Equipment, SCL-1787, 3 April 1958.

(7) Morgan, Clifford T., Cook, Jesse S., Chapanis, Alphonse, and Lund, Max W., Eds, Human Engineering Guide to Equipment Design, McGraw-Hill Book Co., Inc., New York, 1963.

(8) US Army Ballistic Missile Agency, Missile Systems Human Factors Engineering Criteria, ABMA-STD-434, 1 October 1961.

(9) US Army Ballistic Missile Agency, PERSHING System Human Factors Design Criteria, Revision 2, ABMA-XPD-844, 25 March 1960.

(10) Headquarters, US Army Materiel Command, Responsibilities of AMC Major Subordinate Commands and Project Managers in the Application of Human Factors Engineering (HFE), AMCR 70-1, 23 November 1962.

(11) Headquarters, US Army Materiel Command, Mission and Functions of the Human Engineering Laboratories, Aberdeen Proving Ground, Maryland, AMCR 10-4, 25 September 1962.

(12) US Army Human Engineering Laboratories, Maximum Noise Levels for Army Materiel Command Equipment, HEL STD S-1-63, 1963.

(13) US Army Missile Command, Human Factors Engineering in Development of Missile Systems, Missile Interim Specification 10017, 6 September 1963.

(14) Military Specification, Human Factors Engineering in Development of Missile Systems, MIL-H-46819(MI), 9 June 1964.

(15) Military Standard, Missile Systems Human Factors Engineering Criteria, MIL-STD-1248(MI), 20 January 1964.

(16) US Army Human Engineering Laboratories, Human Factors Engineering Design Standard for Vehicle Fighting Compartments, HEL STD S-2-64, May 1964.

(17) US Army Human Engineering Laboratories, Human Factors Engineering Design Standard for Missile Systems and Related Equipment, HEL STD S-3-65, September 1965.

(18) US Army Human Engineering Laboratories, Human Factors Engineering Design Standard for Wheeled Vehicles, HEL STD S-6-66, September 1966.

(19) Headquarters, Department of the Army, Human Factors Engineering Program, AR 602-1, 4 March 1968.

(20) Department of Defense, Human Engineering Requirements for Military Systems, Equipment and Facilities, MIL-H-46855, 16 February 1968.

(21) Department of Defense, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, MIL-STD-1472, 9 February 1968.

(22) US Army Human Engineering Laboratories, Human Factors Engineering Design Criteria for Communications Systems, HEL STD S-7-67, 1968.

2A(3). SYSTEM INTEGRATION AND HUMAN FACTORS ENGINEERING SUPPORT IN THE TEST PHASE OF MATERIEL DEVELOPMENT

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As we follow the materiel development cycle from concept to availability for combat, we find a complex system of tests and evaluations ranging from engineering-type tests through troop tests and tests designed to develop doctrine and tactics for the new item. But conspicuous for its absence is any test procedure designed for the assessment of human factors engineering as it pertains to the weapon system considered as a totality.

To a large degree, perhaps, this apparent oversight results from a simple semantic error--just what do we really mean by "system?" And just how do we describe the combat role of any system in isolation--let alone make any objective measurement of its performance?

In discussing these problems and making suggested approaches to their solution, I shall use as a concrete example the efforts of the Human Engineering Laboratories in the Joint United States/Federal Republic of Germany Main Battle Tank-1970 Program, for here we have attempted to develop a total systems approach to the human factors engineering efforts of a complex weapon system--the tank.

To a large degree the magnitude of problems involved in any type of "system" testing depends upon the definition of "system;" at just what level of integration does one cut off related subsystems and associated equipment interfaces in order to have a manageable test but one which is inclusive enough to provide the desired results? It has become accepted as almost axiomatic that the more comprehensive and inclusive the study, the less detailed and less specific the data obtained--while effective human factors engineering requires (for the most part) very specific and very detailed data.

In the program which I shall use as an example, the MBT-70, we consider the tank as a weapon system to include the following: (1) the vehicle itself; (2) its human operators; (3) all on-vehicle materiel required for the performance of its tactical missions; (4) all personal equipment required by the crew;

and (5) perhaps most importantly, since weapon systems operate neither in a vacuum nor on a pool table, we include the operational environment of the system--at least insofar as we can simulate the operational environment.

Essentially, then, the above definition of "system" forces the consideration of much more than the (relatively) simple hardware item called a "tank." We must, for example, now expand our assessment to include the adequacy and effects of such items as the uniforms which the crew members wear; the combat vehicle crewman's helmet (which is an integral part of the communication system as well as an item of personal protection); the gas mask; items of equipment required for arctic operation; equipment for both internal and external communications; the tactics and procedural doctrine which dictate the use of the system, etc. Thus, in order to be able to more thoroughly investigate the specific effects of equipment design on this overall system performance, we at the Human Engineering Laboratories have initiated the development of a research tool which, with continuing development, can ultimately provide an adequate human factors engineering assessment of a complete and complex weapon system.

Naturally, the development of any assessment tool of this complexity and magnitude requires not only the cooperation but intimate participation of many other agencies for successful fruition. Therefore, before addressing myself to the description of our human factors engineering and tank effectiveness course, I would like to discuss the need for and implementation of a close and effective coordination between various agencies at the basic working level.

Perhaps one of the most difficult problems for the investigator when considering a total system is to divorce himself from the tendency to seek the "best" components. He must continually reassert to himself that he is not interested in the "best helmet," the "best gas mask," the "best fire-control system." Instead, he might often find that the second or third best component--which may not even meet the Qualitative Materiel Requirements when considered in isolation--may result in a much more effective total weapon system than would another component which rates higher when examined in isolation. And, of course, the ultimate goal from the user's standpoint is the most "effective" total system--not a mere assembly of high quality components.

Now it is not only conceivable, but unfortunately has frequently happened, that we have type-classified materiel which, when considered independently, met the established Qualitative Materiel Requirements and were essentially excellent items--but they have been items which were in part or completely incompatible with other components. Thus, while they may have been in themselves the "best" equipment of that type, their use as a component of a total weapon system can seriously degrade the performance of the system as a whole.

If we ask just how this could come about, we find that it is not the fault of the Qualitative Materiel Requirements nor the fault of the developing agencies, but due almost entirely to the lack of a suitable and readily available test vehicle for objectively assessing the performance of subsystems and components as they affect the total system. Thus, the individual agencies are often committed to the development of components almost in isolation. Sometimes it is only after the item is in the later stages of development that interface problems in the area of human factors engineering are considered. By then we are already committed to a firm concept which can only be modified in a piecemeal fashion.

What has been needed to avoid this, and what we feel we have begun to develop in our test program, is an assessment vehicle which can provide the means for coordinating early in the development cycle the efforts of all component developers whose end items must function together as an integrated whole.

For the first time, we will now be able to provide a test facility where a variety of agencies can participate--each as specialists in their own area--in order to obtain quantitative measures of how their components affect overall performance. Thus, they can modify their components--and this early in the design phase--to make certain they will interface correctly with other components and thereby not degrade performance. But of even greater importance in the long run, they will be able to obtain hard numbers, in terms of mission performance, which the user can understand, as to the importance of the contributions which their items make toward ultimate combat effectiveness.

I would now like to describe our Human Factors Engineering and Tank Effectiveness Course. In essence, this test course is only a research vehicle or tool whereby we can measure the effects of equipment design characteristics (from the human factors engineering point of view) on system performance. We will do this by developing a realistic environment in which we can evaluate the total system performance (man-machine) in its operational situation relative to effectiveness of mission accomplishment.

To better explain these goals, let us look at the various levels of operation or performance. First, of course, is the level of the individual "task"--that is where the operator pushes a particular button or manipulates a single control. This is the most basic level of performance; if the man cannot perform each task adequately, the man-machine system can never be fully effective.

The second level of performance is the "function." Examples of functions are (1) ranging, where the man must perform several discrete tasks in proper sequence to perform the function of ranging correctly, and (2) driving, where many tasks must be performed in an ordered sequence.

But the level of performance of most importance to the military is that of the mission--can the man-machine system effectively perform its mission in a combat situation? Effective performance at the mission level presupposes effective performance at the function and even the basic task level, not only of each individual crewman, but of the entire crew and vehicle operating as an integrated and coordinated total system.

In order to examine mission performance and the effects of the discrete task and function performances on overall mission performance, we have further developed the instrumented, two-sided combat scenario as a basic research tool. Now, while there is nothing new in the use of basic combat-type scenarios themselves as research tools, it is the degree and type of instrumentation that enables us to obtain human factors engineering data from which we can recommend changes in equipment design and operator procedures that makes our course unique.

In the development of the basic tactical situations used in our scenarios, we rely largely upon a mission narrative provided by the user which defines the role of the tank in combat. Thus, each tactical engagement in our scenario is, to the extent possible, taken from an engagement found in the mission narrative. The mission narrative also determines the environment, both within and outside the vehicle. Thus, the test situations themselves will be consistent with the tactics and doctrine concerning the future employment of the vehicle.

For example, one such scenario is shown here (Figure 1). In Phase A the tank crew is assigned the mission and they perform pre-operation checks. They then begin the course. In Phase B they are attacked by an enemy helicopter; their mission: survive (by evasive movements) and destroy the enemy attacker (with the secondary weapon). Then they continue to Phase C where they are attacked by two light antitank weapons. They continue moving while delivering fire on both weapons with the co-ax and secondary weapons.

Continuing on, they must ford a water barrier after which, in Phase D, they are met by a superior force of enemy tanks and forced to withdraw to a defensive position and prepare for an enemy attack.

In order to give an example of types of information which will be obtained from these scenarios, let us pull out one engagement--the helicopter attack--for a more detailed examination. The time lines for Phase B are shown on this chart (Figure 2). We have a line S for the system, C for the tank commander, D for the driver, and G for the gunner. Insofar as mission performance is concerned, the important events are shown on the system line. These are when the helicopter initiates its attack and when the tank fires effectively and destroys the attacking helicopter. However, as you can see on each of the crewmen's time lines, there are a number of individual tasks and functions which must be

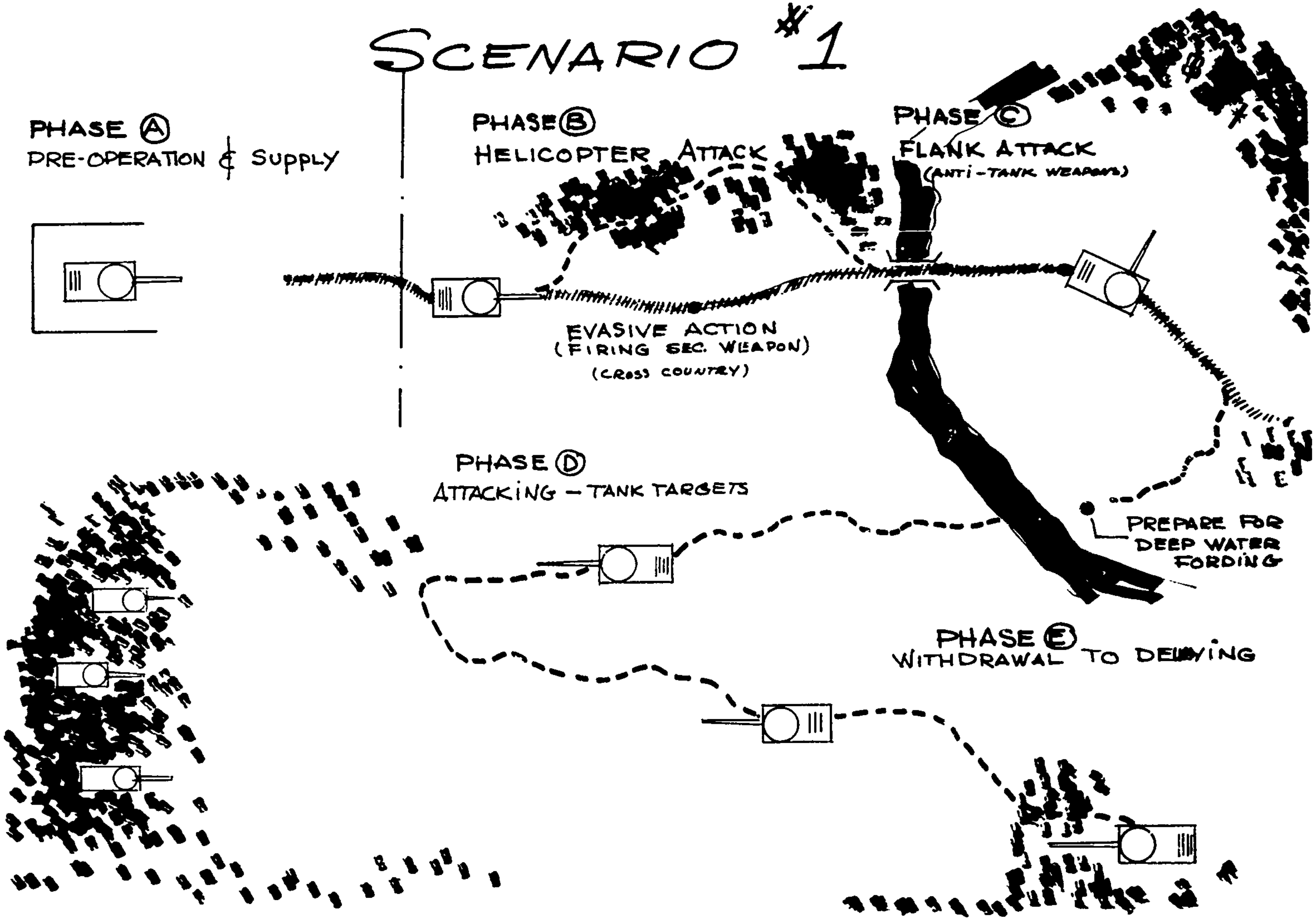
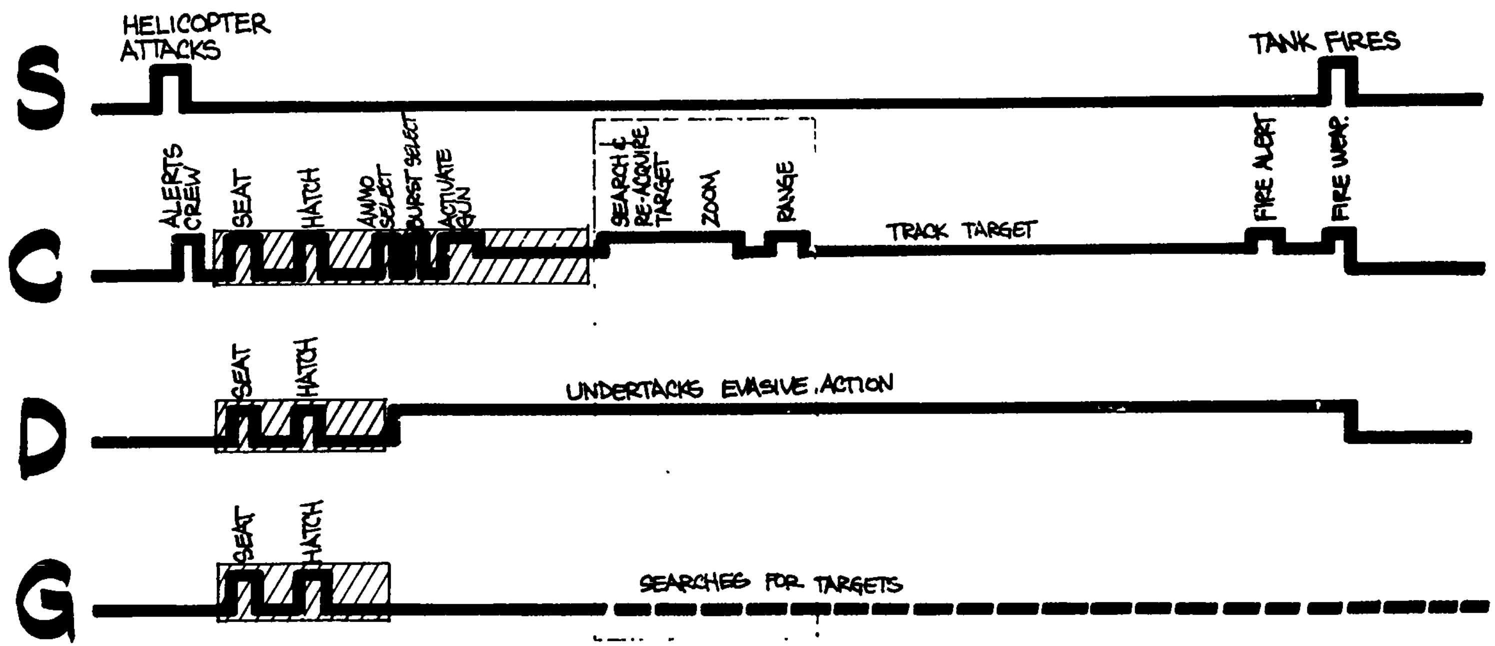


Figure 1. Schematic of Tactical Engagements in Scenario 1

PHASE B:



S
C
D
G
HELICOPTER ATTACKS
TANK FIRES
ALERTS CREW
SEAT
HATCH
AMMO SELECT
BURST SELECT
ACTUATE GUN
SEARCH & RE-ACQUIRE TARGET
ZOOM
RANGE
TRACK TARGET
FIRE ALERT
FIRE WEAP.
UNDERTACKS EVASIVE ACTION
SEARCHES FOR TARGETS

performed in sequence in coordination with other crew members in order to survive and accomplish the mission. For example, as the tank commander detects the helicopter, he alerts the crew. According to the mission narrative the tank has been traveling open-hatch. The crew must first button up, which means they must lower the seat, unlock the hatch, close it and lock it. The driver must also do these things before he begins evasive action, even though during the time he is lowering the seat and closing the hatch the tank becomes an increasingly vulnerable vehicle. Meanwhile, the tank commander is faced with a number of problems. After he closes the hatch, he can activate his secondary weapon and reacquire the target through his weapon sight, which now becomes a difficult job because his driver is undertaking evasive action and his gunner is traversing the turret in order to search for other enemy targets. These two movements give him one set of sensory inputs through his sense of balance and movement, while his eyes are giving him another set of sensory inputs through the optical system. Once he does acquire the target, his job is one of ranging, tracking the target, and destroying it. You can see we are concerned here not with just how accurately a man can shoot, nor how agile the tank movements are, nor how effectively the gunner can search for other targets, but we are concerned with all of these as they interact in a realistic environment to accomplish a given military mission.

Now, through analysis of these data, we will be able to tell just which tasks or which functions unduly extend the time required for effective mission accomplishment. Is it, for example, the time required to lower the seat or to close the hatch? This type of question is seldom considered in a normal evaluation of effective firepower, yet it is a question which could be of utmost importance in survival and mission accomplishment when the system as a whole is involved.

Our basic criteria for these tests include, of course, many of the standard and accepted concepts. However, in order to more thoroughly describe and define realistic criteria in terms of mission accomplishment, we are forced to redefine some of these concepts in terms which include the human factors element as differentiated from a strictly engineering-type definition. For example, we have defined tactical mobility not just as cross-country speed, or speed of the tank on roads, or cruising radius, but in terms of movement of the vehicle in response to the will of the tank commander. Of course, the tank commander must exert his will through the vehicle driver--so we now find the communications as important for tactical mobility as the driver's ability to manipulate the vehicle.

Another term which we have had to redefine is combat agility. Here it is defined as any vehicular movement which decreases the probability of the vehicle being hit when under direct fire. This definition, as you can see, is considerably different from any strictly engineering definition which concerns only the vehicle's ability to accelerate, stop, turn, etc., for now we look at agility from the viewpoint of enemy capabilities as well as the vehicle's characteristics and the way these two factors interact in a combat-type environment.

Vulnerability of the vehicle is defined in terms of several factors, including time of exposure to enemy fire and degree of exposure (which includes the angle and size of the presented target) as well as the factor of combat agility as previously defined. This means, for example, that the measure of vulnerability now includes potential use of the cover and concealment afforded by the environment in which the vehicle must operate.

Now that we have stated our objectives and described the methodology (test course) proposed for achieving them, let us see just what we might logically obtain through the conduct of this program.

Most evident, of course, is the fact that such a test course as this would provide us with an objective and quantifiable measure of relative system performance under operational conditions, a method of equipment assessment which could ultimately provide quantitative measures of the gains or losses in combat effectiveness provided by new weapon systems. But this is not solely the realm of human engineering and, in reality, it is not one of the goals of our program. Indeed, this could be accomplished perhaps more easily by conducting a similar, though simpler, test devoid of the detailed instrumentation required for the purposes of human factors engineering--for to simply compare systems one would only need to know how the totality of each system performs and need not be concerned with the specific contributions of the subsystems or components.

While we as human engineers are not concerned with evaluating the effectiveness of total systems in order to compare one system with another, or for the systems evaluations, we must have some means of reliably measuring the effectiveness of mission performance for use as a criterion--and this measure must be sensitive enough to discriminate between the performances of weapon systems. We must go even further and expend the effort required to measure in detail the effects of each basic man-machine interaction as it contributes to the performance of the total system. Only through this detailed examination of how specific equipment design elements affect the basic tasks and how these tasks affect function performance, which in turn affects mission performance, can we operate as effective human engineers. Only then will we have a research tool which will enable us to:

a. First, isolate those tasks and those individual functions where the human components of the particular system, as tested, require excessive time or make mistakes, or otherwise degrade total system performance.

b. Second, recommend equipment modifications and/or design changes which, by facilitating the crew's performance of their critical tasks and functions, might significantly increase the total system's capability to perform its required mission. And, most importantly, with regard to reducing the development time required for new weapons, we will be able to make these recommendations early in the development cycle rather than wait for the results of user-type tests where it is often far too late to make basic changes in the system.

c. And third, re-evaluate the performance of the modified system in order to measure, in terms which are meaningful and important to the user, the effects which our suggested design changes could be expected to have on combat effectiveness.

SESSION 2B
MANPOWER RESOURCES AND HUMAN FACTORS ENGINEERING

Chairman: G. G. Burgess
Office of the Deputy Chief of Staff for Personnel
Department of the Army
Washington, D.C. 20310

2B(1). TECHNIQUES FOR DEVELOPING SYSTEMS TO FIT MANPOWER RESOURCES

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INTRODUCTION

Within systems, the requirements for human resources are caused by three factors. These factors or generators of requirements are (a) the hardware which requires men to use it or maintain it, (b) the tactical organizational and operational environment which requires men to staff it and perform in the "real world," and (c) the logistic considerations which require men not only for parts and spares, but for food, shelter, fuel, transportation, communications, and other functions.

If systems are to be created that are balanced to operational readiness requirements, especially within manpower and skill resources to be available, then these factors have to be considered during the systems conception in a related and systematic way along with all other factors and not be simply a "blank check" fallout requirement of the other factors as has been the history of the manning area. It is becoming more obvious that the services are beginning to feel the need to exert some measure of control over system design where human resources are involved.

In the recent Human Factors Journal article, "Human Resources Engineering: A New Challenge," (1) this trend was traced from one of reacting to predicting to controlling. However, it is one matter to cite systems that caused a great deal of consternation and adjustment and to bemoan that methods were largely intuitive, did not provide analytical tools, relied on bookkeeping procedures and were seldom applicable to prehardware stages of system development, and quite another matter to develop acceptable techniques. Progress has been made slowly and this paper will now report on some selected research results.

HUMAN RESOURCES INFLUENCE DESIGN

Obviously one has to prove that human resources such as manpower and skills does affect design and show how it affects design or the cornerstone of the controlling process can not be laid. To get the answers, we of the Human Resources Laboratory in conjunction with the Bunker-Ramo Corporation conducted a study (a) to determine the effect on system design of using certain human factors data, in this case, manpower and skills data as design requirements, and (b) to determine under what conditions these inputs could be made to have maximum influence on system configuration (2).

The study simulated the design of the Titan III propellant transfer and pressurization subsystem (PTPS) by gathering the equipment and personnel documentation produced during the Titan III PTPS development and distilling them into the key inputs which had been provided to the original designers.

Six highly experienced propellant system designers (average 17 years experience) were selected as subjects and given the problem of designing the PTPS, starting from the statement of work. As equipment inputs, they received the information the original designers had received -- functional requirements, equipment specifications, and hardware information. They also received in the statement of work, a manpower constraint which required them not to exceed a certain crew size and skill level. In addition, they received incrementally other personnel resources inputs such as task sequences, human error data, and task time limits. This "design" phase lasted three months and included ten four hour sessions.

During the test period, the engineer subjects were required to develop all the outputs they would ordinarily be required to produce in actual design: schematics, equipment descriptions, operating procedures, control panel sketches, lists of required hardware. The detail these engineers provided was great enough so that at the end of the testing period the subsystem designs could be evaluated by mathematical systems effectiveness measures, including equipment reliability and safety.

In addition, at the end of each test session, the engineers were interviewed intensively to determine whether in their opinion the personnel data inputs were useful to them and if the data had influenced their design.

TABLE I

IMPACT OF MANPOWER AND PERSONNEL SKILL CONSTRAINTS ON DESIGN

Measure (Average)	Design Goal	
	Small Crew/High Skill	Large Crew/Low Skill
Human Functions	4.7	7.0
Equipment Functions	58.7	68.0
Required Personnel	6.0	8.3

Results of This Study

The major results and conclusions of the study were these:

1. Manpower and personnel skill data can have an influence on system configurations. Examples of this influence are given in Table 1. The three designers with a design goal of a small crew with high skill produced top-level schematics averaging 4.7 human functions, and the three designers with a design goal of a large crew with low skill produced top-level schematics averaging 7.0 human functions. The "small crew" designers averaged 58.7 and the "large crew" designers averaged 68.0 for quantity of items of equipment to be operated by personnel. Finally, the "small crew" designers produced configurations that required on the average 6.0 personnel to provide operation and maintenance, whereas the "large crew" configurations required 8.3 personnel.

2. The manner in which the individual engineer designs has a significant effect upon his reaction to the manpower and personnel skill data. The engineer's design concept is so quickly developed, based on his own past experience, that traditional incremental timing of the human factors inputs lag that concept. The engineer resists any change to his initial design as a restriction on his creative freedom.

3. The potential influence of manpower and personnel skill data inputs on system configuration is much greater than presently recognized or achieved. The inputs would exercise much greater effect if they were (a) included in the statement of work as design constraints, and (b) phrased in concrete-relevant terms.

Encouraged by the results of this research, we selected an air-to-ground missile system and on this more sophisticated system we are both replicating and expanding this type of research. During this effort, special attention is being focused on how the data are used in design and the format in which the data are most effective and helpful to the designers.

RELATING MANNING AND OTHER SUPPORTS TO SYSTEM OPERATIONS

Making human resources inputs to the design concepts will aid in developing a better system but all persons who have worked in systems development are aware of the "iterative" processes which occur throughout systems development and that the conceptual phase while important is only one part of the systems continum. As the hardware concepts begin to "firm," methods are needed by which to match or balance through tradeoff practices the hardware, human and logistic functions in order to get a best mix depending on the "real world" operational goals. While our research pertained peculiarly to the human resources, we had to be concerned with the over-and-under loads or bottlenecks anywhere in the system since a change in any part of any one of the three major functions usually and immediately upsets the balance and affects the other two values. A very simple case in practice would be illustrated when due to Air Force operations, if too many systems failed and piled up in lines awaiting service, although available men may be 100% utilized, the weapons operational readiness may still decrease. Therefore, a method was needed to locate these probable bottlenecks in early development rather than later when crash programs in the human or hardware sides of the system could result in more resources and expense and less operational capability. To answer the question for how to relate manning and other support requirements to system development and operations, we of the Human Resources Laboratory in conjunction with the RCA Company conducted a study (3, 4, 5).

The research was carried out in three phases: (a) development of a model based on queuing theory, (b) development of queuing tables to provide queuing characteristics of systems having spare or passive standby units (these tables permitted tradeoffs between such items as men, skills, spares levels, and downtime with given values of operational readiness), and (c) applying the research model to early weapon system data and comparing that output with operational wing data for the system. The results of these tests have shown that within the models developed, queuing techniques are valid and reliable for predicting requirements and making tradeoffs between manning and personnel skills, logistic supports, test equipments, reliability and maintainability, the number of weapons being supported and system operational readiness.

Examples of Tradeoff Relationships

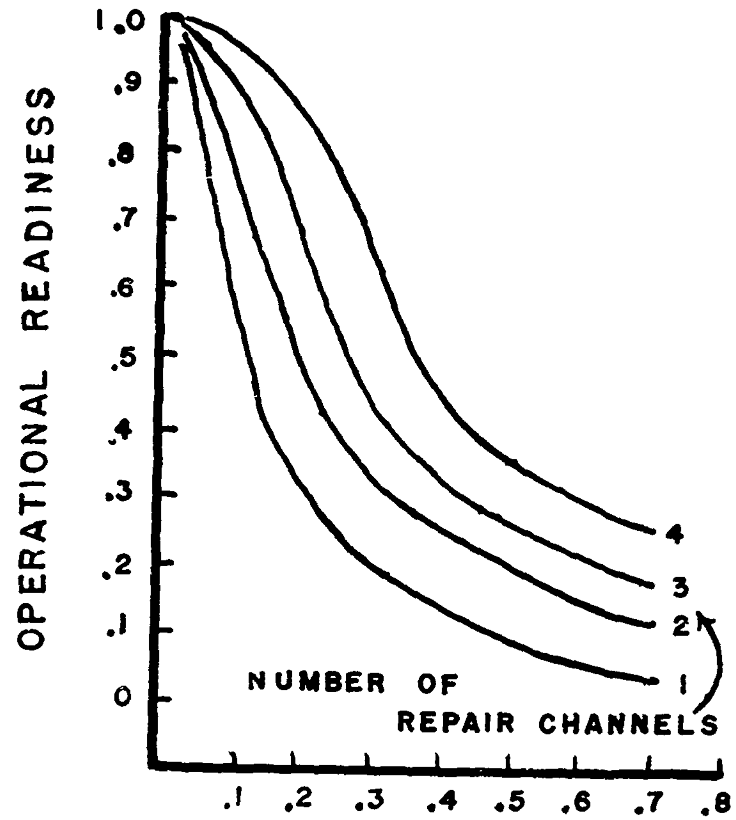
To convey some types of tradeoff relationships, four figures have been prepared. These graphs show representative trends, not actual data from any particular weapon system. Let us look first at the tradeoff of personnel and downtime (see Figure 1) of a subsystem or components, a most common problem in most maintenance activities. The figure is based on a fixed number of spare "black boxes" and operational units in any subsystem. In the figure is the very important "utilization factor" (p) which is a ratio established by the failure rate of the hardware item divided by the repair rate of the item by men. For a specified value of the utilization factor, operational readiness may be increased by addition of repair channels. (A repair channel can be one man or a maintenance team.) For a fixed operational readiness, observe that additional repair channels are required as the utilization factor is increased. Increased skill (training), one might note, would reverse this undesirable trend.

Let us look now at tradeoffs between personnel and spares. The above example for minimizing manning does not take advantage of spares. To further reduce personnel by capitalizing on spares, let us look at Figure 2. This figure is based on a fixed number of repair channels and operational units. For a specified value of the utilization factor, operational readiness may be increased by addition of spare black boxes. For a fixed operational readiness, observe that additional spare black boxes are required as the utilization factor is increased.

Figure 3 is based on a fixed number of operational units and a fixed value of the utilization factor. For a specified operational readiness level, several combinations of spare black boxes and repair channels are generally feasible. Observe that as spare black boxes are increased, the required number of repair channels is decreased.

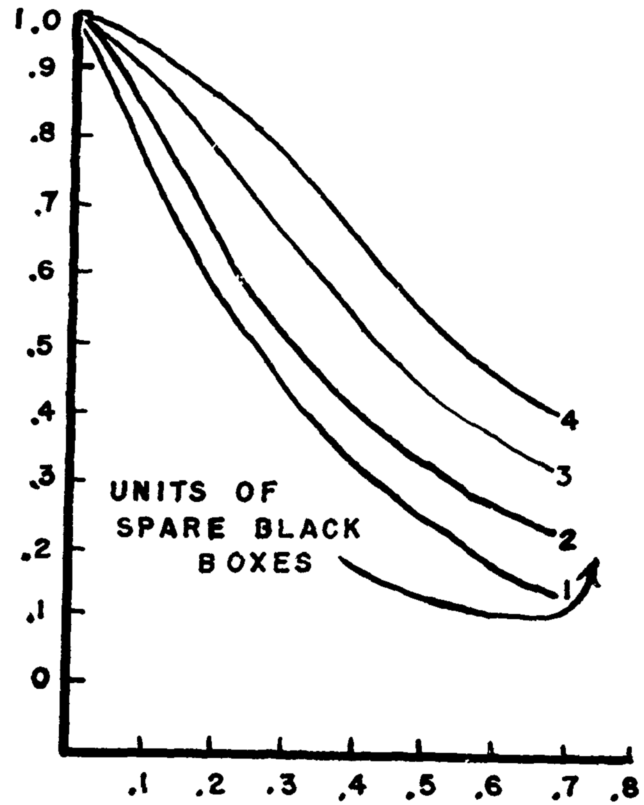
Figure 4 introduces the mighty important cost factor and looks at a least cost method of improving operational readiness. The figure is based on a fixed number of operational units and the cost ratio between such supports as spares (black boxes) and repair channels (people) for a given alternative system design. These curves reflect several ways of achieving a specified level of operational readiness. In general, a combination of spare black boxes and repair channels gives a least cost method of achieving an operational readiness goal.

Cost may be used to determine the optimum choice among several alternatives. It is highly likely that manning for cost minimization will be a goal. From the cost viewpoint, adding more equipment units implies added capital investment, adding repair channels implies added labor costs, and perhapsssome capital investment in repair facilities. Since each system change carries some cost questions, these costs can be weighted



$$\rho = \frac{\text{FAILURE RATE}}{\text{REPAIR RATE}}$$

Figure 1. Operational Readiness Related to Utilization Factor and Repair Channels



$$\rho = \frac{\text{FAILURE RATE}}{\text{REPAIR RATE}}$$

Figure 2. Operational Readiness Related to Utilization Factor and Spare Black Boxes

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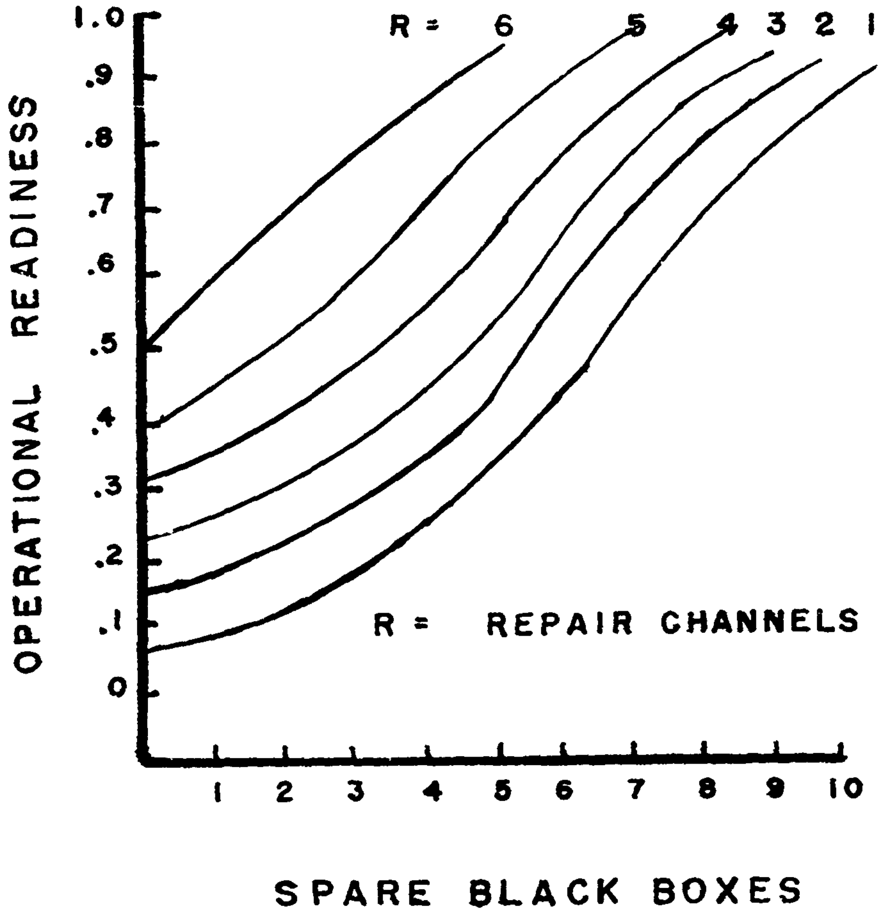


Figure 3. Operational Readiness Related to Feasible Combinations of Repair Channels and Spare Black Boxes

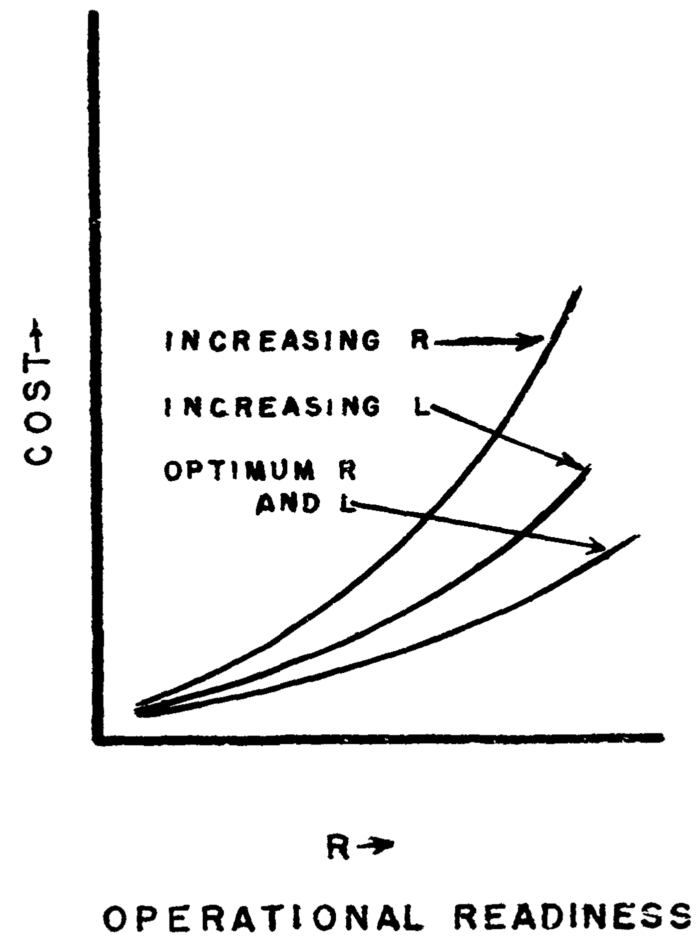


Figure 4. Least Cost Method of Improving Operational Readiness (R = repair channels, L = spare black boxes)

TABLE 2

COST MINIMIZATION

Cost of Repair Channel = 10X | Cost of Spare = X

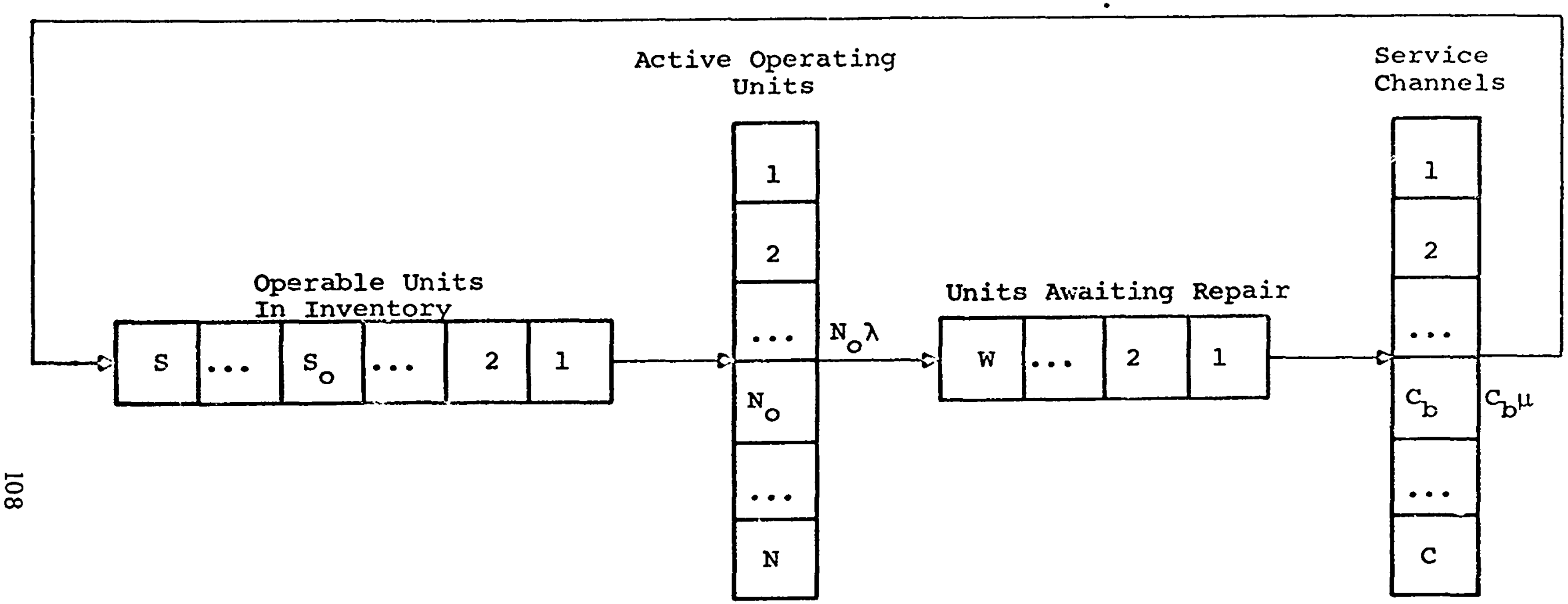
Case	Specified Operational Readiness	N	L	r	ρ	Calculated Operational Readiness	Support Cost
1	.40	4	0	2	.25	.40	20X
2	≥ .55	4	3	2	.25	.56	23X
3	≥ .55	4	1	3	.25	.58	31X
4	≥ .55	4	0	4	.25	.57	40X

against improvements. For example, Table 2 shows four cases or alternatives that have been worked out based on cost, where for purposes of illustration, the cost of a spare was X and the repair channel 10X. In this example, the number of operational units (N) and the utilization factor (p) were held fixed while the number of spares per shop (L) was varied and the number of maintenance channels (r) were varied. From the table, the choice of case 2 would provide the most benefit in a least cost sense.

Application of Queuing Techniques

Since the characteristics of military systems include quantitative elements such as spares, personnel, component failure rates and operational readiness requirements, and the characteristics are for practical purposes enclosed within a cyclical operational system, then queuing techniques can be applied. The best way in practice to apply these techniques is through use of precomputed tables (4). Tables and Fortran programs have been prepared for estimating the interplay within a complex system that depends on capabilities of support elements like personnel, logistic support components, organizational units like repair channels and test equipments to keep a wing of weapons at a given operational readiness level.

Figure 5 depicts an example of a queue model on which the tables are based. The mathematics of the model is based on exponential failure and service channel rates. Although seemingly restrictive in nature, the model provides accurate results even in cases which vary significantly from the exponential. Figure 6 depicts the format of the tables, based on their anticipated uses. Two parameters (N, the units demanding service at any time) and (p, utilization factor) are required to locate each specific table within the range covered. Within each specific table are two additional locators: service channels (C - columns) and spare units (S - rows). For combinations



N = Number of operational positions

N_o = Mean number of operational positions filled

S = Spare units

S_o = Mean number of operable spare units

C = Number of service channels

C_b = Mean number of busy channels

λ = Failure rate of operating unit

μ = Service rate of service channel

W = Mean number of units awaiting service

FIGURE 5. FINITE CYCLICAL QUEUE

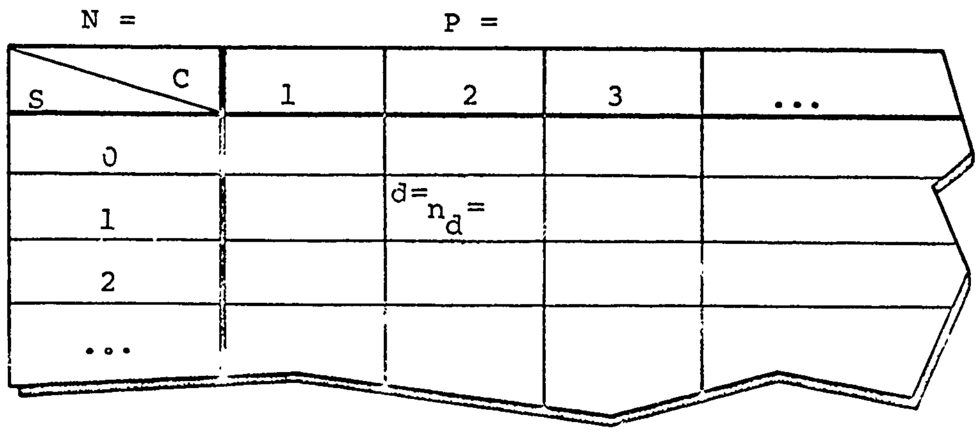


Figure 6. Format of Tables

of C and S there are two output entries; these are d, the fraction of units inoperable in excess of spares and n_d, the fraction of the total number of units down.

The effect on the output entries (d, n_d) of changing either C for a given S or S for a given C may be read directly in sequential order; viz., across a row for C and down a column for S. A particular advantage is that for a specified combination (C, S) the maximum rate of change in the d, n_d may be immediately determined from the difference in value between present value of d and n_d and that obtained from the adjacent row and column.

Perhaps the most important characteristic of this format is that it permits a visual evaluation of the effect or changing S and C individually or in combination. Given cost estimates of a service channel increment and a spare unit, simple cost analysis may be performed directly from the tables. In addition, complex system problems involving evaluation of operational readiness, test equipment readiness, manning analysis and utilization, and levels of maintenance shop activities may be solved with these queuing techniques -- the simple examples of tradeoff relationships between personnel and spares cited above were selected for illustration.

PERSONNEL RESOURCES SPECIFICATION

This paper was directed at ways by which systems can be developed and placed in the inventory and fit available human resources. The first part of the paper reported on the effect human resources information can have on the engineers who conceptualize the new system. However, you should have detected that this effect depends only in part on the engineer and contractor for the other part (the primary initiating part) rests upon the services to (a) specify to the engineer designer the manning and skills to be available for that hardware, and (b) to package that human resources data in some meaningful form useable by the engineer. What those data are, where and how obtained, and the format is a major order of business for human factors scientists. The second major part of this paper reported on techniques for interrelating human resources as a major part of the overall supports for a new system with other supports such as those of logistics, maintenance, and organizational activities for the purpose of relating these to system development processes, operational readiness and costs. This third part of the paper reports on a new specification by which personnel requirements will be stated in terms of system requirements and this represents a change for using personnel data in system development processes. The fourth part of the paper reports on the use of computers for handling human factors data during systems development processes. This represents a major change from previous task analysis processes and documents. Both the specification and computer developments have been directed at methods for integrating human resources with the 375 system engineering processes.

The Specification

During the past year, certain Air Force representatives in collaboration with representatives from such industry contractors as Boeing, General Dynamics, and General Electric have studied the procedures by which qualitative and quantitative personnel requirements of systems were determined. Many of you will know this area as QQPRI and will remember the process as the subsequent derivation from hardware subsystems of personnel information like tasks and position descriptions. The joint Air Force/ Industry study recently concluded its work with the preparation of a new "Personnel Resources Specification" (UC-141 and 142). This specification is to be tested by application to a coming weapon system (probably the Inter-Theatre Transport). The study group found that within the 375 processes, the hardware performance requirements are recorded on the Requirements Allocation Sheets (RAS) and translated into Design Sheets which in fact become specifications for Contractor End Items (CEI). From this study of the hardware processes, it was determined that if the personnel side of the weapon system were to become an integral part of the 375 weapon development processes, then personnel performance requirements would like hardware items have to be stated in terms of system requirements and go through the RAS and Design Sheet processes. This represents an important change from previous processes.

Before a personnel requirements sheet similar to a design sheet can be developed, however, personnel performance must be stated in terms of actions that can be observed, measured, and evaluated. This means that personnel systems engineering people must record performance requirements on RAS's in terms of tasks, conditions, and criteria.

Tasks will be stated in terms of end results, which can be observed, measured, and evaluated, and this means that individual and group performance must cite what the man must be able to do. Only those tasks suitable for proof during system test are included.

Conditions under which a specific person or team must perform will be identified, such as the starting condition, specified tools to be used, with or without formal written procedures, assistance or supervision required, and the specified environment.

Criteria or standards of acceptable performance, including the specific procedures to be followed, time limits, and performance accuracies.

These requirements for personnel performance when combined with those for hardware comprise the total systems operational performance requirements, which if not achieved, degrade the accomplishment of the systems mission. The Personnel Resources Specification (PRS) will cite how the personnel performance standards required will be met. This means the personnel requirements are compared with the human capability available and needs for additional training are ascertained.

In summary, you should have detected that while this PRS is a step which integrates human resources into 375 management and engineering processes, it is still primarily a data output rather than a data input device. That is, it does not act and is too late in the system process to act as a constraint or control to engineers conceptualizing systems that will fit within human resources. Furthermore, we can not make that data input step without valid data about the manning and skills of the Air Force population to be available for a specific system when it goes into inventory. Rather, the PRS is primarily a device which "red flags" the areas of tasks, conditions, and criteria within which humans must be trained or prepared to perform in order that the hardware subsystems not continue the malfunction or fail to perform. Therefore, the PRS cites demands that must be met by humans and training activities are the prime target.

COMPUTERS AND HUMAN FACTORS DATA

The size, complexity, and compressed development schedules of modern systems have resulted in the generation of increasingly large amounts of data. Much of this data has eventually reached some form of publication (like task analysis) which in itself is usually inflexible and unweildly, not timely, difficult to update, not reusable on subsequent systems, expensive to prepare and frequently inaccessible.

During the past four years, we of the Human Resources Laboratory in conjunction with the Systems Development Corporation have been developing techniques for handling human factors data in development of advanced systems. In the first phase of this work, we conducted an empirical study to identify who was involved in the generation and use of task data in system development, the types and uses of the data, the input/output relationships of data, the current and potential uses of computers in handling task data, and the desired characteristics of a data handling system (6, 7).

The second phase was directed primarily to the development and application of computer based techniques for handling human factors data that the specialists generated and used in their systems work. Research was conducted on (a) analysis of human factors task data, data relationships, and classification schemes, (b) development and application of thesaurus techniques to control vocabulary proliferation, (c) application of computer storage and retrieval techniques to task data, (d) application of analytic and simulation techniques, and (e) application of current awareness notification techniques (8, 9). The techniques developed were based on the assumption that a user-oriented computerized data handling system will draw human factors specialists closer to needed data. The application of such a system would reduce the problem of data accessibility and allow more effective use of data in the system engineering process. It would also allow reuse of data across systems. A data pool for test purposes was generated. This pool was generated during the early acquisition phase of the C-5A aircraft, the Minuteman Airborne Launch Control Center (ALCC), and the SV-IC Saturn launch vehicle. The data generated on these three systems by the originating contractors were prepared in accordance with newly developed classification techniques and once stored, the data are accessed selectively and processed using a retrieval language approaching English. Among the outstanding features of these programs are: selective retrieval of data through user-oriented query language, current awareness notification, and internal thesaurus computer program techniques. These techniques will result in more effective use of computers and allow the data user and the generator to be drawn closer to the data. The problem of data accessibility presently plaguing the government and industry will be reduced, and the data will be more effectively used in the design and development of future systems. In addition, the time-sharing capabilities of the data handling system will allow multiple users to query the system. This feature will result in reduced cost by improving efficiency of the data uses and the computer use itself.

A third phase was directed primarily to test operations. A test program, using human factors specialists assigned to several System Program Offices (SPO), was conducted to determine whether the computer programs met the requirements as identified during Phase I and II (10, 11, 12).

This research has been fruitful. Several prime contractors have sent many representatives to our laboratory for extended periods to study our "pilot" system and have put similar processes into their home operations. Our first purpose for this research has been attained -- that was to develop and test computer techniques and design a "pilot" model for subsequent development into a data handling system. Based on this research, a proposed Advanced Development Objective, "Automated Information and Data Handling for System Program Offices" (AIDSPO) was prepared recently and is under consideration as a development program.

We see data handling systems as a vehicle for human resources data input to the conception, development, test, and operation of systems as well as the receptor of data output, an integrator of human and hardware data within and across systems, and a feedback mechanism of field performance data to engineers and program planners within the services and industry.

REFERENCES

1. Eckstrand, G. A., Askren, W. B., and Snyder, M. T. Human Resources Engineering: A New Challenge. Human Factors, 1967, 9, 517-520.
2. Meister, D., Sullivan, D. J., and Askren, W. B. The Impact of Manpower Requirements and Personnel Resources Data on System Design. AMRL-TR-68-44, 1968 (in press).
3. Barton, H. R., Purvis, R. E., Stuart, J. E., and Mallory, W. K. A Queuing Model for Determining System Manning and Related Support Requirements. AMRL-TDR-64-21, 1964, AD 434 803.
4. Purvis, R. E., McLaughlin, R. L., and Mallory, W. K. Queuing Tables for Determining System Manning and Related Support Requirements. AMRL-TR-64-125, 1965.
5. Purvis, R. E., Mallory, W. K., and McLaughlin, R. L. Validation of Queuing Techniques for Determining Systems Manning and Related Support Requirements. AMRL-TR-65-32, 1965, AD 615 436.
6. Hannah, L. D., Boldovici, J. A., Altman, J. W., and Manion, R. C. The Role of Human Factors Task Data In Aerospace System Design and Development. AMRL-TR-65-131, 1965, AD 621 379.
7. Whiteman, I. R. The Role of Computers in Handling Aerospace Systems Human Factors Task Data. AMRL-TR-65-206, 1965, AD 631 182.
8. Potter, E. W., Tulley, A. T., and Reed, L. E. Development and Application of Computer Software Techniques to Human Factors Task Data Handling Problems. AMRL-TR-66-200, 1966, AD 647 993.
9. Tulley, A. T. and Meyer, G. R. Implementation of Computer Software Techniques to Human Factors Task Data Handling Problems. AMRL-TR-67-127, 1967, AD 663 209.

10. Oller, R. G. Human Factors Data Thesaurus: An Application of Task Data. AMRL-TR-67-211, 1967, AD 670 578.
11. Reardon, Sue Computerized Human Factors Task Data Handling Techniques: User's and Controller's Operating Guides. AMRL-TR-67-226, 1967.
12. Reed, L. E. Advances in the Use of Computers for Handling Human Factors Task Data. AMRL-TR-67-16, 1967, AD 670 291.

2B(2). TRENDS IN INPUT POPULATION

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The factors which affect the types of persons who enter and remain in military service are numerous, ranging from procurement medical and mental fitness standards by which recruits are screened; through quality of the national health, education and economic programs which affect the characteristics of available personnel; to military policies relating to service incentive such as preferable job training and assignment, pay, occupational satisfaction (fringe benefits), and how these benefits compare with those available outside the military service. Trends discussed here will be concerned mainly with health and physical characteristics of servicemen, and how these qualities may be affected by current and future military policies.

Medical Fitness of Servicemen

The health of personnel entering military service generally is influenced by policies relating to procurement medical fitness standards. The policy affecting most service entrants at the present time is fixed by public law which provides that procurement medical fitness standards shall be no higher than those in effect in early 1945. (1) This law, however, would not restrict the fitness of entrants, which could be attributable to the national general health improvement, and it does not affect military medical fitness policy pertaining to procurement of personnel for specialized training and assignments. Rate of military disqualification for medical reasons of preinductee Selective Service registrants examined for military service steadily increased over the eleven-year period beginning 1 January 1966 through 31 December 1966. See Table below.

Disqualification Rates of Preinductees for Medical Reasons - 1956 through 1966 (2)

Year	Rate of Disqualification (Percent)
1956	17.6
1957	19.1
1958	22.3
1959	24.7
1960	25.0
1961	23.5
1962	25.7
1963	27.1
1964	23.6
1965	24.1
1966	25.5

This increase in disqualification rate is probably due to improved screening techniques, rather than a decrease in general health of examinees or any increase in fitness standards. It does, in all likelihood, indicate an increase in selectivity and an upward trend in the general medical fitness of persons who enter military service. This increase can be expected to continue only as screening methods are improved. Occupational specialization in the military possibly has advanced at an equally rapid rate as in private industry. This, in its way, has served to demand better than average health fitness of personnel, primarily because the specialized fitness requirements are in addition to the general level of fitness required for a rigorous occupation. For example, the serviceman must first be fit for combat before he is considered for a radar equipment operator or repairman which requires above the average vision. Many such military specialties are filled through voluntary enlistments, particularly when the specialty has motivational appeal. Public law restricting the medical fitness requirement does not apply in these cases. Thus, the various military departments are more selective medically and more healthful personnel are recruited. During the three-year period, 1964-1966 inclusively, 74.6 percent of the 1,241,524 persons enlisting for military service were qualified in physical category A (with no functional incapacity) while 70.7 percent of the 725,007 inductees during the same period qualified in this physical category, indicating that enlistees normally are better qualified medically than is required by the established fitness standards. (3)

Procurement medical fitness policies are designed to ensure recruitment of personnel who meet the current standards, with a sufficient number of over the average qualified personnel to fill special requirements. Experience has shown that the current standards are adequate for this purpose. In terms of the military physical profile factorial system (4) (symbolized by P (Physical Capacity or Stamina) - U (Upper Extremities) - L (Lower Extremities) - H (Hearing and Ears)- E (Eyes and Vision) - S (Psychiatric) - PULHES), the fitness qualifications of persons currently entering service, which are not expected to change significantly in the forseeable future, are as follows:

73.1 percent of all entrants, enlistees and inductees, are qualified by physical profile serial 111111, Code A (No demonstrable anatomical or physiological impairment within established standards).

26.9 percent are qualified by equal or better than physical profile serial 222221, Code B (Minor loss of digits, minimal loss of joint motion, and visual and hearing loss slightly below those prescribed for Code A). The best Code B profile serial would be one with only one "2", for example, 121111.

Physical Characteristics of Servicemen

The average age of military service entrants today is approximately twenty and one-half years (1966), with more than 95 percent of these persons ranging in age from 17 to 25 years. (2) The approximate average height of entrants in this age group (17 - 25) at the end of 1958 was 68.9 inches (with a standard deviation of 2.7 inches), with an average weight of 158.0 pounds (standard deviation of 24.3 pounds). During World War II, approximately 12 years earlier, approximate average height of this age group was one-half inch shorter and weight was seven pounds lighter. (5) Because of the restriction on procurement height and weight standards, in effect since 1958, it is suspected that average height and weight of service entrants have increased only slightly since that time. Any increase probably would be due mainly to the increasingly liberalized waiver policy.

Beginning about May 1968, weight standards have been liberalized further to routinely accept certain volunteer enlistees who are fifteen percent over the established weight standards and those who are ten percent under the standard weight. The projected increase in acceptable weight is justified by the known increase in height and the standards for height-weight relationship will not be substantially affected. The lowering of acceptable weight is justified by the increased flexibility of military logistics, and to benefit from the specialized technological skills that may be held by the smaller man. Thus, it can be expected that servicemen of the future will constitute a broader range in physical size, larger and smaller.

REFERENCES

1. 50 United States Code 454, Public Law 90-40, Military Selective Service Act of 1967. (Sec. 4(a))

2. Supplement to Health of the Army - Results of the Examination of Youths for Military Service, 195601966 - Office of The Surgeon General, United States Army.

3. Supplement to Health of the Army - Results of the Examination of Youths for Military Service, 1964-1966 - Office of The Surgeon General, United States Army.

4. Army Regulations 40-501, Standards of Medical Fitness, Chapter 9, Physical Profiling, Headquarters, Department of the Army, December 1960. (A copy of these regulations may be obtained from the Superintendent of Documents, United States Government Printing Office, Washington, D. C. 20402 for $1.25. Refer to catalogue listing D 101.9:40-501-reprint.)

5. Bernard D. Karpinos, current Height and Weight of Youths of Military Age, Human Biology - Vol. 33, No. 4, December 1961 - Wayne State University Press, Detroit, Michigan.

2B(3). MATCHING MANPOWER RESOURCES AND REQUIREMENTS

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INTRODUCTION

Most of you attending this conference could readily talk to some aspect of this topic. By judicious selecting of speakers from among you, there would be almost no duplication. Each speaker would surely approach the topic from a direction determined by his own perception of the nature of the problem, the kinds of solutions he believes to be practical, the expertise he brings to bear, and his concept of what the audience hopes to gain. Each potential speaker now in the audience may well be anticipating a discussion developed along the paths with which he is familiar. There is thus a third matching process to which I should like to give priority over those in the title--the matching of the intentions of the speaker and the expectations of the audience. I hope that in none of these matching problems are we contending with irreconcilable gaps.

In brief, an idealized manpower management system encompassing the manpower resource-requirements matching process will be defined and discussed from a modeling-oriented point of view. The problem of interest is the planning, design, and implementation of an efficiently intra-connected manpower system whose functional elements (which may lie across command lines) recognize common goals and have coordinated means of achieving these goals. It will be my purpose to describe how this problem appears as viewed from an in-house research activity, and to propose a role for human factor research activities in the improvement of manpower management techniques. It is this possibility of blending the techniques and substantive content known to the human factors scientist with the quantitative tools of the operations research analyst and computer science professional to solve manpower resource management problems that makes the presentation of a paper on this topic appropriate at a human factors conference.

This blend of techniques and substantive content directed towards a manpower management problem deserves a name of its own. This developing discipline--for such it is--may be aptly referred to as "macro-human-factors." While it would be a mistake to carry the analogy too far, the well accepted division of macro-economic theory from micro-economics provides a precedent for attaching the prefix "macro" to theory and techniques that relate to the aggregate behavior of human factors variables. In this discussion it will be assumed that we are applying macro-human-factor concepts to the manpower management problem before us.

The Functional System

The two cutting edges of the problem of matching manpower resources and requirements as stated in the subtitle (the matching of manpower resources to military requirements and the matching of manning requirements to manpower resources) will not be wielded separately. I will begin with the premise that this particular matching problem cannot be approached adequately by considering requirements to be fixed and resources to be allocated, developed, or otherwise managed--or conversely, by considering resources as fixed and requirements to be managed through assignment of priorities or through more efficient utilization or substitution procedures. Effective matching must relate to all these approaches simultaneously and must have a clearly agreed upon criterion or utility measure to determine how well the system is performing.

We need not--we should not--be sidetracked by organizational considerations. In defining the manpower resources-requirements functional system, we should be charitable enough to assume that top management will not permit organizational boundaries to stand in the way of functional efficiency. As need arises for communication and cooperation across these boundaries, appropriate modus operandi also arise. It is thus reasonable as well as convenient to think in terms of the manpower functional system without regard to whether DCSPER, DCSOPS, ACSFOR, CONARC, AMC, or CDC have the staff or command responsibility for various aspects of the functional system.

The manpower management functional system can be described in terms of resources and requirements as in Figure 1. Note that a process-control model would be more appropriate for depicting the management of manpower resources than would a warehouse-inventory model, inasmuch as the Army is constantly modifying its manpower resources to meet existing and projected requirements.

Similarly, the Army determines its projected and current manning requirements in consequence of, or as a function of, policies and doctrine which the Army develops to

REQUIREMENTS Management Functions	RESOURCES Management Functions
Distribution Priorities	Procurement
Manning Levels	Selection
Job Engineering	Allocation
Requirement Substitution	Distribution-Rotation
	Training
	Retention

Figure 1. The Manpower Requirements and Resources Functional System

meet broad strategic objectives. Let me emphasize that numerous day-to-day decisions regarding military and manning requirements are made at a variety of locations in the Army --decisions which in some cases actually modify requirements and in others provide reestimates of requirements.

The effect of manpower resource management in terms of the training option is partially broken out in Figure 2 to illustrate the broad scope of the functional system. The basic manpower resource unit is the untrained new soldier--not the trained personnel ready to fill military requirements. Thus, the resources available to meet a particular requirement are to a large extent under control of the Army. Conversely, the effect that resource management policies have on requirements is also well illustrated by the training function. It would frequently require an arbitrary decision to say whether strategems employed in the management of training are aimed at increasing resources or at reducing requirements. We have already noted that the functional system required for effective manpower management will not necessarily separate these two aspects of the resource-requirements matching problems.

The Role of Macro-Human Factors

The traditional role taken by the human factors scientist to assist in the manpower management mission has been to provide the interfaces between the individual and the manpower functional system. This application of behavioral science to enhance the performance of individuals within the Army can be thought of as falling within the scope of micro-human-factors. Better measurement devices, better curricula or training procedures, or better man-machine interfaces through the application of human engineering approaches are all examples of contributions to the Army manpower management system which relate to individuals. In contrast, the study of system performance in the context of personnel management policies can be relatively depersonalized as the techniques of macro-human-factors come to the forefront.

A. More Trained Personnel

- Retain Surpluses
- Increase Training Rate (and Procurement Rate)

B. More Effective Training

- Increased Level of Performance
- Reduced Manning Level Required
- Shorten Training Pipe-line
- Reduce OJT Loss

C. Stockpiling of Trained Personnel

Figure 2. Training Policies for Matching Manpower Resources Requirements

The following two examples should not be considered as delimiting precisely the concepts of micro- and macro-human factors but simply as rough indicators of their mutual boundaries at two specific points of interest. The first example is in the problem area spanned by reenlistment variables. Micro-human-factor studies would attempt to provide a means of predicting who will reenlist. The macro-human-factor approach would seek answers to such questions as "How many of a specified category will reenlist?"; "What effect would an increase in reenlist rate have on resource projections (e.g., considering alternative training and promotion policies)?", or, considering known relationships between certain variables, "What effect will prescribed procurement policies have on a future reenlistment rate?" A second example illustrates the boundary in the training area. The development and evaluation of procedures to bring less talented personnel up to prescribed skill levels requires the efforts of micro-human-factor experts, while the determination of the effect of this policy on the retention rate of the trained soldiers (presumably a greater retention rate traded off against the greater training expense and lower predicted performance) would constitute a macro-human-factors study. Many micro-human-factor techniques--such as those which provide measures of human performance, skills, and attitudes--will have increasing usefulness because they are means by which data are acquired for macro-human-factors studies.

The contribution of the macro-human-factors scientist to the improvement of the resource and requirements match within the manpower management functional system would be primarily in the application of operations research and system analysis (OR/SA) techniques, psychological measurement techniques, and a substantive knowledge of the variables relating to Army personnel. This measurement technique and substantive knowledge is inherited from the micro-human-factors scientists. The applicable (OR/SA) techniques do not include a very large representation of the broad spectrum of tools found in OR survey text books. Rather, there would be a somewhat unbalanced emphasis on system simulation via computer models, formal optimization models, heuristic optimization approaches, stochastic processes, and statistical methods. Most of these tools are encompassed by the single unifying concept of a system model containing a criterion (i.e., objective function) to be optimized in the face of system constraints on permissible policies. The usefulness of modeling a manpower functional system in terms of macro-human-factor variables will be discussed in the remainder of this paper.

Models of the Functional System

For our purposes, a model can be described as a logically connected set of rules that abstract selected characteristics of the manpower resource-requirements functional system (see Figure 3). We can further narrow our area of interest in models by requiring that models must provide for the making of decisions regarding manpower policies or personnel actions. Only models which describe manpower functional systems in terms of macro-human-factors variables need be considered in the present context. Models of physical systems which might conceivably be considered analogous to manpower functional systems should be avoided. Just as viscosity and pressure have relevance to a hydraulic model, so

MOS substitution, predicted performance, and rotation policies are concepts which generate variables relevant to manpower models. The functional characteristics of variables in the two kinds of models show little cross relevance. Macro-human-factors problems require that problem formulation be in terms of macro-human-factor variables and that models with appropriate functional characteristics be developed.

What is a Model: - a small copy or imitation? - a standard? - a preliminary representation? -- A logically connected set of rules that abstract selected characteristics of some phenomena or system

Figure 3. Definition of a Model

The concept of a model has value in solving the resource-requirements matching problem even when the functional system is too complex to quantify, the system goal too elusive to define, or organizational barriers prevent the functional system from operating in the most effective manner. As a first cut at the problem, we can segment the functional system into several smaller models for which the criterion can be defined and the required decisions effectively implemented. Also, the process required to make the decisions which bear on the values taken by the criterion variable need not be completely quantifiable in the sense that the model output is uniquely defined by the input. The model may quite frankly resort to sub-optimization approaches and contain decision points which require human judgment rather than data and formulae. In spite of such formidable difficulties, an overall model can be created which includes criterion functions to be maximized or minimized as the system goal (with cost or utility functions related to each system goal and each decision alternative) and constraints on decision alternatives defined.

Thus far, we have a loose concept of a model in which there may be several criterion variables and decision sub-models defined in a manner which might well defy exact solution of the optimization problem within the present state-of-the-art. The optimization problem is further complicated since this loose model of the functional system would most likely contain several subjective decisions at crucial points and would require the accurate measurement of a variety of human factor variables. It is understandable that such a model does not often appeal to an OR analyst looking to apply his analytic tools. Such a model could be expected to be more challenging and exciting to the macro-human-factors scientist.

In terms of an idealized model for the problem discussed here, the maximum utility of the functional system being modeled would be achieved when a feasible configuration of manning requirements having a maximum value for the utility function is found. The feasibility of a particular manning requirements configuration is demonstrated when the manpower resources are shown to be sufficient to fill the manning requirements. These resources may be optimally allocated, trained, or otherwise manipulated in order to show that a match of manning requirements and resources is feasible.

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The utility of the functional system is defined in terms of the military requirements--either in terms of the extent to which military requirements are met or in terms of the utility value assigned to a particular configuration of military requirements that can be met. A practical model would probably require the consideration of a hierarchy of military requirements ranked in order of the utility assigned by top policy makers. In the latter case, the objective of the decision process in matching manning requirements and manpower resources would be to meet the highest ranking military requirement. One way or another, the optimal solution must maximize military utility (expressed in terms of military requirements) within the bounds of a feasible match of resources and manning requirements.

The necessity to find a configuration of manning requirements which is consistent with a configuration of manpower resources and at the same time maximizes a military requirements criterion function makes it likely that solutions will be iterative in nature and approximate rather than exact. Such approximations are often sufficiently close for operational management purposes.

The model of the functional system can confine itself to "horizontal" movement in which the state of the system, possible decisions, and consequences are considered at a particular point in time. Exercising such a model through several such time slices permits the addition of a vertical (time) dimension with additional variables and functions. In such a model, both horizontal and vertical changes can be manipulated to alter the value of a criterion function at a future date or during some future time interval.

It has been noted that the functional system may have characteristics which prevent the development of a single integrated model that can provide a good fit to the total system. Thus, description of system goals and constraints may require the use of several loosely defined models of varying degrees of abstraction and quantification, some sparsely connected with others. These system models should incorporate decision models of various types.

Decision Models

Decision models may be concerned only with constraints, as in type 1 of Figure 4. Other models may have constraints and a goal (objective function) but no systematic approach to making optimal decisions. Since our goal is to improve the decision process rather than to describe an existing, possibly inappropriate process, a type 2 decision model would be incorporated in a system model only if the data required to effect the desired optimization must remain outside our grasp, or if the capability to effect an improved decision must be considered unlikely for organizational reasons.

Type 1.	Constrained system with no objective function
Type 2.	Expedient system with effectiveness measure (but no optimization algorithm)
Type 3.	System with effectiveness measure and approximate optimization algorithm
Type 4.	Optimized Model

Figure 4. Decision Models of the Functional System (Varying Degree of Optimization)

While fully optimized decisions (type 4) represent the ideal solution, the approximate solution (type 3) may be sufficiently close to the exact solution to make an exact solution impractical. The convenience of being able to make decisions at separated locations with an approximate algorithm may far outweigh the slight gain provided by an exact but necessarily centralized solution.

Decision models may relate to specific actions (see Figure 5, type 1), as when EM are given initial assignments by a computer program which sequentially maximizes the fit of counselors' recommendations, minimizes travel costs, and maximizes predicted performance (Army Aptitude Area scores). Other decision models may select optimal policies to be applied in managing resources or determining manning requirements. For example, Mr. Kenneth Haynam of BESRL recently reported on an optimization algorithm which will find a constrained cross-training policy for minimizing the cost of meeting all prescribed contingencies (military requirements). BESRL is also developing decision models in which an out-of-kilter algorithm can be used to find policies which will minimize flow between certain nodes in a dynamic flow model. This latter model would in effect find an optimal policy for distributing manpower resources under prescribed system constraints (requirements, nondeployability of personnel, etc.) while minimizing a particular undesirable use of manpower resources.

The formulation and application of decision models, with optimization algorithms where appropriate, is an important part of the modeling process, but it is by no means either the beginning or the end of the research required to apply macro-human-factors to the manpower functional system. Research directed towards better measurement of personnel system variables will frequently have to be accomplished before systems models can be developed. Also, the identification or development of criterion measures may in itself constitute a major research study.

Type 1.	Personnel actions optimized
Type 2.	Policy Optimization
	a. Aviator cross-training policies
	b. Rotation policies (out-of-kilter algorithm)
Type 3.	Simulation to determine "best" feasible policies

Figure 5. Optimization Models

All disciplines or technical areas, including macro-human-factors, have requirements for both research and operational personnel. Both ends of the research-operations continuum require all the skill and creativity that can be brought to bear in applying the relatively new macro-human-factors discipline to complex personnel management problems.

Yet there is need for a clear distinction between the missions of macro-human-factor specialists who make their contributions in research organizations as constrasted with operational organizations. There are important differences, one being in the degree of responsibility for a given operational system. The greater responsiveness to immediate operational problems which should characterize the operational organization is traded off against the greater freedom to exercise scientific judgment found in the research organization. The research organization will also generally have wider experience with a variety of problems through its Army-wide mission. Macro-human-factors expertise is needed in both research and operational organizations with close cross coordination if the resources-requirements match is to be effectively accomplished.

Those who have been waiting for the speaker to begin a detailed description of a specific model for the manpower requirements-resources matching process--as their cue to either start or stop listening--can relax. It isn't going to happen. BESRL (Mr. Haynam) did make such a presentation at the most recent Army Operations Research Symposium. A model which would provide an appropriate example of a manpower management decision problem, along with an optimization algorithm, was provided to those who had chosen to attend the more technical of two alternative sessions. At the end of the symposium the distinguished professor invited to summarize and evaluate the conference stated that such method-oriented technical papers were not appropriate for presentation at an Army Operations Research Symposium. I would not presume that a Human Factors Conference would provide a more appropriate audience for a technical paper on models. Instead, I will offer to distribute revised copies of Mr. Haynam's paper to interested persons at this conference and suggest that other interested persons obtain a copy of the more complete BESRL publication which will become available at a later date.

SUMMARY AND CONCLUSIONS

The matching of manpower requirements and resources is currently attempted within a complex functional system which cuts across existing organizational lines. The development of a "loose" model of this functional system is a feasible accomplishment. Improvements, including the insertion of appropriate decision models and realistic criterion measures, could be incorporated into this overall "loose" model. The techniques and substantive knowledge required to accomplish this modeling and improvement of the personnel management system forms a relatively new field of macro-human-factors. It is felt that the OR methodology required in this new field should not be overemphasized at the expense of the substantive contributions of psychology and personnel management. For our matching problem, modeling should be preceded by a problem formulation phase, with emphasis on the measurement and manipulation of human factor variables in both phases.

Human factor specialists should not continue to leave the field of macro-human-factors to those trained in other fields (e.g., economics). The nature of the variables in manpower models requires the application of human factor principles for realistic system simulation, optimization of system criteria, or prediction of system results as a consequence of using various policy alternatives.

I am not saying that only macro-human-factor specialists should work with manpower models. Our problems in this area are too pressing and numerous to afford any diminution of productive effort.

Instead, I am proposing that more personnel and measurement psychologists should be assuming the role of macro-human-factor specialists.

Lastly, the human factor specialist should perform in both operational and research roles. All of us are aware of the necessity for close communication among personnel management, operators (action officers, etc.), and modelers if solutions are to be meaningful. The conclusion that the operational agency affords the best opportunity for closing this communication loop can hardly be contested. However, as was pointed out above, compensating advantages can accrue to the location of a macro-human-factor scientist in a research organization. Really satisfactory progress in the solution of macro-human-factor problems will occur only when coordinated efforts are based in both operational and research activities.

2B(4). MODELS FOR ESTIMATING PERSONNEL COSTS

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It is a pleasure to have been invited to discuss the cost model before this Human Factors Conference. Looking at the historical events leading up to the formation of our study group, we find human factors considerations the prime motivators for the cost model study.

In December 1964, the Secretary of the Navy directed that a task force be established to investigate Navy/Marine Corps personnel retention problems. The task force was given a very broad charter. It was specifically directed to examine the retention problem from practically every conceivable human factors aspect.

In January 1967, DDR&E and ASD(SA) initiated a study to determine "what work should be done on man/machine interface in the design and operation of weapon systems for maximum effectiveness and minimum life cycle cost." In both studies human factors and man's effectiveness were prime considerations. Dr. Weisz, the technical director of HEL, participated in the second study.

In both studies it was apparent that a standard definition of personnel cost was lacking and a uniform data bank where one could obtain personnel costs was a sine qua-non.

So, in the now famous 26 April 1967 memorandum, the ASD(SA) directed each of the services to nominate a working member and an alternate to a study group that would develop a "military manpower cost model to be used in weapon systems analysis." I am the Army member of the study group. There also appears to be some White House concern over the lack of useful manpower cost data. In addressing the 1966 Air Force sponsored Anniversary Symposium on Personnel Research and System Effectiveness, Mr. Jack Carlson, a member of the staff of Council of Economic Advisors, in referring to personnel "cost factors," stated that they "usually reflect only current budget costs. They do not include in-kind benefits such as dependent medical care or future cash payments such as retirement or 'insurance' payments for disability. There is no costing of personnel as they flow through career patterns, including expenditures for training, education, orientation, and relative levels of performance. Consequently each service has practically no information as to the cost of each personnel type. One reason for this situation is the difficulty of developing this kind of data in the present structure of the planning-programming-budgeting system. Apparently no attempt has been made to develop data for a personnel system." (1)

The inadequacies of military manpower cost can best be gauged by the marked lack of symmetry in the treatment of manpower cost as compared with that of hardware. In the typical weapon systems analysis, the cradle-to-grave or life cycle hardware cost categories include: research and development, investment, and operations and maintenance. The manpower costs are generally limited to training, travel, pay and allowances. Limited as most weapon systems cost models are to budgeted items, those data elements that are not included in the budget or are subsumed under other elements - not easily identifiable - are usually not considered. A typical manpower life cycle cost that is customarily excluded is the procurement cost, a large portion of which is borne by the Selective Service office. You see, this is a non-DOD cost. But the most drastic bias is introduced after military separation.

When equipment becomes obsolete, DOD either junks it or retrieves a small salvage value. Not so, as regards military personnel. When the enlisted man or officer separates, he immediately becomes eligible for a whole list of benefits, the cost of which does not show up in the DOD budget, but is carried by civilian agencies, as for example, Veterans Administration and the US Civil Service Commission.

The nature of the guidance given to the study group is summarized in Chart 1.

ADMINISTRATIVE GUIDANCE

In-house effort.

Maintain close coordination with RMS and JUMPS.

Identify and standardize cost categories, data elements, applicable to all of the Services.

Develop standard cost formulae, formats and procedures.

Each of the Services to develop its own computer programs.

CHART 1

First of all, the effort was to be performed in-house. Not only that, we don't even have a budget. There are a variety of on-going efforts within DOD with whom we exchange information so as not to duplicate our efforts. One of the most important contributions will be the identification and standardization of all cost categories and their elements, uniform for all of the Services. In this, we will work closely with the DOD data element standardization project. Computer compatibility is difficult to achieve. Hence, the Services will do their own programming subject to the procedures established by the study group.

The technical constraints imposed by OSD will cause our model to differ quite radically from previous models. (Chart 2) Total government costs will be identified and categorized according to personnel administrative functions. The rationale for including total government cost, I have already explained. We find, furthermore, that indirect support costs are generally missing from the other models.

TECHNICAL CONSTRAINTS OF THE COST MODEL

Total government costs, not just DOD costs.

Include indirect manpower costs.

Personnel capital investments with appropriate discount rates.

Payback rates.

CHART 2

Our model will not be appropriation oriented. It will be more economic cost oriented, although we will tag our data items with appropriate identifiers. Premiums for future employers' costs that are met by annual appropriations such as pension and unemployment insurance benefits will be actuarially computed by grade. Other innovations will also be included.

The study group has added some constraints of its own. (Chart 3)

STUDY GROUP ADMINISTRATIVE AND TECHNICAL CONSTRAINTS

Charge all costs, from the employer's point of view, to the duty position/billet.

Study group will design the data bank.

Include usage factor for real estate, plant and equipment.

CHART 3

We will charge all costs to a duty/position billet. These will be employer costs. We will structure the data bank. In most cost models, because they are appropriation oriented, the cost of property and equipment that has already been purchased is considered to be excluded in the sense that such costs do not figure in current budgets or appropriations. The study group has decided to include fair usage or rental costs for land, plant and equipment, regardless when they were paid for. Such items will be identified.

Because many duty positions, especially in the indirect support areas are filled by civilians, a subsidiary civilian life cycle cost model is required. The development of this is being recommended as a separate study.

Our study group has been in existence for a year and a half, during which time we devoted most of our effort to selecting the appropriate cost data elements and items and to providing several of their definitions. The data elements and their definitions account for most of our second report distributed in May.

During the next several months we will be engaged with what I consider to be the heart of the problem: formula development and estimation of non-DOD generated costs. With regard to the former, we will rely heavily on the research being performed by Navy's personnel research activity at San Diego and on that being performed by B-K Dynamics, Inc. who is developing a manpower life cycle cost model for one of the future Navy ships.

Chart 4 lists by personnel function the non-DOD generated cost items. I shall explain the less obvious ones. The US Office of Education subsidizes the several public school districts for each student in grades K-12 who is a child of a military member or of a Federal Civil Service employee. The dispensing formula depends on the applicable office of education appropriation. Another cost is incurred by the Post Office. Part of the cost of their annual operations is generated by their operating certain military post offices and by their handling of military personnel mail.

CHART 4

COST ITEM OR BENEFIT BY PERSONNEL CATEGORY AND NON-DOD AGENCY

CATEGORY	ITEM OR BENEFIT	AGENCY
Procurement	Recruitment	Selective Service
Sustainment	Aid to Impacted Areas	US Office of Education
Distribution/ Management	Postal Services	US Post Office
Post Separation	Disability Pension	Veterans Administration
	Education and Training	Veterans Administration
	Health and Accident Services	Veterans Administration
	Welfare	Veterans Administration
	Unemployment Insur- Benefits	Department of Labor

Ex-servicemen separated under other than dishonorable conditions and ex-Federal Civil Service employees are entitled to unemployment insurance. The states administer these programs almost exactly as they do their own state unemployment insurance laws for the private sector. The cost of the benefits and of the Administration is met by the US Department of Labor. In the calendar year 1967, the states paid out in unemployment insurance benefits $42.3 million to ex-Federal Civil Service employees and $46.3 million to ex-servicemen.

How large is the non-DOD support cost? No one knows. But we will attempt to determine it.

I will close by discussing some of the problems confronting the study group. (Chart 5)

PROBLEM AREAS

Nonstandard terminology.

Training.

Lack of statistical data.

Statistical standards.

Data management.

CHART 5

Nonstandard Terminology

The study group is well aware of this problem. It has been charged with the standardizing the terminology across the Services. We will be depending upon the efforts of the assigned responsible agencies under the data elements and codes standization program.

Training

Training costs required to support our model will be difficult to obtain. Since the formation of the study group, two related study efforts have been initiated. One is a study underway at USCONARC - COMPT that is responsive to a 21 November 1967 request of COA. The other is being conducted for the DOD Life Cycle Costing Steering group. Interdepartmental task group #6 has been assigned the life cycle costing of training. Army action has been assigned to AMC. Although the study group of which I am a member will be able to obtain some useful data from the former, the latter group interestingly enough will look to us for support.

Lack of Statistical Data

In many instances the data we require have not been recorded in the detail demanded by the model nor by the data items in the data bank. On the other hand, in recent months in-house study groups and research contractors have been hampered by the lack of historical time series. Our computer rooms are essentially service bureaus. Generally, when they receive new data, they update their stores and generate new reports to interested users. These users are only interested, it appears, in an immediate problem. Consequently, they purge their files about every six months. This policy must be reversed.

Statistical Standards

User is rarely, if ever, provided with the limitations on the use of statistical measures. We shall endeavor to capture and record the assumptions, techniques used, and limitations of use for all of our data.

Data Management

Along with the problem of loose statistical standards, the impact of poor data management upon models and upon decision-making is very severe. This is not only a military problem. It exists throughout government and industry. We will attempt to develop some procedures that may improve the quality of output.

I would like to close with mentioning a fundamental conceptual difference between the cost model I have discussed and most other DoD cost models now in use. In our guidance, the study group was asked to provide in the resulting data bank non-DoD support costs and indirect manpower support costs. The typical weapon system cost model or other man/machine cost models by which man/machine trade-offs can be made, exclude such indirect support costs on the hardware side. For example, such non-DOD costs as that of accelerated amortization, subsidies, and of basic research should be included on the hardware side. If we include indirect manpower support costs, as for example, that of running ODCSPER, then similar costs of operating AMC and DCSLOG should be included on the hardware side.

As of this writing, such inner model conflicts and other comments on the Second Interim Report of the Study Group are being evaluated by the ASD(SA)

REFERENCES

(1) Personnel Research and Systems Development; Proceedings of the Twenty-Fifth Anniversary Symposium, USAF Personnel Research Laboratory, Lackland AFB. PRL-TR-67-13, Dec. 1967.

SESSION 3
DEVELOPMENT OF OVERSEAS SECURITY OPERATIONS

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3A. ESTABLISHMENT AND DISCUSSION OF PRINCIPLES OF COUNTERINSURGENCY

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I am honored with your invitation to come here today to discuss with you a problem of our common interest: counterinsurgency and particularly the socio-political and human aspects of it. Of course, it is almost impossible, and inadvisable, to try to separate these from the proper military aspects since both form an entity so interrelated that it cannot and should not be separated. The point I like to stress is that the military must not only thoroughly understand these aspects but also consider them fully in their operations. Thus there is a sine qua none requirement for governments in charge of counterinsurgency to plan all these aspects, the military and nonmilitary, into a common harmonious plan of operations. This unfortunately has not been always realized in the past.

I will cover briefly the need for a theoretical solution of the problem of counterinsurgency (under which I understand a need for deep knowledge of all aspects of it), then will discuss principal mistakes which were and possibly are still being committed, and finally will propose some principles for you which I believe must be respected if a counterinsurgency is going to be successful.

After my presentation we will have a discussion period at which I will try to answer your questions.

Gentlemen, a general disregard for the theoretical solution of counterinsurgency problems is to be blamed for difficulties which governments encounter in dealing with insurgencies. What is usually being done by free-world governments is that they start reacting to moves of revolutionary leadership, including use of force, with complete disregard for the principles which have been derived from a long experience in this type of conflict. It was only when some of these governments had been severly mauled in the process that they eventually started studying and applying existing knowledge. But, of course, precious time, blood and treasure had been already wasted and chances left unexploited. And in the case where a government wanted to learn from other nations' experiences there often was a tendency to blindly copy, and apply to their own situation, the other nation's experiences, disregarding the dissimilarities and uniqueness of each situation. Malaya and Vietnam are totally dissimilar. Generally, too much reliance on the historical cases without having a good knowledge of the basic principles has contributed to misconceptions and to the failure of the operations in the field.

It is true that the principles of counterinsurgency, particularly in the area of human factors, have not yet been defined in the textbooks, although the human beings - the people - are the principal target of both sides in this type of conflict. However, a serious student of insurgencies and revolutionary movements could have deduced them from the long-standing experiences the world has had with this type of warfare. Of course, a good understanding of the special nature of a conflict, of the enemy's strategy of subversion, of revolutionary ideas, and of human nature, is required for such a work.

The principles which I am going to discuss are based on both published and unpublished material which I have studied in the last 44 years and on my personal experiences.

Before I would discuss the principles, I would like to make a few comments on the nature of war in South Vietnam. The war in South Vietnam has both internal and external aspects. It is a politico-revolutionary warfare and insurgency inside Vietnam supported from outside, combined with an outside aggression through infiltration of North Vietnam regular army units, and through establishment of a conventional type front on the 17th parallel. Further, it has characteristics of a civil war within a country where one side is killing the other primarily for the political reasons. Thus the South Vietnam Government and allied forces have to deal not only with a domestic communist revolution instigated and supported politically, militarily and otherwise from outside, but aggression by the armed forces of North Vietnam as well. Being also civil in nature it involves the country at large in conflict with the South Vietnamese communist led belligerent minority. The result is a uniquely complicated war. A war which requires much more than proper counterinsurgency and conventional type efforts.

I wish to make clear to you that I am going to limit my discussion to the principles which deal with counterinsurgency only. Those regarding conventional type operations, as for example the U.S. operations along the 17th parallel and against North Vietnam's regulars in South Vietnam, or our air-bombing of North Vietnam will not be discussed, although these are contributing enormously to counterinsurgency.

First let me dwell for a while on the mistakes which have been committed in order to follow a logical order of things and make it easier to understand the principles.

It is true and we all know it that the intricate nature of revolutionary and insurgency movements -- with their inherent psychological, political, ideological, economic, and military implications, make counterinsurgency extremely complicated, confusing, and most difficult. Plans and actions by the governments are exposed to influence arising from a complexity of causes including those for which governments -- rightly or wrongly -- are blamed and held responsible. The mistakes are committed not only because of lack of intelligence information -- intelligence is only a fraction of the problem -- but primarily because of not correctly understanding and interpreting revolutionary conditions, the type of target aimed at by the enemy, general objectives of revolutionaries, and of political strategy used by revolutionary leadership. When we add to this the fact that the civilian authorities of a less developed country are usually entrusting the military with a total responsibility for this almost entirely political warfare, (as you know in some countries they throw the total responsibility on the military) one can easily understand why the problems in that case become so complex and muddled. Usually the military of these countries have less knowledge of the political, ideological, economic, psychological and other problems and implications than the civilian authorities reasonably should have.

Being not "politically" prepared for such a mission they are exposed to make all kinds of mistakes. To make things even more complicated we may say that in some less developed countries there may be no other government organization in existency (e.g., well trained and strong police force like in Malaya) which would be better organized than the military. In many cases even if civilian and military forces are combined, there is plenty to be desired in regard to the needed understanding of the problems, and ability to do the job. And on the enemy side, these forces of order are opposed by an enemy organization and leadership well disciplined and trained and well versed in all the aspects of political and revolutionary warfare.

The mistakes may be irreparable and contribute to either temporary or final failure or cause an unnecessary prolongation of insurgency. And it is because of these mistakes that the enemy often succeeds. I will mention only a few:

Diem's government contended that insurgency in South Vietnam was caused only by infiltrators and not also by internal troublemakers, in order to cover for dissatisfaction with his regime and state of affairs at home. (And at that time Hanoi used to infiltrate political agitators and not regulars.) This resulted in concentration of all counterinsurgency efforts to the borders and left local Communist undergrounds free to organize new additional infrastructures, and pockets of resistance throughout the country.

The Frency branded the whole Algerian movement as Communist, thus ignoring the rebel nationalist political goals, and antagonizing the majority of Algerian people.

Initial belief of the French military that they could quell a revolutionary movement by the use of conventional forces only and particularly lack of a sound counterinsurgency concept and doctrine, resulted in heavy losses, disappointment in military strategy for both French officers and soldiers, and in a delay in timely application of necessary political measures. As a result, the insurgency was prolonged for years, cost France billions in money, and finally was settled by the consent of President De Gaulle, with victory for the revolutionaries. The revolutionaries have won that battle in Paris, not in Algeria. Today Viet Cong are trying to do the same. The lesson is that in any political warfare, the home front is important and may become crucial for victory.

In Malaya, in the early stages of insurgency, the authorities failed to be in close touch with the masses of people and to protect them from Communist influences and terrorist activities; lack of psychological operations, civic action, and of security programs was evident. Permitting dual military and civilian control of the army when it operated in aid of civil authorities, and the slowness in adjusting the governmental machinery to deal with the insurgency, were additional mistakes. These and other factors prolonged the rebellion to almost 12 years, and increased the cost in lives and money. And this happened in a situation at least 20 times simpler and less complicated than the situation in South Vietnam.

In almost all cases of insurgency the most serious error made was to confuse the real causes of the rebellion with the "favorable factors" which revolutionaries inevitably exploit. Ignorance of this provoked confusion about what should be done and how the problem should be approached. Few understood that while political, economic, or social grievances (in Marxist terms, "internal contradictions") may help opponents of the government to foster a revolt, the elimination of them per se by the government is seldom, if ever, the sole aim of the revolutionary leaders. In many cases, governments have enacted reforms only to have them rejected by the rebels; simply because the acceptance by the rebels of improvements and reforms made by the government would in itself eliminate the favorable factors upon which the insurgents are basing their appeals to insurrection. Therefore, let us not check ourselves with "if only government would do this and that." In South Vietnam, all constructive and useful government programs are violently opposed by the NLF. Similarly, the improvements made elsewhere in Indochina, the Philippines, and Malaya have been opposed by the revolutionary leadership. In Algeria, political reforms instituted by the French were dismissed by the National Liberation Front as meaningless; and large-scale economic and social reforms were distorted and publicly misrepresented as admissions of French weakness.

Another grave error is the failure to detect and evaluate a revolutionary infrastructure in time, before the outbreak of hostilities, and to appreciate the powerful and dangerous force of this basic part of any revolutionary organization. In Algeria, the French wrongly believed they had crippled the budding revolutionary movement in 1950-1953, after several well-known leaders had been arrested; French intelligence underestimated the strength of the infrastructure political activities and particularly its capability to influence minds of the Algerian people. It demonstrated great ignorance of the enemy's strategy of conquest of the people's minds.

The gravest error is a lack of intensive activity among masses of people by the governments, and by private civilian organizations and groups. Because no government on this earth will be able to do all these things by itself, private initiative is a "must."

It is also unfortunate if a government puts confidence only in its administrative, police, and military machinery and their superiority in material equipment and destructive power, while underestimating the strength and capability of the revolutionaries for subverting the people's minds.

Lack of understanding of the development of a revolutionary movement results in lack of sound planning. Plans for well orchestrated actions of political, psychological, economical and social nature at all levels and in all phases of insurgency, including the pre-insurgency phase, are indispensable in order to combat the factors favorable to the revolutionaries.

It would be a grave error not to consider that the ideologies may, in many instances, be more important to some people at a given moment than any economic progress offered by a national government or a foreign power; it would equally be an error to believe that economic progress must not keep pace with political progress, if stability is going to be achieved and maintained. The Communist parties are preaching that "the ideological front is one of the most important in the struggle for the victory of Communism." It is the ideology with promises which makes the so-called "no-good-soldier" and "no-good-peasant" fight well on the Communist side. Further, a belief that economic progress alone will always resolve political and social matters and ideologies may be not only naive but even dangerous in spite of benefits from economic progress. Failure to recognize the true causes of discontent, including evolution or change of these causes in the minds of people during an insurgency, and failure to take proper remedial actions in time, may cause counterinsurgency efforts to be misdirected.

Once a revolution has broken out, the government must not make the mistake of thinking that the sole aim of the rebels is the purely military one: that of engaging the government's troops. To the contrary, the major goal is to win the civilian population over to their side. The task for the government, then, is maintaining and/or "retaking" control over the population. But to do this successfully an active interest as well as participation on the part of the population itself is imperative. Therefore, a grave error is to permit the people to become mere observers; to have a role as a third disinterested party whose sole interest is to be protected by the government. This has been the case in many counterinsurgencies, including Laos, Algeria, Malaya and South Vietnam.

In order to make pacification effective, the government must implement measures which lead to the elimination of the causes of the revolt. It must introduce radical and effective political, economic and social reforms while simultaneously denouncing Communist subversion and offering to the people an ideology and system of government which would be more attractive than that of the Communists.

Possibly the gravest error is not to properly evaluate and give due consideration to the invisible part of the revolutionary structure; to its infrastructure. A sound evaluation of infrastructure in each phase of insurgency must be reflected in the government's planning and in development of concepts, doctrines and tactics; in selecting correct weapons for the job; and in development of material and non-material support for counterinsurgency. This must be always done in a timely manner and applied equally to the planning on the national, province, and sector level. And for dealing with, or for attacking targets of the enemy infrastructure and support organizations, one needs a well prepared and systematically executed intelligence, informational, political, re-educational, and psychological operations program, in addition to administrative measures and civic actions. As to the guerrillas, the effort directed against them must be commensurate to their aggressiveness and to the probable and possible damage which may result from the guerrilla action; particularly one must watch for the psychological effect of the guerrilla actions the revolutionaries are always aiming at. This effect must be considered from the point of view of both the short and long-range consequences for the pacification, and both within and outside the country.

The undecided masses, no matter where they are (even in Saigon) and what their occupation (taxi drivers and servants), must become the targets of the government, simply because they are targets of the enemy infrastructure. Here lies the importance and indispensability of the psychological operations in every phase of insurgency. Its target is the whole nation; guerrillas and non-guerrillas, young and old, military and non-military. It must defend and protect people, troops, and government operations from enemy agitation and propaganda, and to win and return the hostile others to one's own side. Thus, psychological operations, as an instrument of "political struggle" in counterinsurgency must be elevated to the level of a weapon of supreme importance. And I would like to stress that under psychological operations one must understand not only propaganda but also any other military and non-military operation aimed at psychological effect, (e.g., air-bombing) as well as any planned frutiful fall-out from any land, air and sea operation and action.

Of cardinal importance is to understand that two opposite fronts--friendly and insurgent--are composed of the people of the same flesh and blood; of brothers, sisters, relatives, and friends; of divided families. On this frontless front the opposing numbers may have an interest to kill each other or not to kill each other; even to preserve the enemy and help him. During my campaign I have met so many mothers, fathers, sisters and brothers of rebels, who, in spite of their hatred of Communism and of rebel causes, were helping them because their dear ones were in the Communist ranks.

Let me now propose some principles for you. I will discuss them not necessarily in order of their relative importance. Their application, and priority, will depend on the existing situation.

Principle of Preservation of Existing Base (and under a Base I mean the people). The governments should concentrate their efforts on fighting the armed insurgents, taking care of the population, and on eradication of undergrounds not only in liberated areas, but should simultaneously initiate the civic action, informational and educational, economic and other programs for the benefit of masses of the population throughout the country, in order to:

a. Crystalize and increase the existing active moral and other support from the masses; win over

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undecided persons, and neutralize those who sympathize with or are helping the enemy morally or otherwise

b. Prevent the enemy from eroding this government base by use of subversion, propaganda, terror, and other means; and

c. Preserve and enlarge this base so that the revolutionaries will have less chance to erode it and less and less support for their destructive effort. If this is done the enemy will have no chance for victory. (Of course, the enemy can continue to harass the people and the government by use of small guerrilla units and undergrounds, but without a serious danger for the nation. In time, because of having no adequate base among the people, he will be forced to corner himself into a besieged area where he will have no external or internal support and where under pressure of the government he will be obliged to give up or to wither away. It is clear that the psychological operations. information, education and re-education, and other government and nongovernment activities will have to be used for the completion of eradication of the remnants of enemy undergrounds throughout the country.)

This is a basic principle which was not respected in Vietnam particularly during the Diem regime. If this principle is applied now in Thailand where possibly this base is still preserved by 95 - 99 percent, the rebels will never have a chance of success in that country. Thus the principle of preservation of existing base is an extremely critical principal.

<u>Principle of Orchestration of Effort</u>

The counterinsurgency effort--political, economic, psychological, military and other -- must be orchestrated. Orchestration is needed target-wise (guerrillas, insurgent infrastructure, people's masses, intellectuals, etc.), time-wise (all phases and subphases of insurgency), and location-wise (free areas, enemy held areas and liberated areas). In Vietnam this principle was disregarded for a long time.

<u>Principle of Psychological Effect</u>

Since the primary, if not the only, target is human beings, not to gain ground, every non-military and military operation and action must be aimed at and result in a desired psychological effect, by which the minds and hearts of people could be changed. Psychological effects spread like a chain reaction and know no borders and barriers. They travel from battlefields to the rear areas and vice-versa. No action, military or non-military, is worthy of sacrifices and effort if they do not result in the desired psychological impact.

<u>Principle of Utilization of Total Forces</u>

This principle dictates that both the strategy and the tactics must combine and fully utilize the military, administrative, police, moral, economic, and other forces within operational areas and at all command echelons. If the operational area concept is applied, as it always should be (and I am referring to regional forces to which pacification of areas is entrusted, as for example in South Vietnam), even a regimental sector is not a shallow front, but an area with all the overt and covert elements of a revolutionary structure and population in it; and in which support by the population must be obtained. In fact, one can say that every RVN regimental commander is concerned not only with a "military situation," but with a total revolutionary situation of his sector. Thus the strategy and tactics in counterinsurgency differ from those in conventional wars. Both the strategy and tactics are of civil-military character in the full sense of meaning, and it is almost impossible to speak about an autonomous military strategy as applied on a conventional front. Therefore, one cannot disassociate the military from political and other actions. This indicates to you what kind of training and education an RVN regimental commander and his battalion commanders must have and what kind of officers the U.S. should send to advise them. As to proper military tactics in counterinsurgency, one can speak about them only in case where a combat procedure against a group or a unit of insurgents is concerned. In other words, proper military tactics exist as such only within the framework of "guerrilla-counterguerrilla" combat.

Principle of Use of Force

The counterinsurgency forces must not resort to use of force for achievement of goals which can be achieved through use of other means. Destruction of civilian property -- if damage cannot be compensated for with the same or better materials and soon enough to avoid sufferings and deprivations -- and losses of civilian lives, are the most damaging for the government's effort. No matter how these may appear to be expedient, damaging, destroying, and killing of innocent people always and unavoidably creates more distrust, disaffection, and above all, more hate. By killing, new martyrs are created, which is an incentive for more ardent hate of the government. That is exactly what the enemy in Vietnam wants us to do. The principle, therefore, is the full use of non-military civil means for achievement of goals of pacification. Crude force is utilized only as secondary means; and is proportioned according to the results desired and the framework within which it is used, but having always in mind its possible adverse effects, psychological, moral, and otherwise.

Principles in Relation to Intelligence

An effective organization for the collection of information, aggressiveness in the collection, and instantaneous exploitation are the requirements for success. Since counterinsurgency operations are interwoven and affect each other, there is no such thing as exclusively military intelligence. I am not referring here to intelligence collection effort needed for Air Force targeting but intelligence about guerrillas and infrastructure.

Further intelligence must constantly have for its target all the parts of the enemy organization, and its effort must be commensurate with the size, importance, and aggressiveness of all parts of the enemy organizations (guerrillas, regular units, infrastructure, front organizations, etc.). The infrastructure may, taken as a whole, consume the greatest part of the intelligence effort. This, again, is a principle which was not always well understood by the Vietnamese and their indigenous collection agencies, including millitary.

Another consideration (particularly for land operations) is full coordination of collection of intelligence and placing it under a single civil-military or military-civil command on all echelons of command. As to exploitation, the principle must be: instantaneous exploitation with freedom and duty to effect exploitation on all the echelons equally, especially on the lower echelons. For in counterinsurgency the one who is the closest to the scene and events is the one who should command.

Dissemination of intelligence must be instantaneous, general, lateral, and at the same time vertical; and free of all obstacles. Both collection and exploitation must be coordinated by collection and action centers, which must be established in operational sectors and subsectors; and at district levels of urban and rural areas of a country.

Principle of Activity Among Population (Communists call it "political struggle")

Activity or "political struggle" among the population must be constant. The population, being the source of power for both insurgents and forces of pacification -- depending which side has more sense for using it to his advantage -- must be won to one's own side. Here again, the psychological operations and indoctrination and civil affairs programs are indispensable for success.

As to the physical control of the population, it may be applied -- possibly temporarily -- to groups of populace and individuals as deemed necessary and it must be resorted to with the greatest care and discrimination. For it must be recognized that revolutionary warfare is a war without a defined front line; with base support, which is the people, fluctuating and changing to variations in public opinion and public adherence to the cause of insurgents or of the government. And public opinion, existing but not always openly expressed, may be and should be changed by loyal influential citizens and all segments of the population.

Principle of Population as a Factor to be Considered in Every Military Operation

The principle is that the population factor must be considered in every military plan and operation, and by every leader and commander, even at the lowest level of the counterinsurgency effort. If the population is controlled, it will become the human reservoir, source of information, and ally of the government.

As to the resettlement of the people for the purpose of security and control, e.g., strategic hamlet program, it is justified as the last resort where the government is left without influence on the population, where terror may force the masses to join the side of insurgents, and where forces of order are incapable of insuring a minimum of personal protection. To what degree such hamlets will really represent a front against the enemy will depend on the frame of mind and feelings of the people of these hamlets. Thus, the people in these hamlets must be indoctrinated, morally supported, kept informed, and if needed be reeducated.

The involvement of the people in counterinsurgency is an important principle because the "wars of liberation" are a type of conflict which cannot be resisted and won without complete involvement of the people. One needs the people's self-defense forces, support organizations, intelligence, economic and industrial production, influence on neighbors, and above all, one needs the moral support of the masses. All these form the nation's and government's base and strength. In principle, counter-insurgency must be made a common cause of the populace and of the government. This indicates how important this problem is and how much serious attention must be given to it by a government.

<u>Principle of Aggressiveness</u>

The time factor in counter-insurgency generally works for that party which knows to utilize it to its advantage. It plays an essential role in countering insurgents and is crucially dependent on availability of timely intelligence. Both the insurgent and government forces are in a race for time. I would like to stress that the time factor, type of tactics the enemy uses, and the nature of the conflict call for continuous aggressiveness; for only aggressiveness in all fields of counterinsurgency can counter and/or prevent enemy assault actions, maneuvers, and recuperation from defeats -- both military and political. Therefore, constant uninterrupted air and land aggressiveness, not only against guerrillas and undergrounds and their bases and sources of production, but also in all fields of the government's activity: political, civic, action, psychological operations, informational and educational programs, becomes an important principle. There should be no relaxation in these fields of activity by the government no matter how the situation might look improved and favorable. Revolutionaries do not sleep. Quiet periods of time are used by them to regroup their military, subversive and political forces, to gain strength, to misguide the government, and to strike again with more vigor.

<u>Principle of Prevention</u>

Of course we all know that it is always much less costly, in terms of lives, sacrifices and money, to prevent an insurgency than to fight one when it has already developed. Thus, an early initiation of economic, political, sociological, psychological, military, and other actions by the allied and friendly governments, in order to prevent development of an insurgency, should be a supreme requirement for the security and stability of each country.

<u>Principle of Acting Politically and Seeking Political Solutions</u>

Since the conflict is political in character, has political objectives and uses people politically for achievement of these objectives, the most important or principal weapon of insurgency and counter-insurgency should be political warfare. In it one must primarily think and act politically and use all moral and other forces for achievement of the political objectives. The military forces on all echelons are the exclusive instrument of politics and should be trained and educated politically. In this warfare one should seek primarily the political solutions with the exception where such would mean communization or any other type of dictatorship and enslavement.

So much on principles. There are also some general rules and considerations which must be respected in any counterinsurgency strategy. We have no time to discuss these. But before I would end my presentation I would like to mention some of these:

First, there should be only one "commander in chief" at the head of a unified counterinsurgency command structure. Be he a civilian or a member of the milita y, he must be given complete authority over the total expanse of the endangered country or of affected provinces. He must be in the command of all the civil and military organizations of the critical area. This principle of "unity of effort" should apply equally to his subordinate commanders at the province, district, county, and village levels.

Second, the integration of a country's civil administration, of police and of military forces into one organization within each operational area, may be in many cases not only necessary but the best solution for a successful direction and coordination of counterinsurgency operation.

Third, in some underdeveloped countries, the military, particularly the army, may be the best suited, or the only organization capable of directing a counterinsurgency effort. The other parts of the government apparatus may be too weak and lacking confidence.

Fourth, the functions of government are more complicated in a revolutionary warfare than in a conventional type war. Almost every citizen is more or less directly affected by a revolutionary warfare. On the other hand, all the parts of a national organism -- despite its exposure to the enemy's ideological, political, and psychological activities and terrorist attacks -- must continue to perform their functions normally and without interruption, insofar as possible. The failure of any one of the parts of government helps the insurgent cause; the failure of all the parts would result in disaster. The foregoing merely re-emphasizes the importance of continuing authority vested in a strong leadership. Even within the complex of local activities, no matter how well they are coordinated, someone must speak with the voice of authority. This was repeatedly proven in Malaya, Algeria, and Vietnam.

Five, destruction of the enemy guerrilla bases and forces (distinguish this type operation from eradication and elimination of infrastructure) is the purpose of military or para-military counterguerrilla operations. In principle, such destruction should motivate all combat missions. But destruction does not necessarily mean only the killing. Where possible, surrender is more desirable, and can be better utilized for politico-psychological and propaganda purposes.

Six, in countering guerrillas the purpose is not to hold the ground or prevent the enemy from holding it. Ground is not occupied; it is controlled, a rule which should be strictly respected. Fixed posts and fortifications are used only for the purpose of promoting mobility and safeguarding important installations. If such is not accomplished, there must be no fixed posts and installations.

And finally, the tactical planning is to be done in conformity to the enemy's mentality more than to the terrain. A plan must express the character -- the stability, variability and the instability -- of the enemy. Of course, terrain is considered an element which may favor movement and combat. But to make a plan to fit the character of the enemy, one must know his mentality, his doctrine, training, and way of doing things.

I would like to finish my talk with few words regarding the Soviet political doctrine as recently reformulated, or better restated, in the Moscow's PRAVDA; and applied to Czechoslovakia.

In regard to the Satelite States Kremlin openly states that it will crush, with use of military force, any attempt by the Satelites to deviate from the Moscow line. This includes not only political but also cultural, economic and other aspects of it as well.

In regard to all other countries no matter where these may be located on the earth, the Soviets openly state that it is sacred duty of all revolutionary parties, communist parties, to prevent by use of all means, establishment of rightist regimes in these countries. In other words a communist interference in the internal affairs of other countries is the official Kremlin's policy and sacred duty of all communist parties. And Kremlin will decide which government is rightist and reactionary and which is not. In regard to this it will interest you that almost all the Soviet newspapers stated and continue to state that the U.S. Government is an oppressive reactionary government.

This clearly indicates that we must expect in the future the communist inspired revolutionary movements to develop in any country in which the local communist party may have chance to develop it. This also indicates the importance of countersurgency and well developed doctrines, techniques, and plans; and a need for well educated and well trained U.S. personnel assigned to these countries to advise and train.

Before I would leave this podium I would like to leave you with one thought. Please think of what kind of personnel we need in order to be able to cope with all the problems which insurgency imposes on us and with the application of the principles which I have discussed. Napoleon's famous words to his generals and troops were "Modelez Vous" that means educate and improve yourself so that you may become real masters of any situation. And today we need a model more than anytime in the history to "model" our personnel into it and make them capable of dealing with intricate politico-military problems which insurgencies may impose on us.

SESSION 4
HOST SESSION: USATACOM MISSION AND PROGRAMS

Chairman: Ernest N. Petrick
U.S. Army Tank-Automotive Command
Warren, Michigan 48090

4A. MOBILITY: PROBLEMS, TRENDS AND CONCEPTS

Robert J. Otto
U.S. Army Tank-Automotive Command
Warren, Michigan 48090

Man has been trying very hard for many years to extend his cross-country capability. As depicted in these movie scenes, the environment ranges from large complex displacements, through man-vehicle interface problems, to drastic terrain and environmental changes.

In this presentation, I will discuss two main points of interest to the human factors engineer: First, how man as a crew member, will be affected by trends in suspension design. This topic will include a description of new variable ground clearance suspension systems, automatic ride control, terrain sensing, walking machines and some concepts to reduce noise and vibration in tracks and sprockets.

The second point will address the laboratory analysis and simulations required to insure that new suspensions improve the human vibration environment within the vehicle.

During this discussion, I will also describe our applications of telemetry, development of terrain models, and how road simulators will play an important role in evaluating new vehicles and the resulting effect on human vibration analysis.

Suspension Systems

The performance trends for suspension systems are depicted in three time frames: The present, 1970 - 1975 for the next new series of vehicles, and 1985 for the Army 85 concept (Fig. 1). While these five performance capabilities represent the most significant suspension factors affecting mobility, two directly affect the men within the vehicle: cross-country speed and river egress.

Speed affects the vehicle crew by pitch and bounce accelerations and displacements. River egress affects the crew by exaggerated vehicle pitch angles when exiting streams.

Passive suspensions (Fig. 2), as used on present production vehicles, are characterized by linear spring rates and fixed damping ratios. A typical passive suspension vehicle is the M60 tank which has an average cross-country speed of 7 to 10 mph. Accelerations and displacements in the vertical and pitch mode are the limiting factors. Cross-country speed of 25 mph can be achieved with a passive suspension system by significantly increasing wheel travel, softening the spring rate, and providing controlled damping.

Additional factors (Fig. 3) to improve fight-ability for the crew are:

1. Leveling the gun platform to ease tracking.
2. Lowering the silhouette for concealment.
3. Increasing ground clearance for improved soft soil crossing.

These factors also increase the crew's confidence in the vehicle, and improve the ability to utilize the full fighting potential of the vehicle.

A film clip illustrates the basic differences in ride characteristics between the present M60 and the test rig having the hydro-pneumatic suspension system.

The suspension system of the M60 tank (Fig. 4) is characteristic of current production technology. Note the external hull-mounted volute spring bump stops, shock absorbers and the torsion bars along the hull floor. Collectively, they provide a linear, fixed-energy absorption suspension. This type of system results in a severe rough ride in the cross-country mode.

The high-wheel-travel hydro-pneumatic suspension is shown in Figure 5. It provides improved control of pitch and bounce displacements and accelerations, even at speeds of 25 mph. The system consists of a double-opposed piston hydraulic actuator at each wheel position with a nitrogen charged accumulator, which provides a non-linear spring rate. The damping valve controls flow of hydraulic fluid between the actuator and accumulator, minimizing pitching and bouncing. The position of the wheel with respect to the hull, is controlled by adding or removing hydraulic fluid. This enables the changes in ground clearance.

Semi-active suspension systems (Fig. 6) will have the ability to adjust spring and damping characteristics while negotiating cross-country terrain. Combining the ability to adjust spring and damping rates "on the move" with the already achieved high wheel travel, suspension systems of this type can provide improvement in human environment and further increase cross-country mobility to over the 25 mph required level.

A test-bed vehicle utilizing an inertia controller for modulation of the spring and damping characteristics has been fabricated and tested. This system (Fig. 7) retains the springs of the passive suspension system and adds the ability to sense vehicle pitch acceleration and control the roadwheel position and travel. The cross-country performance and ride of the vehicle is improved through constant surveillance and correction of excessive vehicle pitching. The inertia control unit is the system's key component. The controller regulates fluid flow from a central power source to the hydraulic roadwheel actuators. These actuators, in parallel with the springs, change the springing and damping ratios required to maintain vehicle stability over rough terrain. This translates into a dynamic environment that will permit cross-country speeds of 30 mph, or three-fold improvement over today's production vehicles.

An active suspension system (Fig. 8) is under development to meet a requirement of 40 mph cross-country speed. This requirement entails two major human engineering problems: ride dynamics and human response time. Control of ride dynamics alone will not provide high cross-country speed, because the driver cannot react to each new terrain condition at speeds of 40 mph. Thus, automatic ride control, or a fully active suspension system may be needed to control wheel positions at this vehicle speed (Fig. 9). The system pre-senses obstacles immediately ahead of the vehicle and adjusts the springs, shock absorbers and wheel positions to accommodate the bumps, or stop the vehicle for obstacles beyond the suspension's capability.

Cross-country speeds of 40 mph for future reconnaissance-type vehicles may require a fully active suspension system with a high degree of automatic ride control to insure an acceptable vibration environment for the crew. In this system, a terrain sensor transmits obstacle distance, size, shape and density to a small on-board computer which, in turn, programs the proper spring and damping rates as well as necessary wheel positions to negotiate the obstacle. The roadwheel anticipates the obstacle ahead of the vehicle and gets ready to either lift itself over the obstacle or lower itself to conform to depressions in ground contour. The predictable high cross-country speeds for this concept come from the near elimination of road loads being translated into the vehicle as pitch or bounce accelerations.

Articulation

The tracked-vehicle suspension systems discussed herein may gain further improvements in mobility by the incorporation of articulation. Shown in Figure 10 are three types now in production and a three-degree-of-freedom system currently being evaluated in the "TWISTER" vehicle concept. The current trend in articulation is primarily in the forward-area logistic support vehicle.

The TWISTER includes combat vehicle concepts which may establish a new trend in the application of articulation. Mr. Denn will cover the TWISTER concept in his presentation.

The general effect of vehicle concepts utilizing articulation is to allow closer conformation of the vehicle to the terrain, resulting in an overall improvement in off-the-road performance. In the test bed "COBRA" (Fig. 11) articulation as well as pitch control between units has demonstrated a valuable mobility aid. The upper hydraulic cylinder controls the pitch attitude between the two units of the vehicle to aid obstacle negotiation.

The related film shows the increased COBRA vehicle capability provided by the addition of pitch control during severe obstacle climbing. First, the COBRA approaches the obstacle - - - without using the pitch control mechanism; the front end bulldozes into the earth bank and the vehicle is immobilized. Now, using the positive pitch control mechanism, the front end raises, and the vehicle can now proceed in its attempt to negotiate the bank. The rear unit, which is also driven, pushes the front unit. The nearly-vertical attitude of the front unit somewhat degrades driver visibility temporarily. However, when the pitch control mechanism is released, the front unit tilts down into its natural position and the vehicle completes its passage over the obstacle.

The flexible-frame (Fig. 12) is a type of articulated vehicle where the joint is constructed of concentric coil springs which compress and extend, thus helping each unit of the vehicle negotiate obstacles. This offers improved obstacle-crossing potential over present wheeled vehicles.

Requirements for future mobility will not be met by speed alone. The fundamental proposition is to significantly improve off-road vehicle performance. This includes operation over very steep slopes and rocky terrain even beyond the capacity of the new suspension systems currently under development.

A significant increase in performance in these areas may require a major departure from the conventional military vehicle, this may also bring about new and challenging human engineering problems to solve.

Walking Machine Technology

With support of the Advanced Research Projects Agency (ARPA), TACOM is developing the necessary technology to produce a walking machine (Fig. 13). This is an entirely new concept in powered mobility made possible by advances in force-feedback system technology.

Traced in this movie sequence are the man-machine interface studies conducted for this program and the operation of the first walking machine test bed.

Earlier use of this type of control system was in the "HANDYMAN", a master-slave servo manipulator. It was found that man could perform very intricate tasks even from remote positions.

Next in the development was proof that man and machine can be integrated so that man's sense of balance and natural corrective actions would regulate the balance of a man-machine system. This was demonstrated by the fabrication and successful operation of an 18-foot tall "limited motion pedipulator".

An unpowered full-scale quadruped walking test bed was then fabricated to determine the best driver position, proper length of linkages and driver response to the reaction forces. The arms of the driver operate the front legs of the quadruped, and the legs of the driver operate the rear legs of the quadruped. The level of man-machine compatibility is best demonstrated during the turning sequence.

A sequence shows the powered, four-legged full-scale walking test bed taking its first steps in the laboratory. The force-feedback control proved successful for operating manipulators and a balancing device. This machine utilizes 12 control loops to provide each leg with the required three degrees of freedom. Notice that the machine does not rely on the safety tether and that the operator can quickly react when balance is lost for an instant. The successful turning of the machine demonstrates the great potential of the force-feedback control for accomplishing complex locomotion tasks.

A potential application of the principles being developed in this program is a wheeled vehicle with double-jointed roadarms controlled for negotiating large obstacles. This concept will be described more fully in our presentations by Mr. Denn.

Suspension Design Trends

Now to recap the suspension design trends and the effect on the crew. This time-sequenced suspension system road map (Fig. 14) indicates when the three types of suspensions discussed are scheduled for prototype vehicle application. I discussed briefly five of the systems shown: current torsion bar, piston hydro-pneumatic, semi-active, automatic ride control and walking machine. Those in hardware, as you viewed in the film clips, improve the dynamic environment for the vehicle crews. Terrain sensing, along with articulation and some degree of automatic ride control, may be utilized to control the dynamic input into the vehicle hull. This should provide the crew with the dynamic environment required to be effective during a combat mission at 40 mph cross-country speed.

Noise and Vibration

Another area affecting the crew is noise and vibration or the low-amplitude high-frequency energy input to the vehicle hull. While this band of energy has a detrimental effect on component reliability, it produces a much greater problem for the human occupants of the vehicle. Analysis has shown that one of the biggest contributors to noise and vibration is the track and sprocket. Concept studies have resulted in several possible solutions.

The track represented in Figure 15 incorporates a spherical bearing and pin assembly that provides a constant pitch. The resulting constant pitch ensures matching of the track and sprocket during engagement and disengagement. Field tests of early lubricated-pin tracks demonstrated a pronounced decrease in noise and vibration.

The semi-pneumatic grousers and rubber-covered center guides shown in this track concept (Fig. 16) are designed to provide extremely quiet operation for future reconnaissance type vehicles. The semi-pneumatic grousers will also tend to envelop small obstacles and thereby reduce the motion necessary in the springs of the vehicle. The fiber-glass cables are employed as the driving, load-carrying members and permit some reduction in track pitch change which will reduce noise and vibration emanating from track and sprocket engagement.

The sprocket and hub mechanism illustrated in Figure 17 is designed to provide a free-wheeling friction drive for low torque operation on the highway and a positive drive to meet high torque requirements when traveling on rough cross-country terrain. Hydraulic pressure applied through the final drive hub to the inner surface of the sprocket carrier releases the sprocket from the hub.

This allows the sprocket to free-wheel and the track is driven by support-tire friction. If the support tire slips under the track, the hydraulic pressure is released to provide a solid sprocket hub positive driving unit. The eliminated metal-to-metal contact between the sprocket and track during low-torque operation reduces noise and vibration. This was demonstrated in a test bed tracked vehicle where the vertical acceleration in the crew compartment was reduced 50%.

Laboratory Analysis and Simulation

The second major point covered herein is laboratory analysis and simulation. In view of the unique high speed, off-road performance requirements for military vehicles, it is essential that suspension systems and tracks be fully evaluated in the laboratory and in field tests long before the final vehicle is put into the Army fleet.

In order to conduct these analyses, actual stress, load, pressure and frequency data should be obtained from the vehicle while it is traversing known terrain profiles. Telemetering techniques (Fig. 18) are being employed to measure, receive and record these data from test vehicles. The data are used for preparation of mathematical models to study the effect of the field dynamic environment on the crew and the suspension system. These data are also used to subject crew members to vehicle motions in a seat simulator. A brief movie more effectively illustrates the techniques and trends in laboratory dynamic simulation. Recent efforts to simulate conditions and duplicate failures currently being experienced in the field were very successful. Greater accuracy can be provided through use of road simulators that duplicate the ride obtained from telemetered recordings. Motions realistically duplicate rough railroad crossings, blocks, chuck holes and washboard roads, and random terrain profiles. Laboratory facilities are being designed to conduct engineering audits of future vehicles prior to release into the military vehicle fleet. Figure 19 is one concept of a 50-ton capacity road simulator with a design capability of evaluating the total mobility system and the effect on the crew in closed-loop fashion. This can be accomplished by instrumenting the crew positions or by actually placing the crew in the vehicle. Actual data on the crew would be taped.

Concluding Remarks

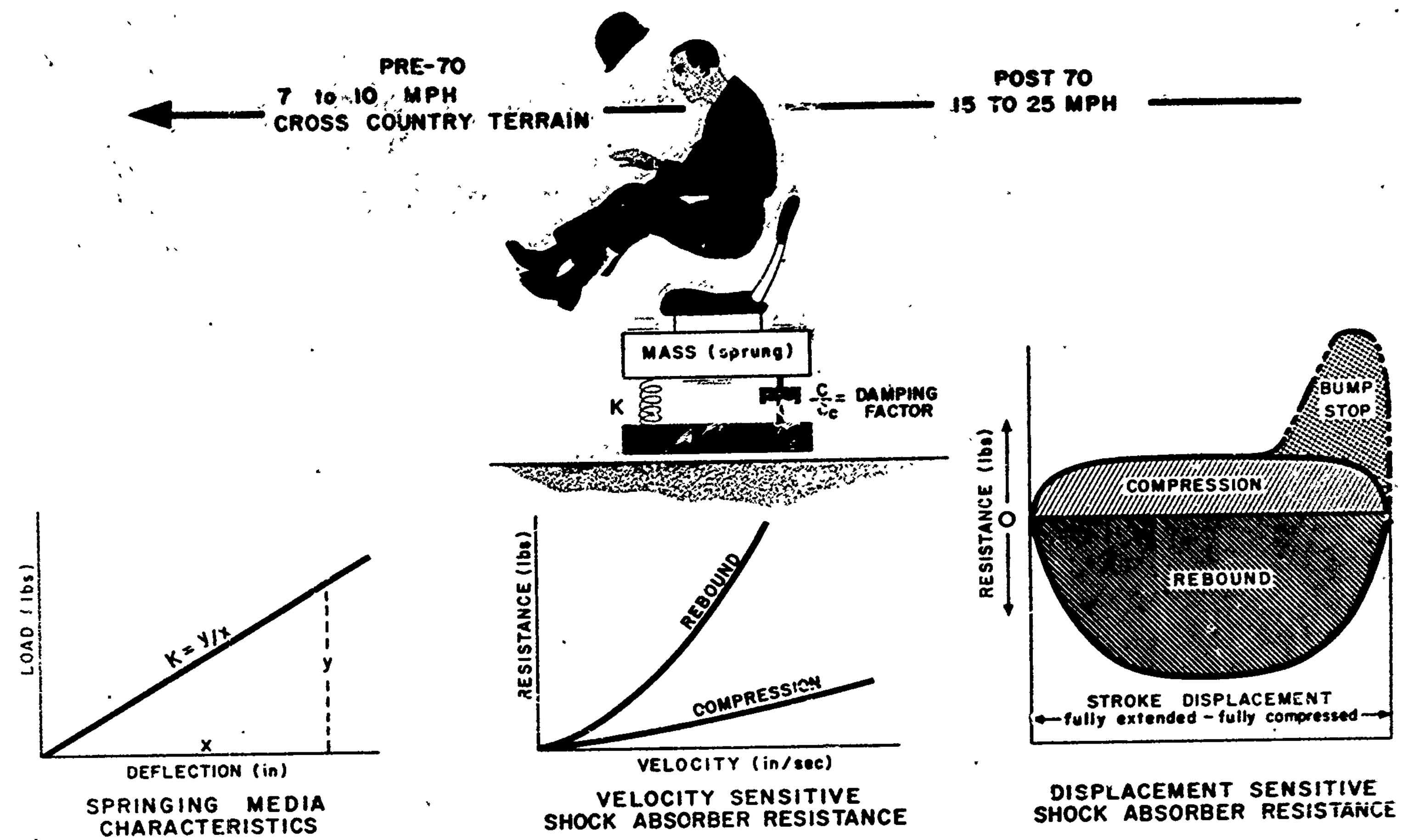
I would like to conclude my remarks with an overall view of where we are today and expect to be in the future with respect to vehicle vibration characteristics.

PERFORMANCE TRENDS-SUSPENSIONS

PERFORMANCE CAPABILITY	PRESENT	1970-1975	1985
CROSS-COUNTRY SPEED	7-10 MPH	20-30 MPH	IN EXCESS OF 40 MPH
DURABILITY (AVG. MILEAGE)	3-4,000 MILES	5000 MILES	10,000 MILES
POWER LOSS-ROLLING RESISTANCE (LBS/TON OF VEH. WT.)	44	38-40	1-25
SOFT SOIL MOBILITY (DEPTH OF MUD TO IMOBILIZE VEH.)	20 IN.	28 IN.	35 IN.
RIVER EGRESS (UNAIDED PROBABILITY OF EXIT)	25-50%	50-75%	75% (WITH SELF-RECOVERY CAPABILITY)

Figure 1.

PASSIVE SUSPENSION SYSTEM



- **A SUSPENSION SYSTEM WITH FIXED SPRING AND DAMPING CHARACTERISTICS, RESPONSIVELY ACTUATED BY TERRAIN CONTOUR.**

Figure 2.

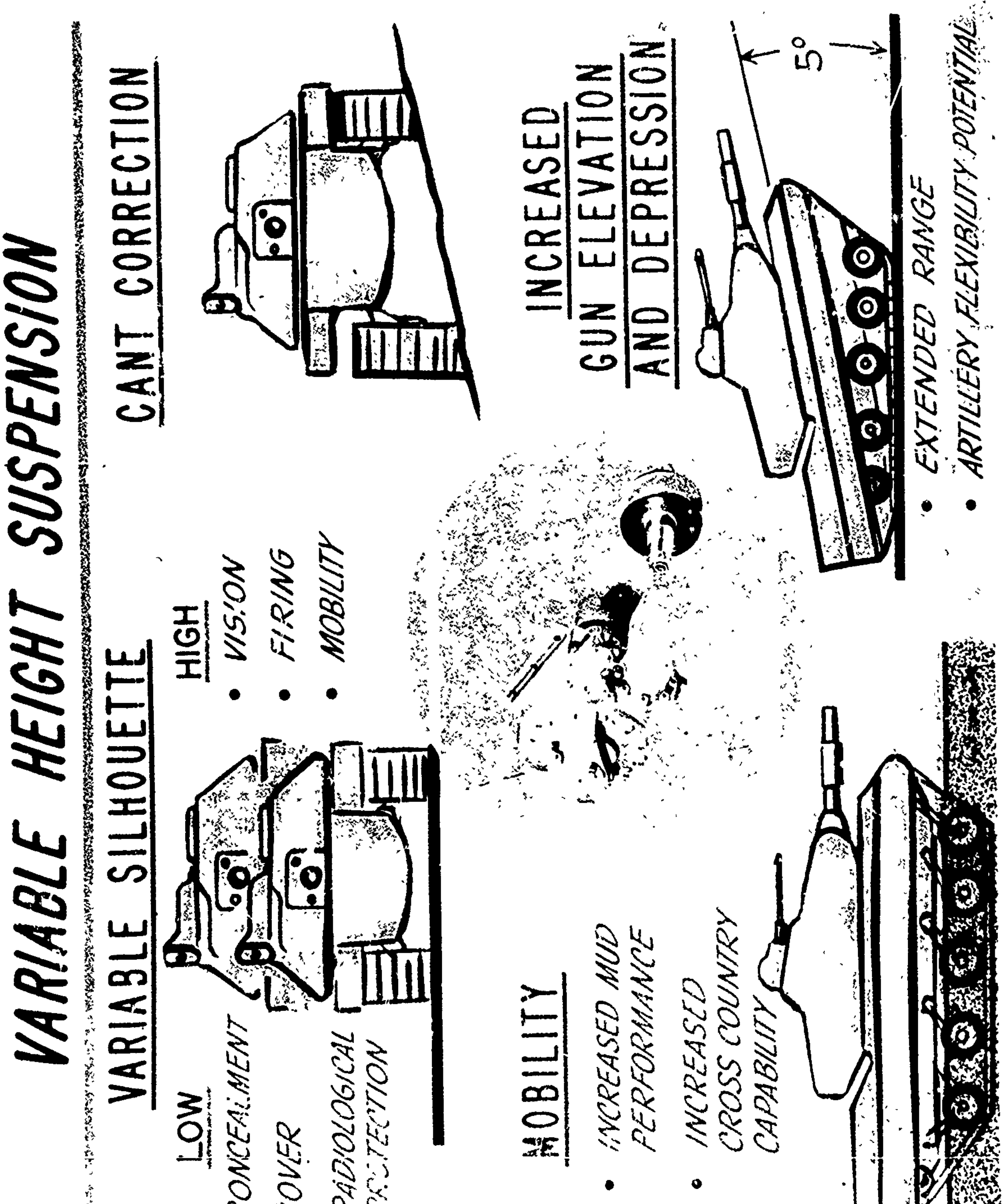


Figure 3.

333-404 O-69—11

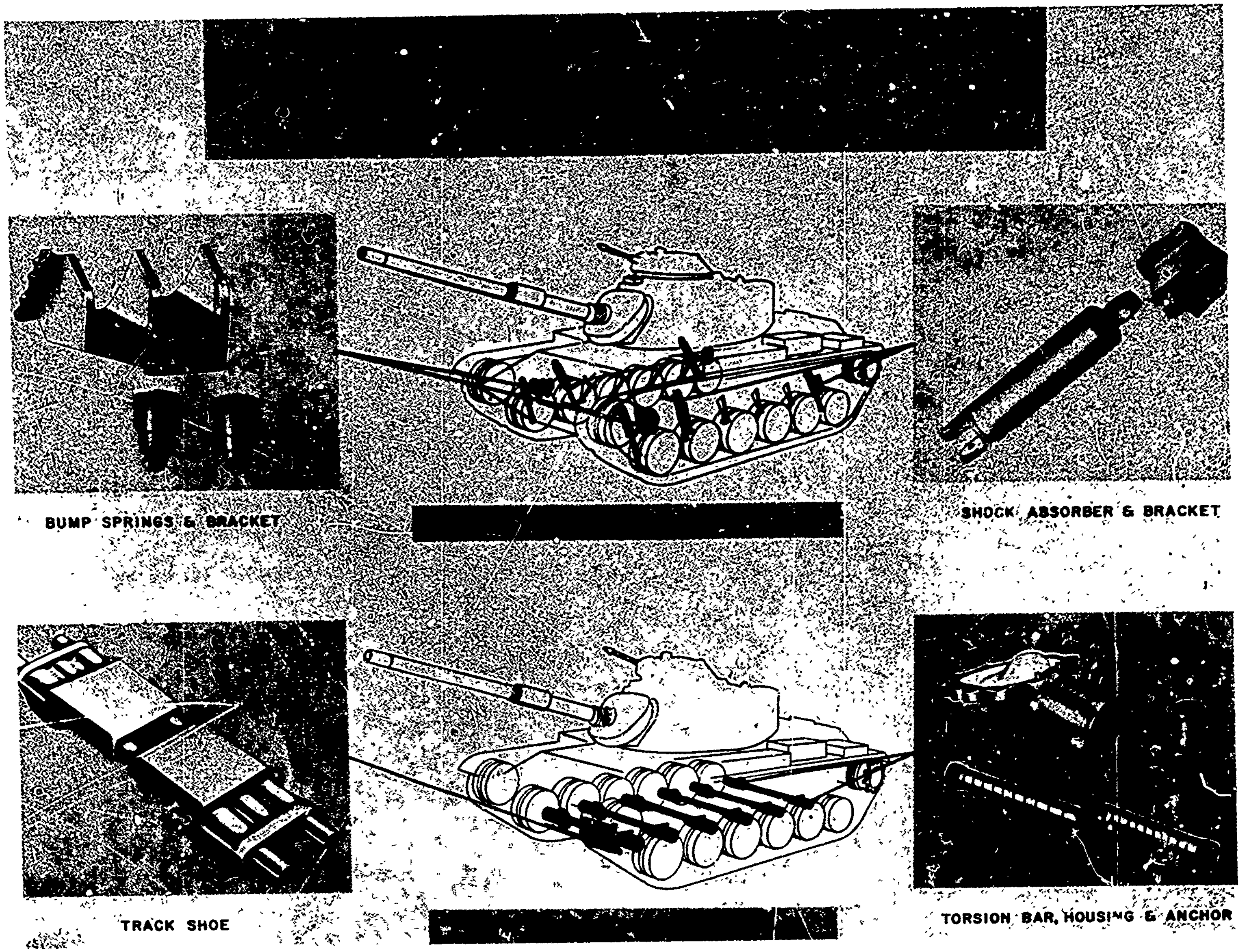

BUMP SPRINGS & BRACKET
SHOCK ABSORBER & BRACKET
TRACK SHOE
TORSION BAR, HOUSING & ANCHOR

Figure 4.

PISTON·HYDRO-PNEUMATIC SUSPENSION SYSTEM

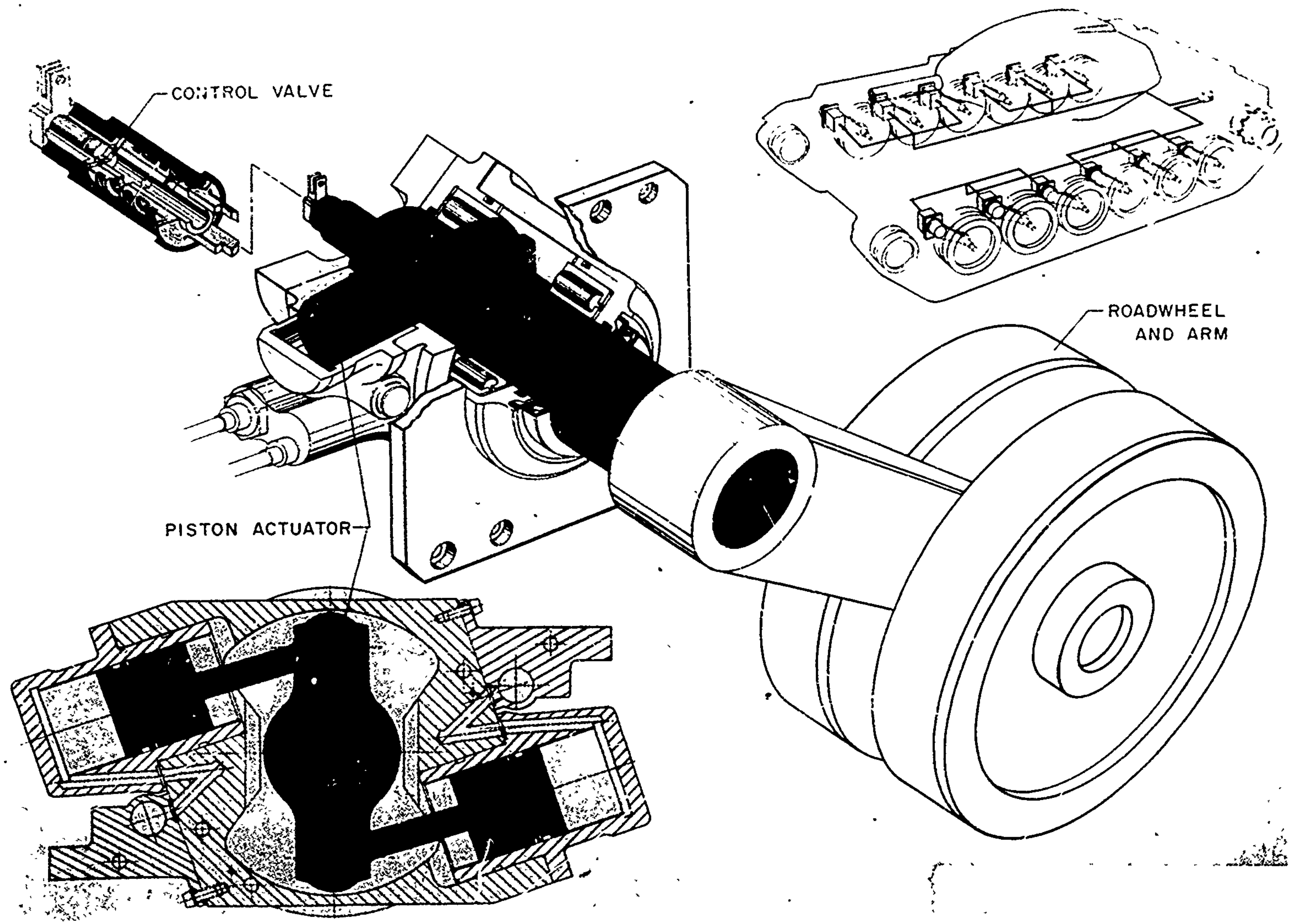


Figure 5.

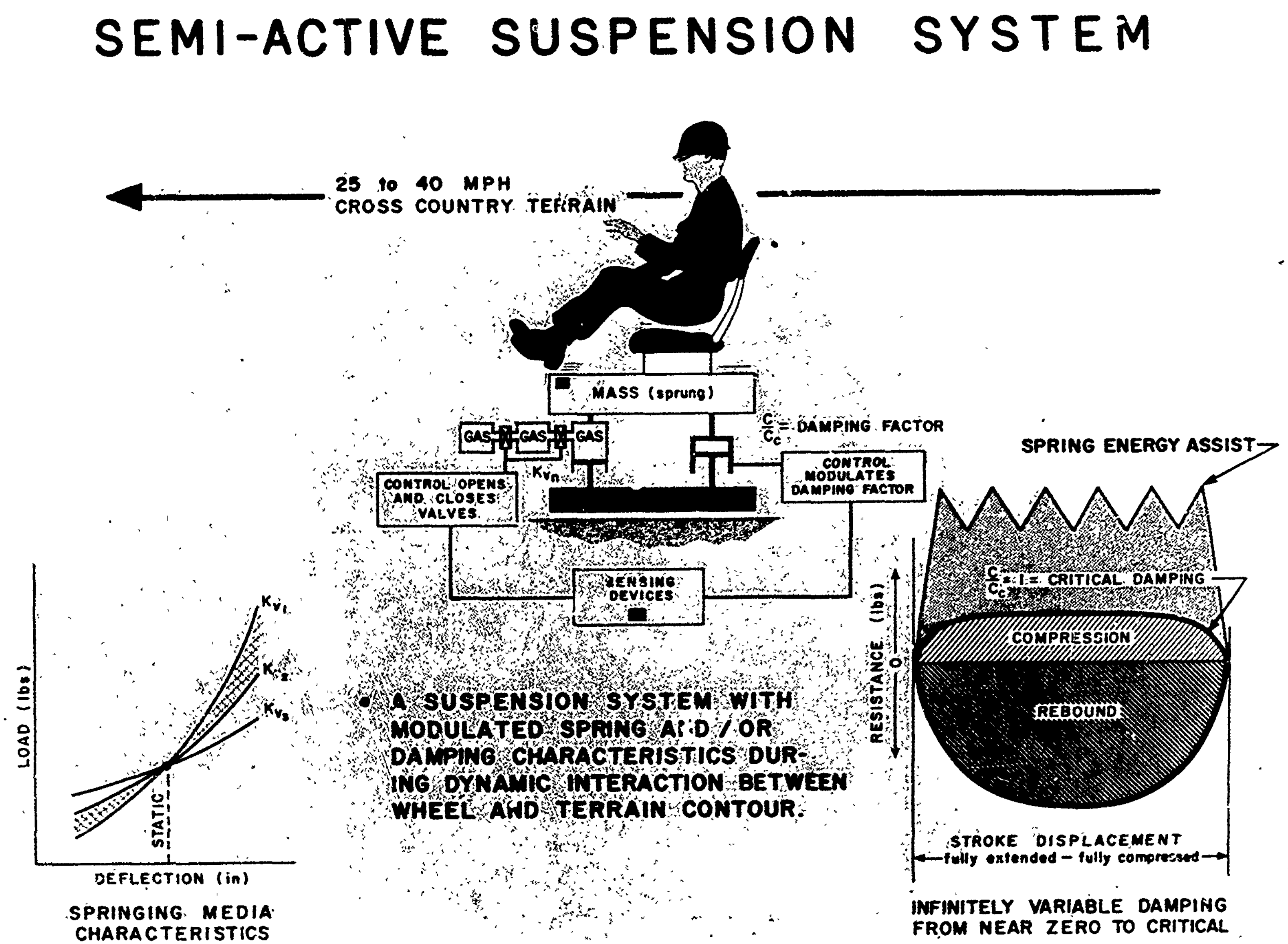

SEMI-ACTIVE SUSPENSION SYSTEM
25 to 40 MPH
CROSS COUNTRY TERRAIN
MASS (sprung)
GAS
GAS
GAS
K_{V_n}
$\frac{C}{C_c}$ = DAMPING FACTOR
CONTROL OPENS AND CLOSES VALVES
CONTROL MODULATES DAMPING FACTOR
SENSING DEVICES
LOAD (lbs)
DEFLECTION (in)
STATIC
K_{V_1}
K_{V_2}
K_{V_3}
SPRINGING MEDIA CHARACTERISTICS
• A SUSPENSION SYSTEM WITH MODULATED SPRING AND / OR DAMPING CHARACTERISTICS DURING DYNAMIC INTERACTION BETWEEN WHEEL AND TERRAIN CONTOUR.
SPRING ENERGY ASSIST
CRITICAL DAMPING
COMPRESSION
REBOUND
RESISTANCE (lbs)
0
STROKE DISPLACEMENT
fully extended — fully compressed
INFINITELY VARIABLE DAMPING FROM NEAR ZERO TO CRITICAL

Figure 6.

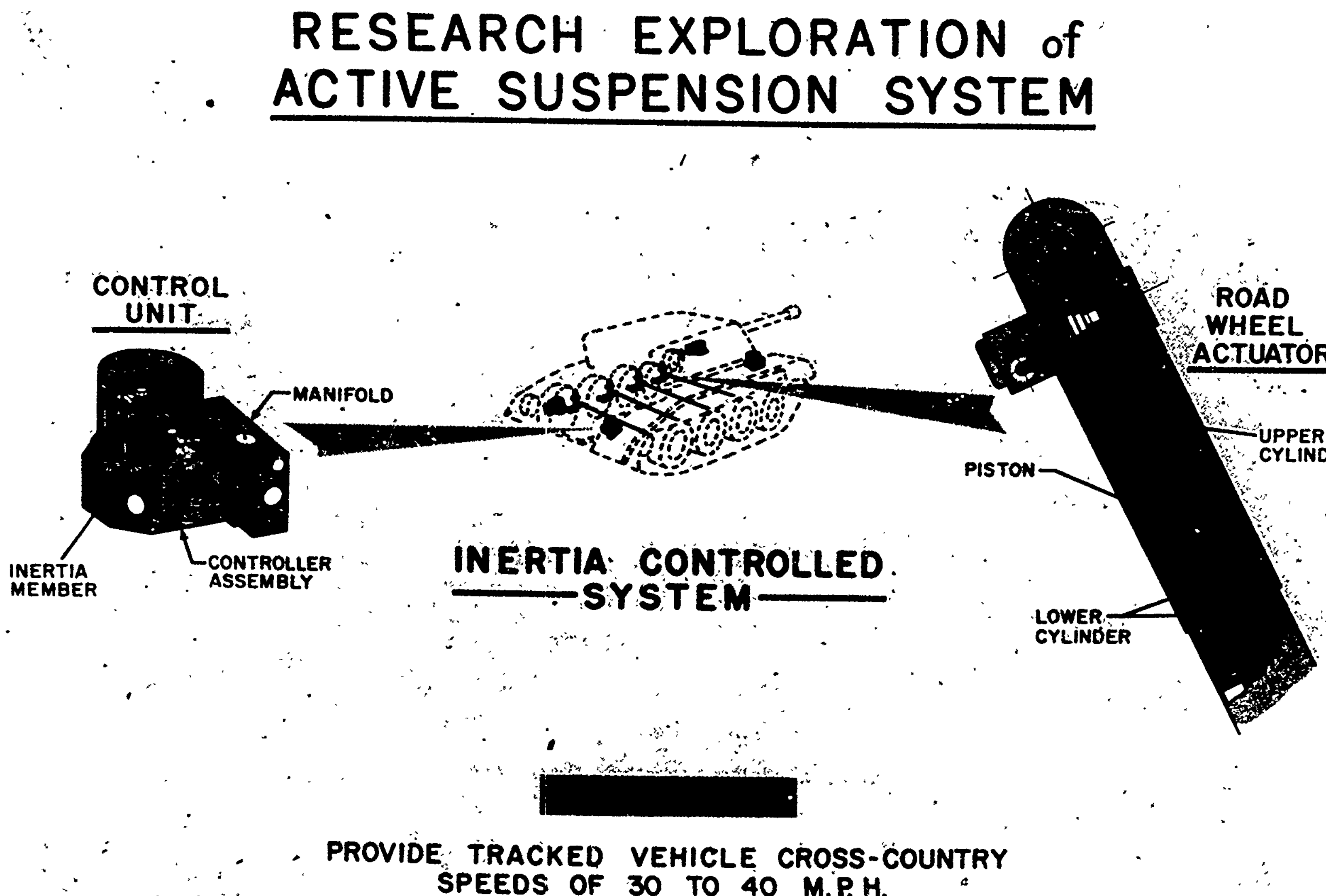

RESEARCH EXPLORATION of
ACTIVE SUSPENSION SYSTEM
CONTROL UNIT
MANIFOLD
INERTIA MEMBER
CONTROLLER ASSEMBLY
ROAD WHEEL ACTUATOR
UPPER CYLINDER
PISTON
LOWER CYLINDER
INERTIA CONTROLLED SYSTEM
PROVIDE TRACKED VEHICLE CROSS-COUNTRY
SPEEDS OF 30 TO 40 M.P.H.

Figure 7.

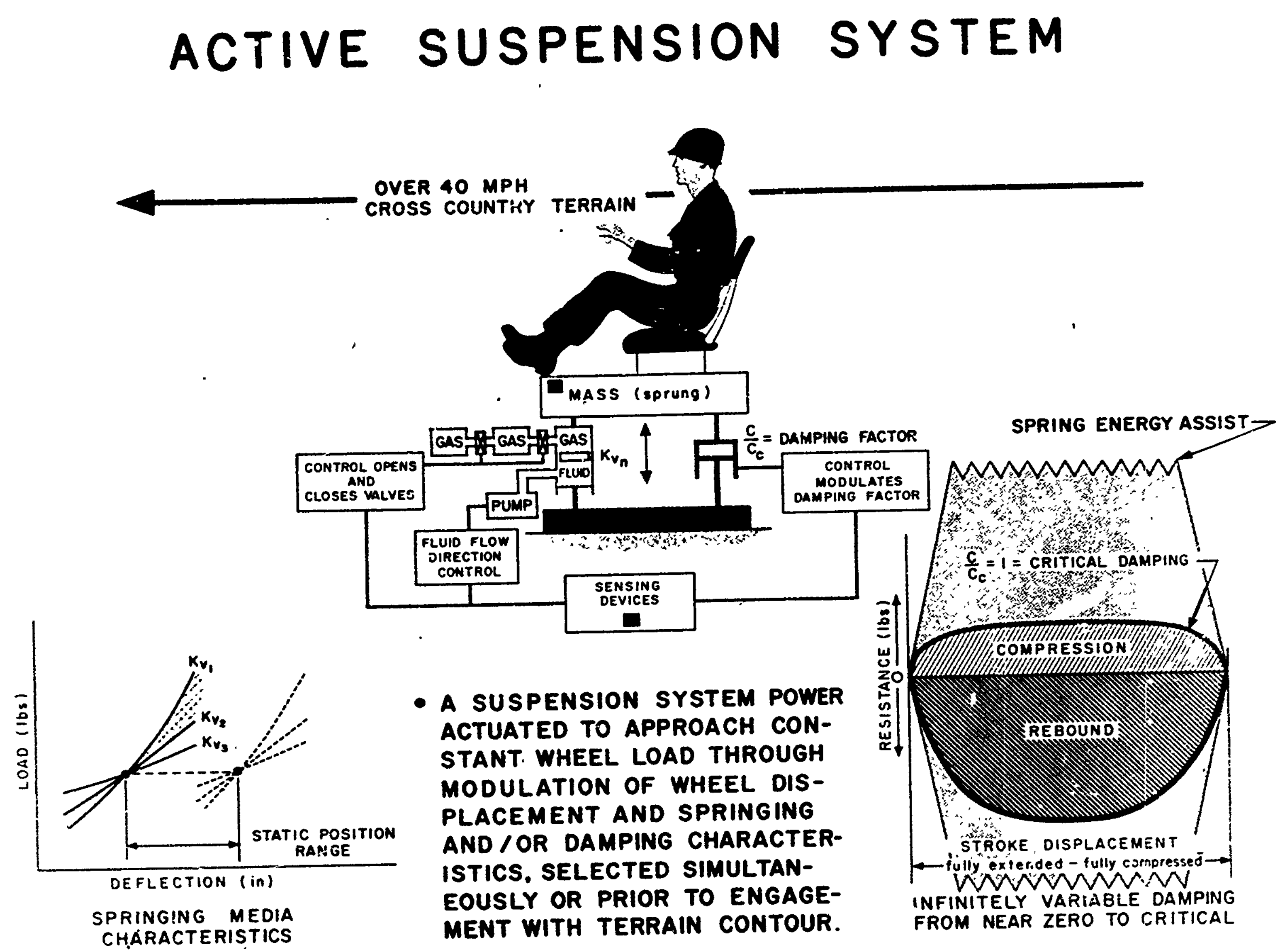

ACTIVE SUSPENSION SYSTEM
OVER 40 MPH
CROSS COUNTRY TERRAIN
MASS (sprung)
GAS
GAS
GAS
FLUID
PUMP
K_{v_n}
$\frac{C}{C_c}$ = DAMPING FACTOR
CONTROL OPENS AND CLOSES VALVES
CONTROL MODULATES DAMPING FACTOR
FLUID FLOW DIRECTION CONTROL
SENSING DEVICES
LOAD (lbs)
K_{v_1}
K_{v_2}
K_{v_3}
STATIC POSITION RANGE
DEFLECTION (in)
SPRINGING MEDIA CHARACTERISTICS
• A SUSPENSION SYSTEM POWER ACTUATED TO APPROACH CONSTANT WHEEL LOAD THROUGH MODULATION OF WHEEL DISPLACEMENT AND SPRINGING AND/OR DAMPING CHARACTERISTICS, SELECTED SIMULTANEOUSLY OR PRIOR TO ENGAGEMENT WITH TERRAIN CONTOUR.
SPRING ENERGY ASSIST
$\frac{C}{C_c}$ = I = CRITICAL DAMPING
RESISTANCE (lbs)
O
COMPRESSION
REBOUND
STROKE DISPLACEMENT
fully extended – fully compressed
INFINITELY VARIABLE DAMPING FROM NEAR ZERO TO CRITICAL

Figure 8.

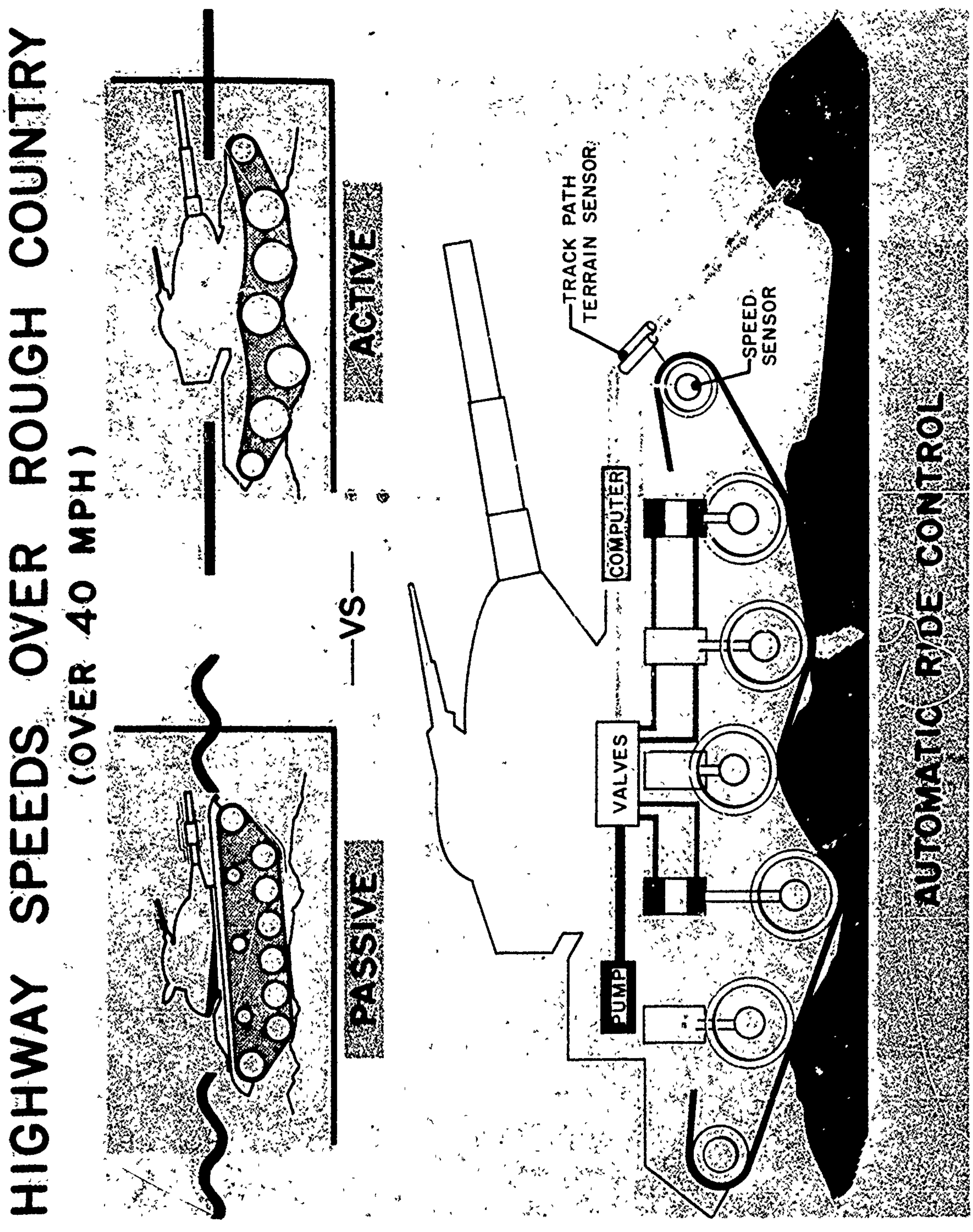

HIGHWAY SPEEDS OVER ROUGH COUNTRY
(OVER 40 MPH)
PASSIVE
—VS—
ACTIVE
PUMP
VALVES
COMPUTER
TRACK PATH
TERRAIN SENSOR
SPEED
SENSOR
AUTOMATIC RIDE CONTROL

Figure 9.

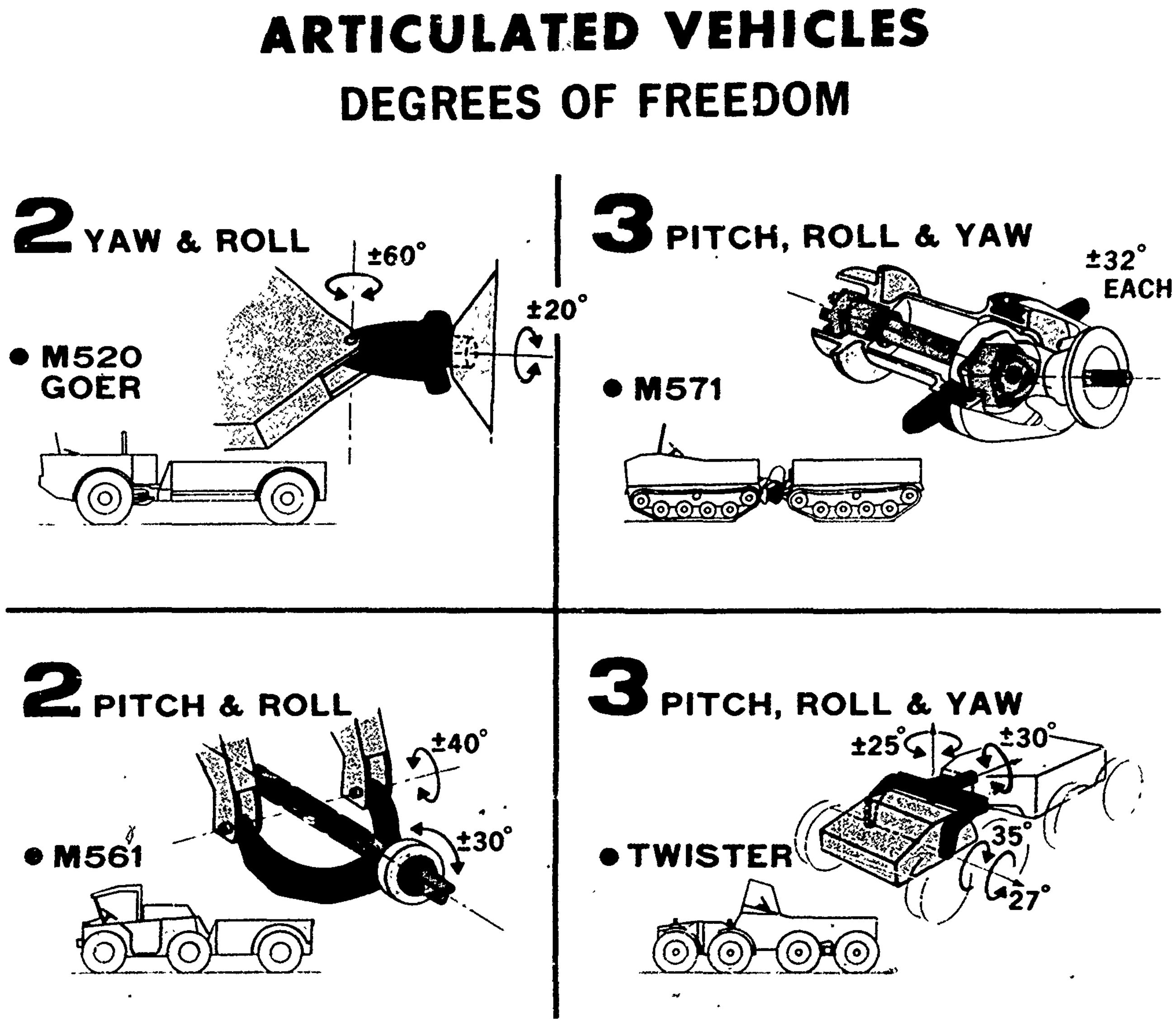

ARTICULATED VEHICLES
DEGREES OF FREEDOM
2 YAW & ROLL
±60°
±20°
• M520
GOER
3 PITCH, ROLL & YAW
±32°
EACH
• M571
2 PITCH & ROLL
±40°
±30°
• M561
3 PITCH, ROLL & YAW
±25°
±30°
35°
27°
• TWISTER

Figure 10.

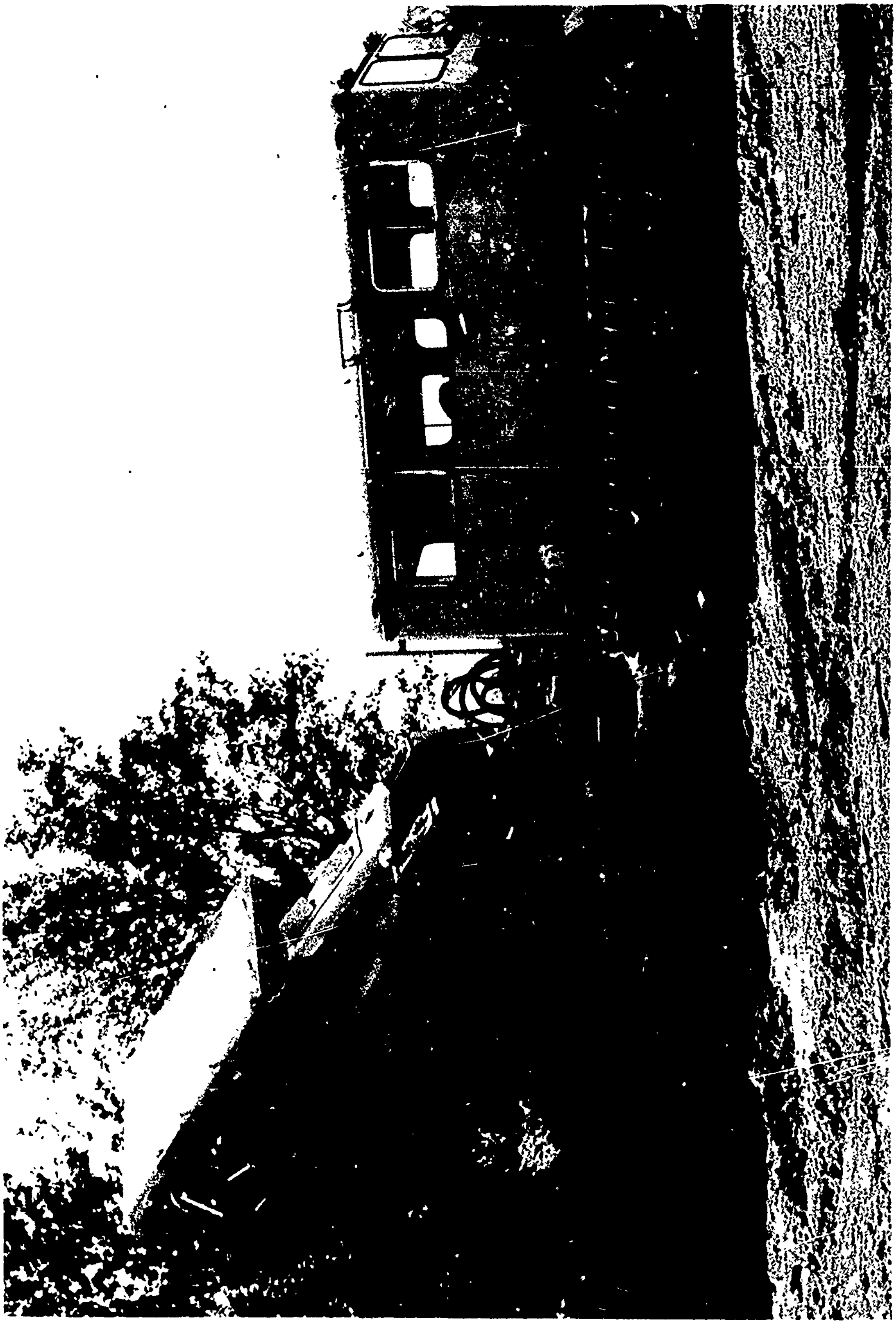


Figure 11.

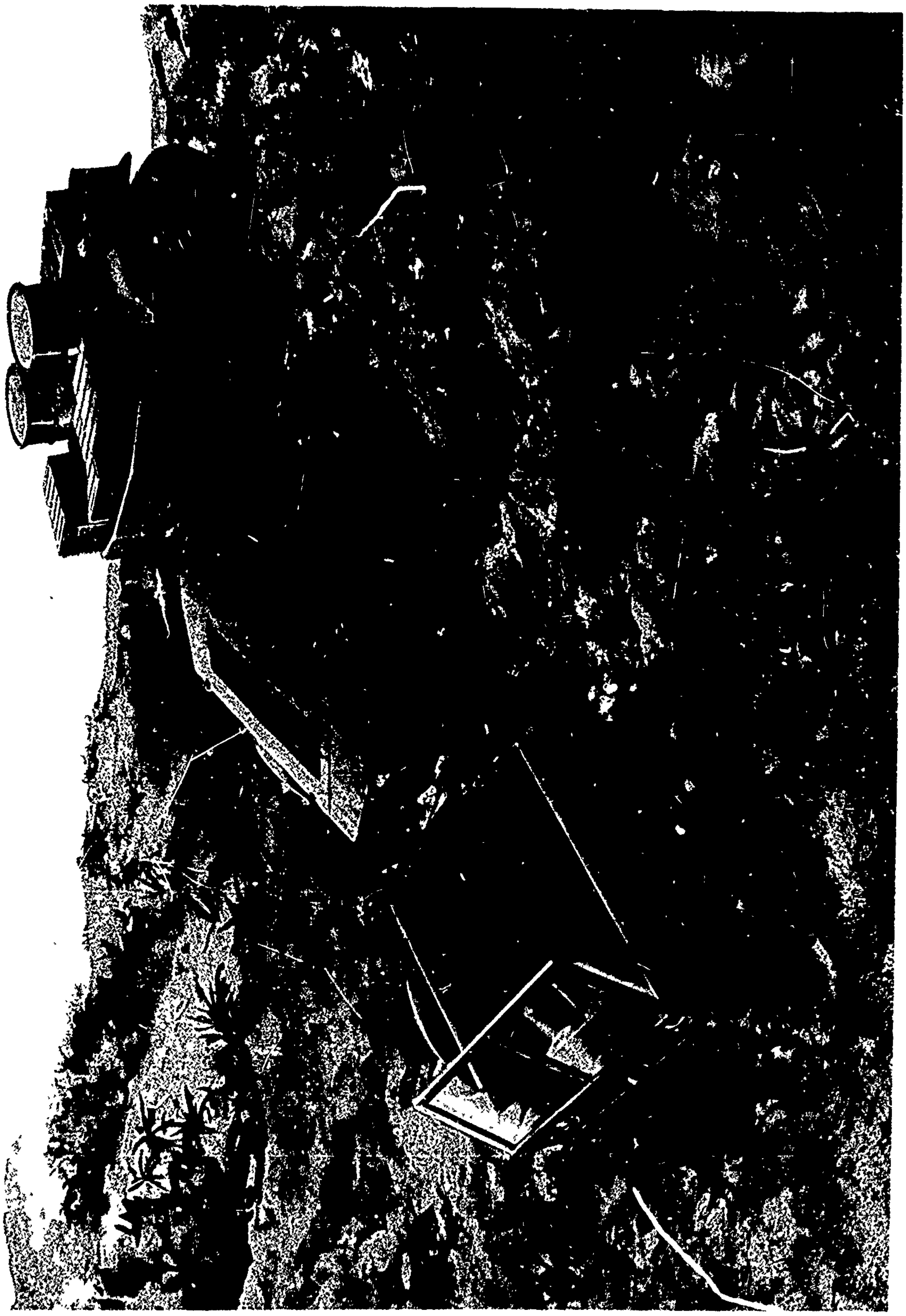
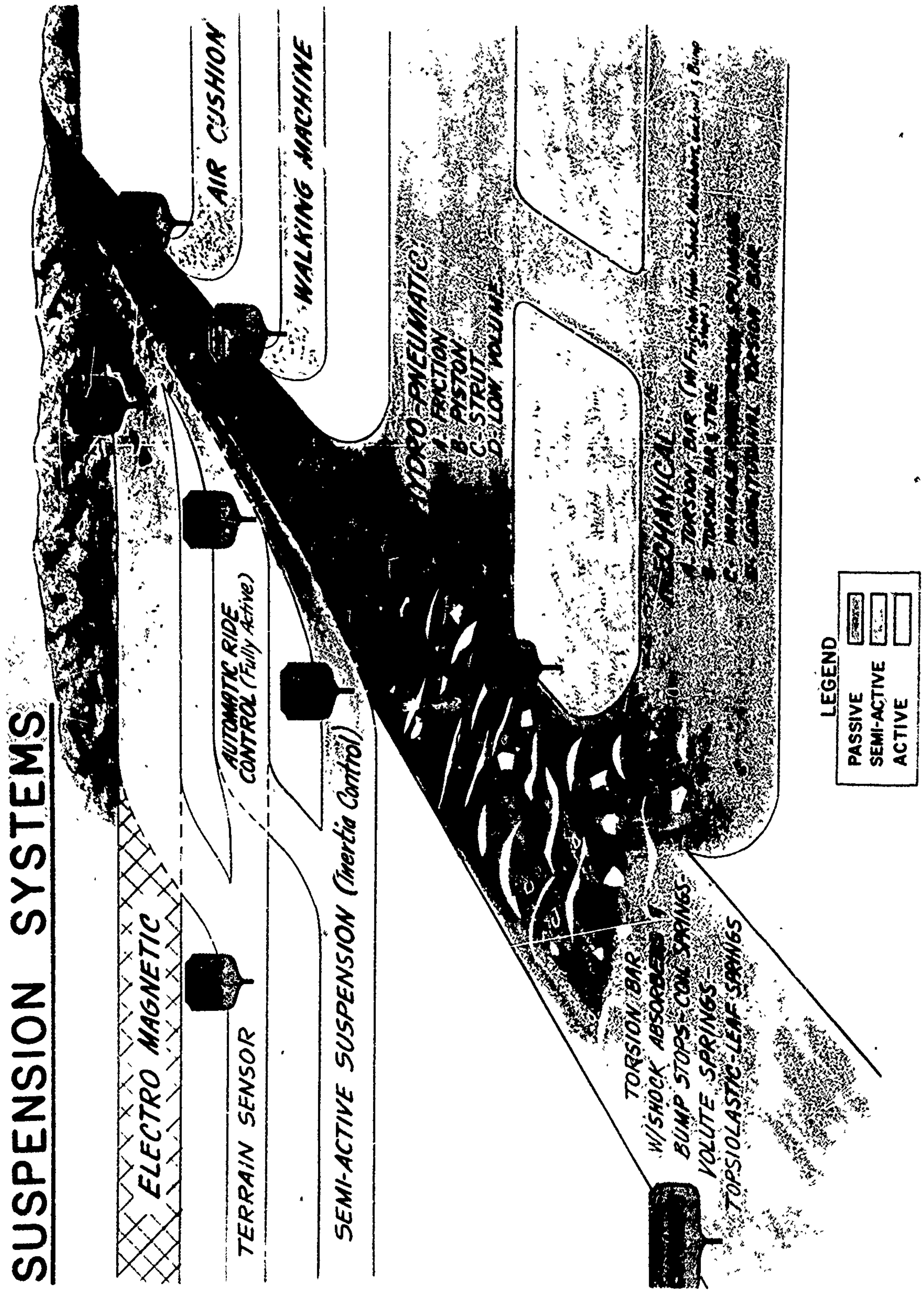


Figure 12.

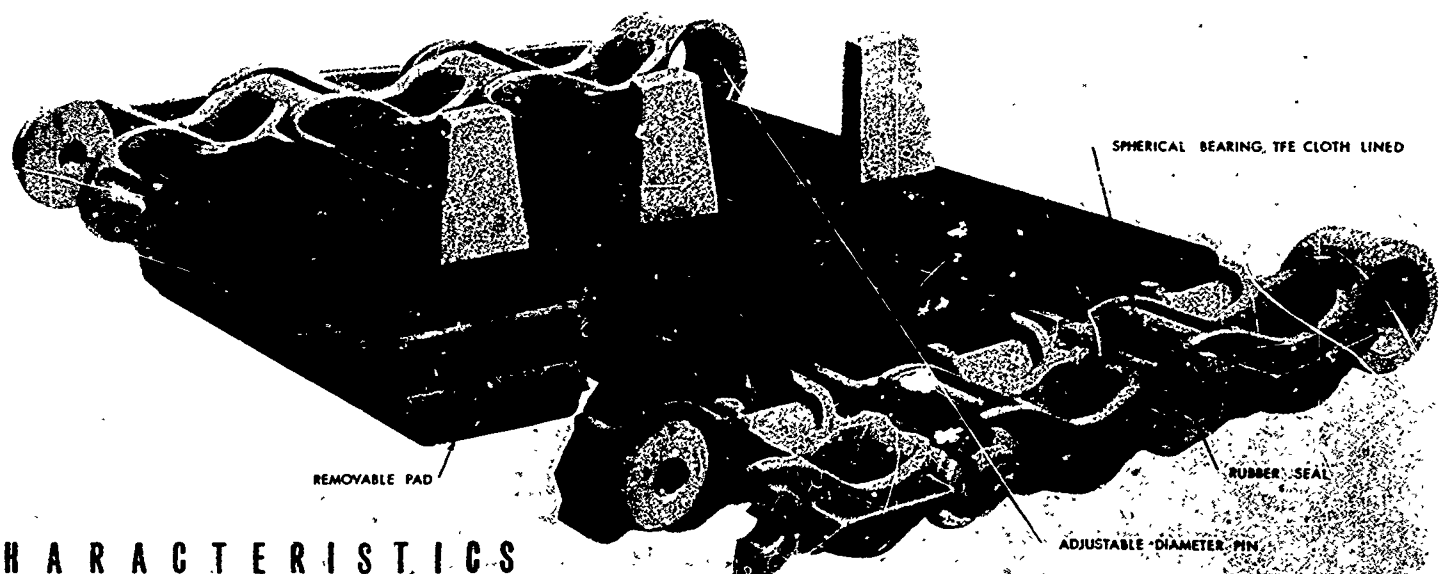
Figure 13.



SUSPENSION SYSTEMS
ELECTRO MAGNETIC
TERRAIN SENSOR
AUTOMATIC RIDE CONTROL (Fully Active)
SEMI-ACTIVE SUSPENSION (Inertia Control)
AIR CUSHION
WALKING MACHINE
HYDRO-PNEUMATIC
A. FRICTION
B. PISTON
C. STRUT
D. LOW VOLUME
MECHANICAL
A. TORSION BAR
TORSION BAR
W/SHOCK ABSORBERS
BUMP STOPS-COIL SPRINGS
VOLUTE SPRINGS
TOPSIOLASTIC-LEAF SPRINGS
LEGEND
PASSIVE
SEMI-ACTIVE
ACTIVE

Figure 14.

25" SELF-LUBRICATED PIN TRACK

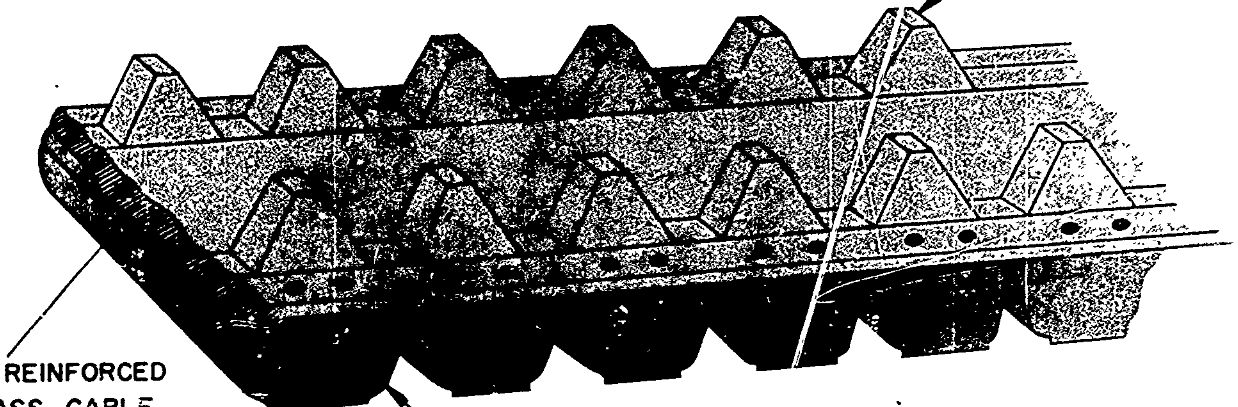


CHARACTERISTICS

WIDTH	25 INCHES
PITCH	6.6 INCHES
SHOE	HOLLOW STEEL CASTING
BEARING	SPHERICAL
PAD AREA	75 SQ. IN.
DRIVE	DUAL SPROCKET
WEIGHT	100 LBS./FT.
VEHICLE WT. CAPACITY	110,000 GVW

Figure 15.

LIGHT WEIGHT HIGH MOBILITY TRACK



WEIGHT/FT. : 11.5 POUNDS
WIDTH : 12 INCHES
PITCH : 6 INCHES
BUOYANCY : SUPPORTS 20% MORE THAN IT'S OWN WEIGHT IN WATER

THE DRIVE SPROCKET CONSISTS OF TWO CIRCULAR STEEL END PLATES JOINED BY TWELVE HOLLOW STEEL PINS WHICH ARE WELDED TO THE END PLATES.

Figure 16.

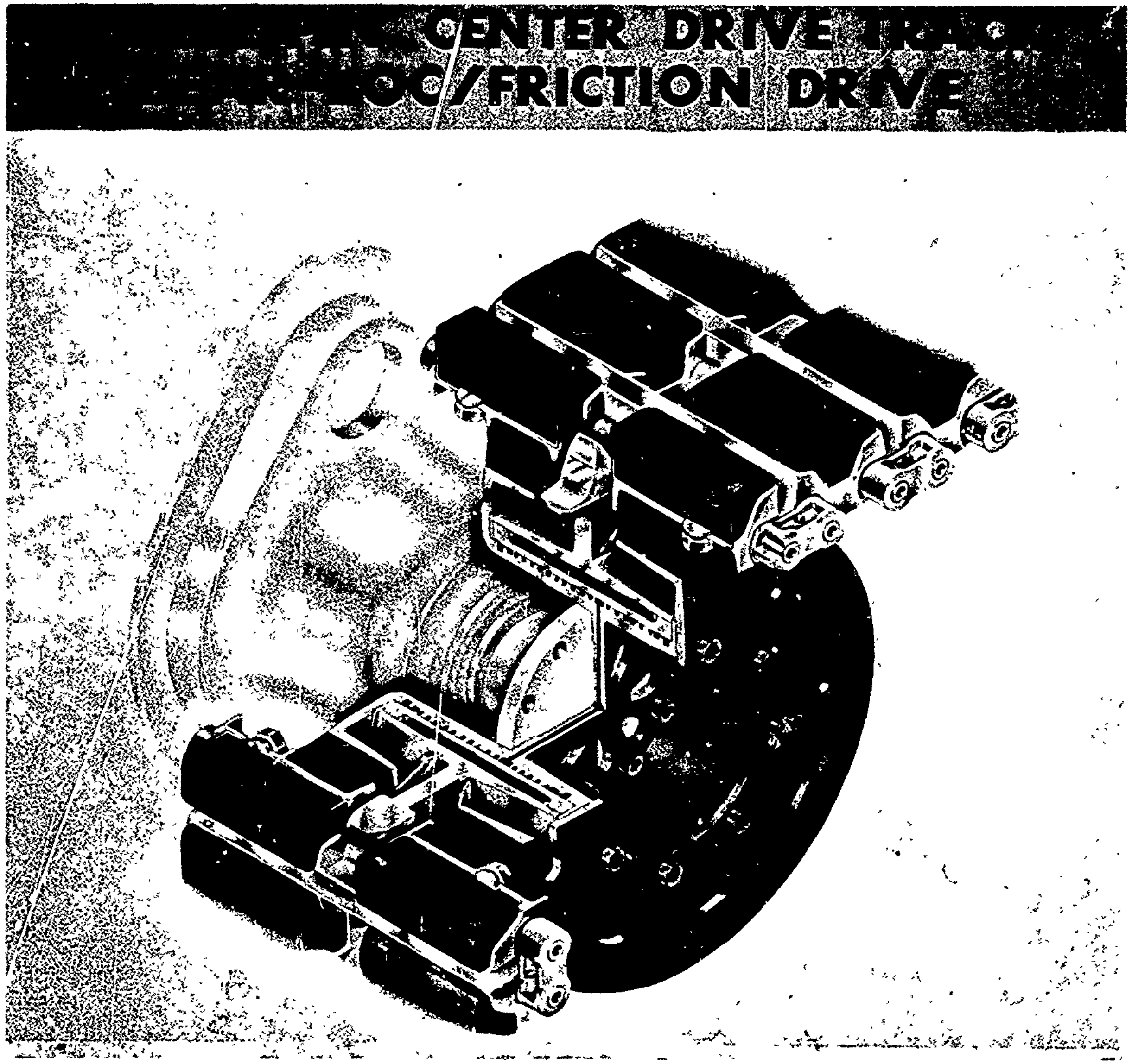


Figure 17.

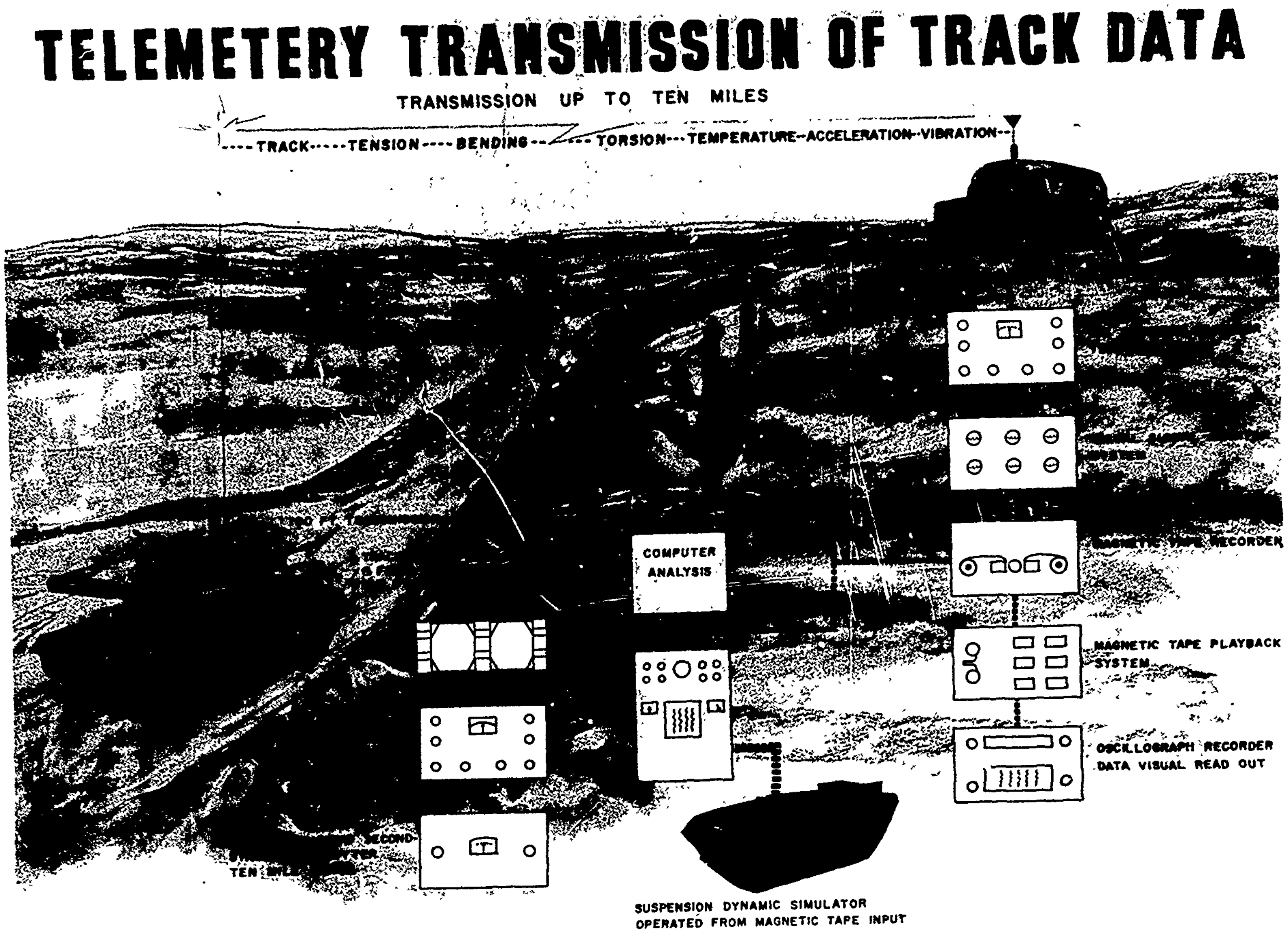

TELEMETERY TRANSMISSION OF TRACK DATA
TRANSMISSION UP TO TEN MILES
TRACK-----TENSION----BENDING----TORSION---TEMPERATURE--ACCELERATION--VIBRATION
COMPUTER ANALYSIS
MAGNETIC TAPE PLAYBACK SYSTEM
OSCILLOGRAPH RECORDER DATA VISUAL READ OUT
SUSPENSION DYNAMIC SIMULATOR OPERATED FROM MAGNETIC TAPE INPUT

Figure 18.

50 TON CAPACITY ROAD SIMULATOR

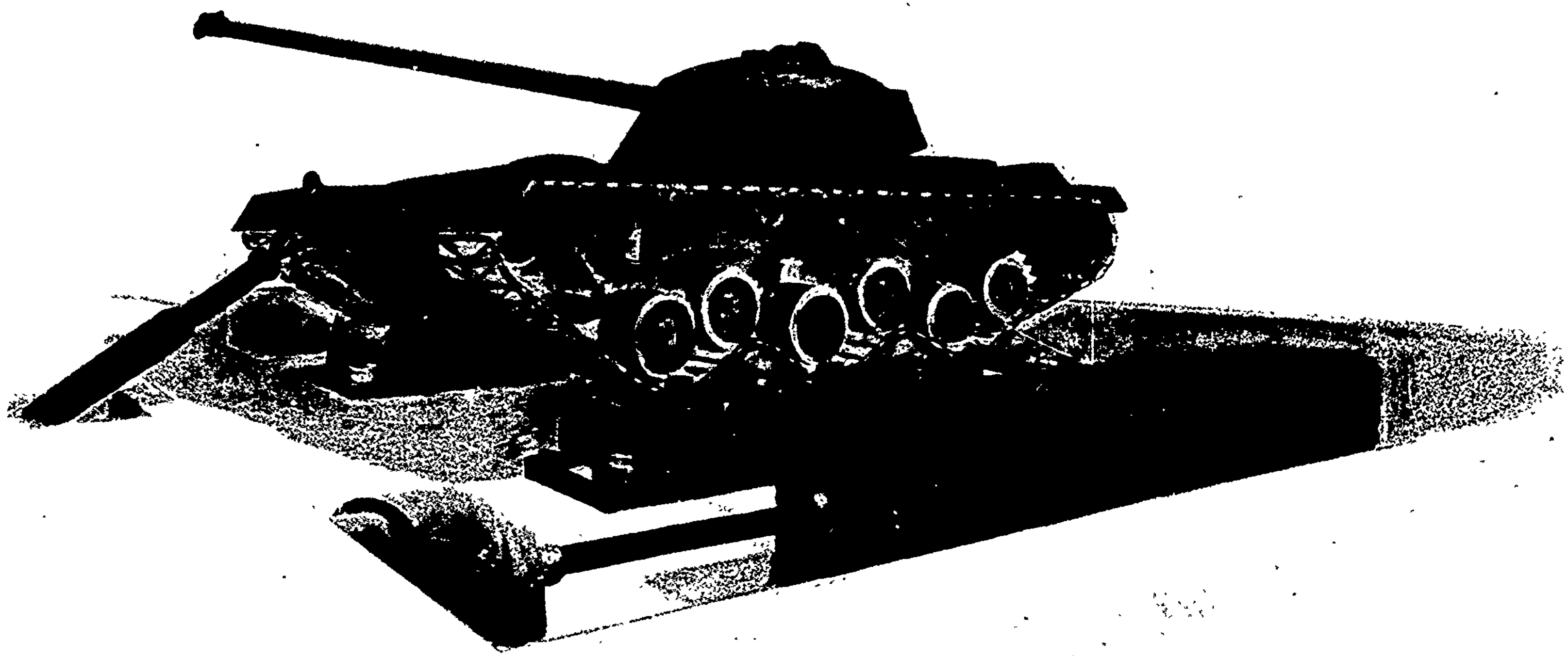


Figure 19.

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The vehicle vibration generated by the suspension systems covers a broad spectrum of frequencies, displacements and accelerations. Over average cross-country operations, vertical frequencies range from under 1 Hertz to 500 Hertz. Displacements range from micro-inches to 12 inches, and the accelerations up to 3 g's. These can occur in the vehicle at speeds under 10 mph. The development programs presented today on suspensions, tracks and drives are directed at reducing this severity by at least 50% while increasing cross-country speed 5 fold, or to about 40 mph. Evaluation of individual components and computer analysis show that these goals can be reached. If these goals are met, the crews in future tracked and wheeled vehicles should be able to perform their respective missions with much greater efficiency and fewer casualties.

4B. SIMULATION APPLIED TO HUMAN FACTORS RESEARCH

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The usual mission of a vehicle is to transport a payload over some distance. The payload may take a variety of forms: logistic, tactical, combat, fixed or variable. The speed at which the vehicle is able to execute an assigned mission is an important design consideration.

From the initial pioneering efforts, high vehicle speed has been a sought after objective. The progression to the present state-of-the-art has been largely achieved by engineering manipulation of weight, size, and power in order ot produce behavior which could be considered in some sense best.

Today, the parameter of speed is properly linked and associated with the operational environment. In 1964, Wilcox (1) suggested mobility should be defined as average speed taken over a spectrum of starting points, destinations, terrain paths, seasons, maintenance schedules, etc. In this context, mobility is presented in a dimensionable form. Units of velocity are available for quantitative and qualitative measurement.

Among Research and Development people, mobility reported as average speed (miles per hour) does not arouse disagreement. Field results are readily accepted. Computed forecasts of mobility, however, have not universally shared this confidence.

Accurate prediction of mobility performance is dependent upon the description of the terrain, the vehicle design and the driver. The interdependence and influence of these elements will now be considered.

In the terrain element there are two characteristics that may inhibit speed performance: soft-soil limitation to repeated trafficability; and terrain contour presented as micro or macro-obstacle barriers. High speed mobility (20-50 MPH) can generally take place only when trafficability is not restrictive. Therefore, the speed of advance is primarily governed by the ability of the driver and other passengers to withstand the vibration levels that are produced when the vehicle is traversing rough ground. (2) The response of the human when thrust into this complex vibrational environment is the central theme of this paper.

Vibrations resulting from the ground disturbance have commonly been referred to as "ride" motions, and the vibration response of a ground vehicle to terrain contour is known as the "ride" behavior. Since vehicle ride is a major mobility criterion which places an upper limit on cross-country speed, achievement of higher sustained speeds is dependent upon solution of the cross-country vehicle ride problem. (3)

Vehicles supported on pneumatic tires generally achieve two widely separated natural frequencies of vibration; one for the sprung mass, and another for the unsprung system. The natural frequency of the latter is higher by a factor of ten or more. This means that the wheels respond to the high frequency content of a terrain contour; whereas, the sprung mass is sensitive only to the low frequency content in the ground profile. As forward speed increases, the long wave lengths of large amplitude that are normally present in cross-country terrain become disturbances which excite the sprung mass resulting in severe ride.

Ordinary track-laying vehicle suspensions are similar to the suspensions of wheeled vehicles, with the exception that the roadwheels are enclosed by an endless track. The roadwheels run on the track rather than running directly on the ground. The track is "laid" on the terrain ahead of the front wheels and picked up behind the rear wheels in a continuous process. Thus, the road for "tracked" vehicles is the track. The roadwheels transmit the terrain reaction forces into the hull through the suspension springing and dampers.

If there are levels of vibration under which the vehicle crew cannot perform their function or control the vehicle adequately, then a limit on forward speed is automatically encountered. The mobility limitation may be a single factor, or several factors acting in combination. The human factor element includes vehicle ride, as pitch, bounce, fore and aft, roll and side to side accelerations which the vehicle occupants may be required to tolerate as shock or fatigue effects. Other influences may be soil characteristics, suspension, power, reliability and driver skill. Because the interaction among these factors is complex, useful forecasts of vehicle speed are best made through computer-aided design studies based on validated mathematical models.

There are available a number of techniques for evaluating high speed mobility. Techniques which differ in generality and ease of application appear in references (2) (4) (5) (6).

The Environment

Heal and Cicillini (1964) (8) reported thirteen terrain profiles, intended to serve as a data source for computer studies. These profiles have been used as representative of both domestic and European areas of operation. Other profiles are presented in the USATACOM Land Locomotion Division Road Atlas. (9) References (7) and (9) describe the terrain profiles as range and elevation; power spectral density (PSD) characteristics are also offered as a function of spatial frequency. The contribution of describing random terrain by PSD techniques comes from Bogdanoff. (9) The terrain is random in the sense that wave length and amplitude order can only be described as a statistical parameter.

Briefly, the concept of PSD takes the square of the root mean square (RMS) value of amplitude for a specific wave length and yields the mean square value for that bandwidth. The mean square value is divided by the bandwidth as it is made to approach zero and this is known as PSD. PSD is proportional to the square of amplitude; hence, a representation of terrain as PSD versus wave length describes the power distribution of the environment. The ordinate, power spectral density, has units of ft^2/cycle/ft, and the abscissa, spatial frequency, has units of cycles/ft.

Power concentrated at frequencies below the region of 0.02 cycle/ft approximately characterize the gross terrain features or terrain macrogeometry. Power concentrated at frequencies above 0.02 cycle/ft approximates the extent of the terrain microgeometry or surface roughness. (7)

The Vehicle

In the early 1960's, the U.S. Army Tank-Automotive Command sponsored research programs to develop computer techniques which would calculate vehicle ride motion over cross-country terrain. Methods of simulating vehicle motion in three dimensions were developed by the USATACOM Scientific Computer Division and the University of Michigan, Institute of Science and Technology. (10) These studies produced mathematical models for analysis of angular motion of the vehicle about its tranverse axis (pitch), translational motion in a vertical direction (bounce), and movement about the longitudinal axis (roll).

In real life, a vehicle travels over the road encountering surface changes as it proceeds. Duplication of this physical situation in the computer is controlled by presenting the road profile to each wheel separately. The presentation is phased so that the rear wheels "see" the same non-deformable terrain irregularities as the front wheels, but at some time later.

Simulation of vehicle motion by means of electronic computers augments analysis methods by permitting rather detailed investigation of the effects of suspension design on ride characteristics, and of the stability of the vehicle in the presence of other forces. The validity of the computer approach (10) was tested and compared by experimental measurements.

The correlation study was based on a field test program of a medium tank and a four-wheeled vehicle. However, the mathematical model was prepared for vehicles having any number of wheels and, with modification, is applicable to articulated vehicles.

The Driver

The attitude of the operator of a vehicle is an important part of the mobility system, for indeed, a poorly trained or unmotivated operator can easily render a vehicle immobile under marginal or near-marginal conditions.

The environmental conditions sensed by the driver are the presence of obstacles, unexpected rough terrain, poor traction, deep ruts, weather and visibility. In a computer study of mobility, this complexity can be controlled as in reference (7). Whether or not the vehicle would be stalled by the obstacle would, of course, depend upon obstacle size and shape, vehicle characteristics and vehicle velocity at the time of encounter.

The assessment of driver response

to vibration is a fundamental problem upon which the success of computer-aided design of vehicles is dependent. This importance has prompted the treatment of human vibration as a separate subject of research by many investigators. Current bibliographies record over 1500 separate studies directed to resolve individual problem areas of identifying human response to vibration. (11) Progress had been made, but research finding had not produced an analytical procedure with potential for application of trade-off studies of vehicle speed, crew fatigue, and crew discomfort.

In early 1963, it appeared that research groups were resigned to continue the practice of placing dependence on experimental tests to assess the effects of vibratory environments. Programs based upon the required analytical approach were not evident. Therefore, USATACOM began a basic study in this area to fulfill the need.

The research work maintained primary emphasis on random vibration since it had been generally recognized that random vibration best described the environment created by air, sea, and automotive transportation vehicles.

Initial research steps were basic and conventional and centered upon vertical sinusoidal tolerance studies. This introductory work was then extended to pitch and roll motions. The angular information which resulted was new. Experiments were then conducted to obtain tolerance data for random vibration. After this was accomplished, a temporary impasse was encountered. The problem which arose was that random environments existed in an infinite number of patterns. A new approach was sought to by-pass this limitation. The approach selected was to test the applicability of transfer function techniques to human vibration. The first success in this venture was to relate transfer function statements to experimental data. This work was reported in 1965 to the Society of Automotive Engineers. (12) (13) With the new flexibility afforded by the transfer function, the area of human comfort was studied. From this resource, the new criterion "absorbed power" was developed by R. A. Lee. (14)

The concept of "absorbed power" is based on the recognition of the elastic and damping properties of the anatomy. For example, if the seat that you are sitting on should begin to vibrate, there would be an energy input and an energy flow; the seat cushion would deflect and your body would move or be displaced. This elastic movement requires an expenditure of energy as it is damped by body tissue. The average value of the rate this energy is absorbed is referred to as "absorbed power". However, if a steel block replaced you on the cushion, the "absorbed power" of the block would be zero due to its inelastic properties.

"Absorbed power" can be computed easily. A time history signal of acceleration from magnetic tape or directly from an accelerometer (during field measurements) is sent into an electric circuit representing the force transfer function. The output from this circuit is force. The input acceleration record is also sent through an integrator producing velocity. The force and velocity signals are then multiplied and put through an averaging circuit producing average "Absorbed power". Since "absorbed power" is a scalar quantity and no longer a vector quantity, it can be added directly for various modes of motion as shown in figure 1.

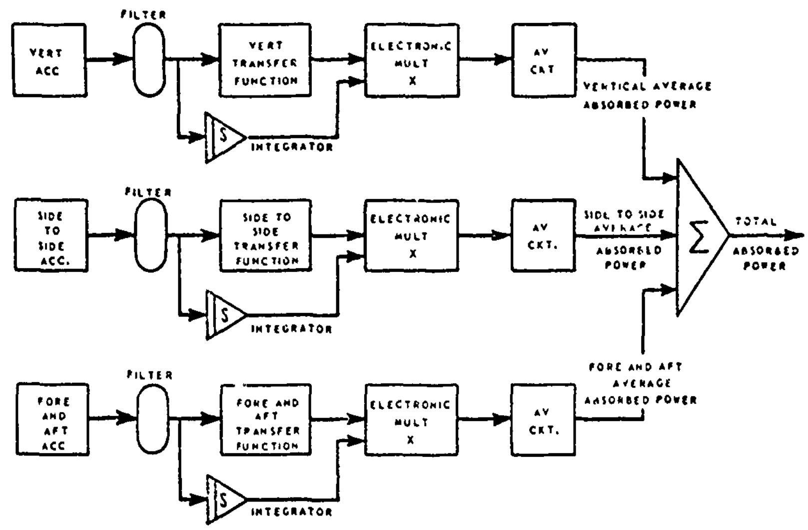

Figure 1. Absorbed Power Measurement

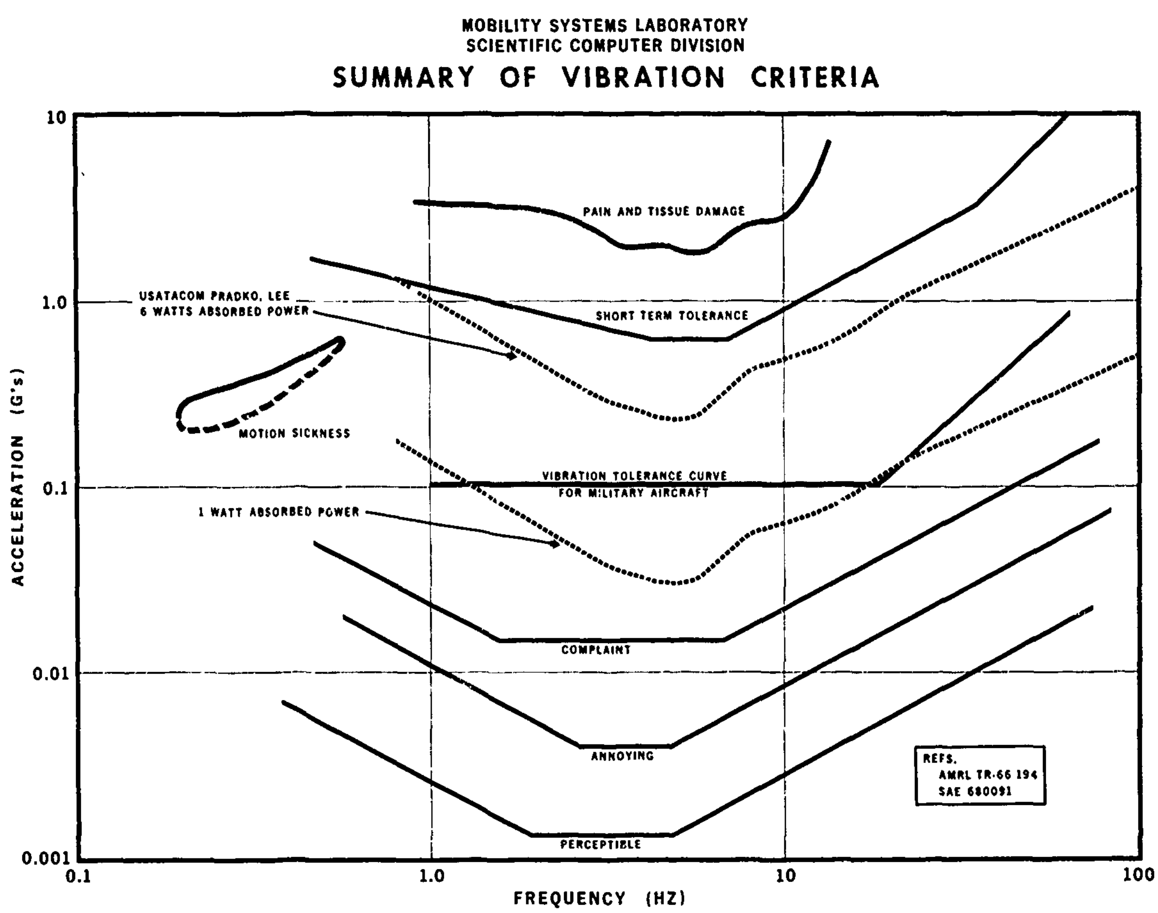

Figure 2.

Mathematically, absorbed power is given by:

Average "absorbed power" =

where F(t) is the input force to the body and V(t) is the velocity where the force is applied.

In early tests, "absorbed power" confirmed the popular opinion that subjective response was non-linear. For example, in the acceleration amplitude of vibration was doubled or halved, the ride sensation did not necessarily vary accordingly. In later experiments, it was shown that subjective response was predictable using the "absorbed power" measurement. Experiments were designed to evaluate the ability to discriminate different vibration inputs and to order their comfort or severity.

"Absorbed Power" is frequency sensitive, as shown in figure 2. Vibration of frequencies at about four to six hertz are the most severe since major body resonances occur in this range.

The distinct advantages of absorbed power as a measure of vibration severity are:

1. Application to random vibration.
2. Human response can be predicted from information describing the acceleration of vibration without the use of a test subject.
3. Vehicle ride can be computed with relative simplicity for multi-degree of freedom systems where bounce, fore and aft, side to side, pitch and roll motions are involved.
4. Human response to vibration can be predicted using time or frequency domain information.
5. Computation of absorbed power can be programmed to permit "on-line" computer studies of vehicle ride.

The use of "absorbed power" in computer forecasts of vehicle mobility has been successfully tested in 1966. (15) Computer prediction was correlated to field measurements of maximum vehicle speeds (figure 3). The field exercise was conducted in Houghton, Michigan, over an undeveloped open dirt trail. The performance of three drivers was averaged for three different runs. (15)

The terrain contour was surveyed for computer input. The vehicle vibrations were calculated using the mathematical model reported by Heal. (4) The absorbed power was measured as outlined in "Vibration Comfort Criteria". (14)

The results were graphically interpolated for maximum speed at a reference level of six watts "absorbed power".

The correlation shown in tabulated and graphical form (figure 3) between the computer forecast and actual test values substantiate the use of the "absorbed power" theory in vehicle design studies.

Vehicle/Man Mathematical Model

Two general methods used for computer analysis of vehicle systems are time domain analysis with deterministic inputs and frequency domain analysis using statistical inputs (16). Time domain analysis is rather lengthy and time consuming with large volumes of output data requiring reduction but it produces the greatest amount of information and detail. In addition, it can be used to represent the actual system responses as a function of time for use as an input to motion simulators. Frequency domain analysis is very fast, economical

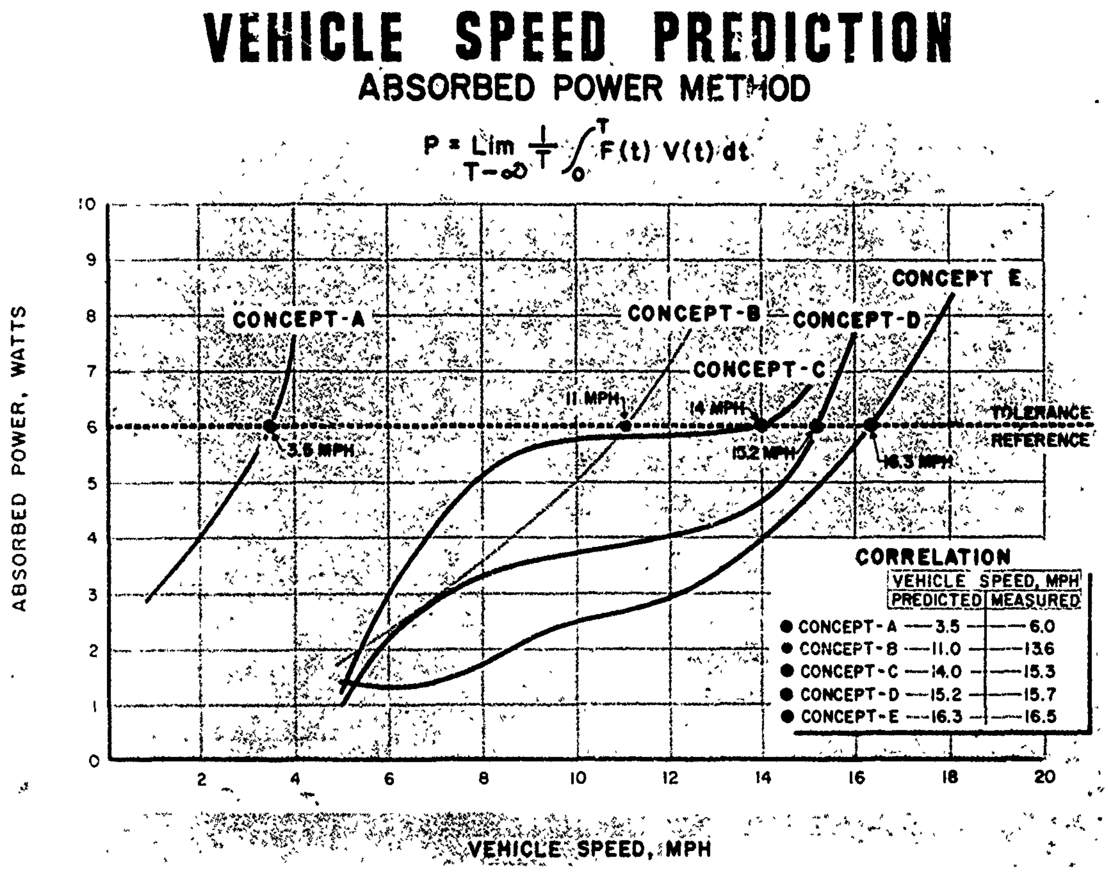

Figure 3.

and provides information on the frequency content of the motions directly. It is limited in that it requires a linear model to represent the vehicle system and is only adaptable to steady state analysis unless time dependent, non-stationary techniques are used.

To model a system in the time domain, it is necessary to represent the physical characteristics mathematically in the form of differential equations. The vehicle parameters are represented in the equations as coefficients of the dependent and independent variables, which describe the motion of various points in the vehicle, and can be used to describe its behavior. The differential equations can be programmed on either an analog or digital computer and are used to simulate the vehicle motion as a function of time.

The basic method of solving these equations is through a series of integrations. On the analog computers, each varialbe integration is done electronically while on the digital computers, the integrations are done using numerical techniques and iteration to converge at a solution.

To analyze a system in the frequency domain, the system of equations are transformed to the frequency response function with linear coefficients. The input and

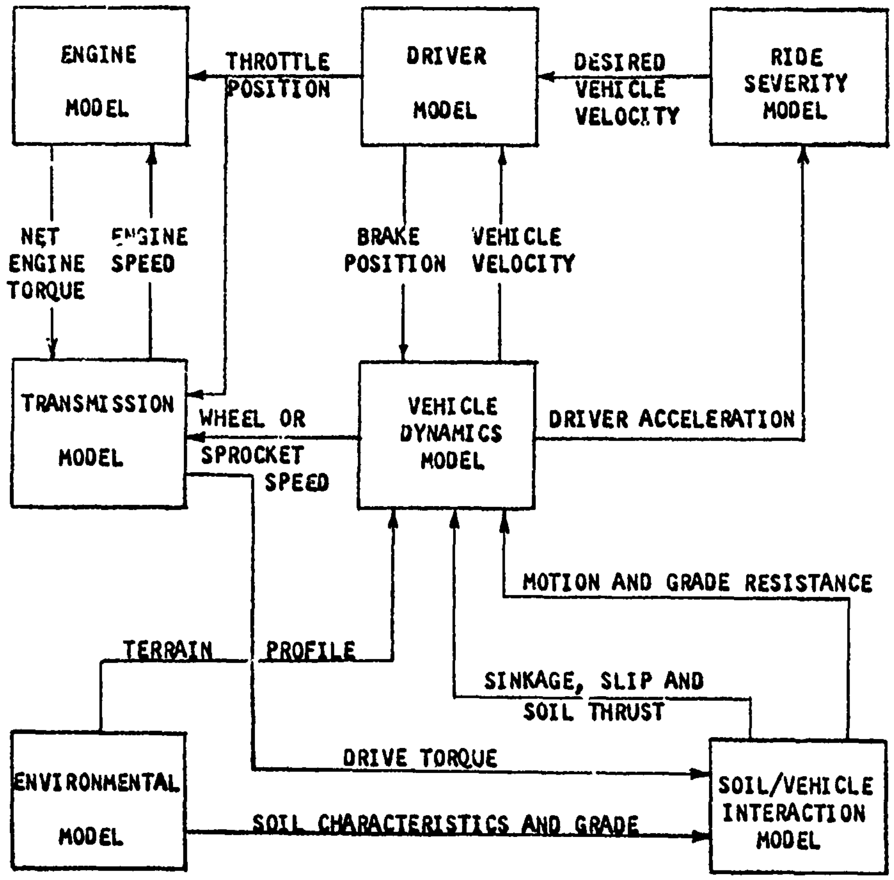

Figure 4. Mathematical Model of Vehicle/Man System

output of the system are described by the power spectral density (PSD) of each. In order to use the PSD of terrain profile as an input to this system, the constraint of stationarity is assumed. The output PSD is computed, using the following relationship.

$$S_o(f) = G(jf)^2 \quad S_{in}(f)$$

Where,

$S_o(f)$ PSD of output variables

$S_{in}(f)$ PSD of terrain profile

$G(jf)$ Frequency response function

For a system with more than one input, in the case of a vehicle with more than one wheel, $G(jf)$ must be expanded to include the cross spectral density which describes the correlation between the various inputs. Since this model uses algebraic expressions, no matter how complex, and does not involve any integrations, it is easily adaptable to the USATACOM time-sharing terminals.

The techniques for simulating the vehicle and computing the ride severity allows us to evaluate the vehicle effect on the man, but how the driver responds to this vibration and controls the vehicle must be included in order to analyze the overall vehicle/man system. This requires a means of representing the driver reaction with the automotive and soft soil performance of the vehicle.

A model has been developed that predicts the automotive performance, using the driver reaction model and the environmental description (17). The desired velocity is compared to the actual velocity of the vehicle in order to determine the throttle and brake settings to the power plant and power train model. This model, used in conjuction with the soil/vehicle interaction model, as depicted by the vehicle model and course description in the schematic, determines the actual vehicle velocity, closing the system loop. By combining these models, a total vehicle/man system model is constructed as shown in the schematic in figure 4. The use of the effective mass/inertia frequency response function and absorbed power approach as an analytical description of the vehicle/man interface is represented by the ride severity model, along with the vehicle dynamics model. The information that is determined using this model is used as an input to the driver reaction and perception model in the form of a desired vehicle velocity or a maximum vehicle velocity at which the driver can still control the vehicle. Thus, this model is now being used to predict and evaluate the vibration and impact effects on the driver and, in turn, the overall performance of the vehicle/man system.

References:

1. Wilcox, H.A., "Implications of Current Scientific Research for Future Mobility", Papers presented at the 1964 Mobility Forum, Allison Division, General Motors Corporation, Indianapolis, Ind.

2. Van Deuson, B.D., "A Study of the Vehicle Ride Dynamics Aspect of Ground Mobility", Vol. 1, March, 1965.

3. Cornell Aeronautical Laboratory; notes 1960

4. Heal, S.F., "Suspension Analysis", Dynamic Simulations Laboratory, Research Division U.S. Army Tank-Automotive Center, April, 1961

5. Bussman, Dr. Dale R., "Vibrations of a Multi-Wheeled Vehicle", The Ohio State University, Technical Report, August, 1964.

6. Smith, R.E., "Vehicle Random Terrain Response", Food Machinery Corporation, San Jose, California, September 1963.

7. McKenzie, R.D., W.M. Howell, D.E. Skaar, and A.V. Butterworth, "Evaluation of Counterinsurgency Mobility in Relation to Environment", GM Defense Research Laboratories, June 1966

8. Heal, S.F., and C. Cicillini, "Micro Terrain Profiles", Report No. RRC-9, U.S. Army Tank Automotive Center, 14 August, 1964

9. Bogdanoff, John L., Frank Kozin and Louis J. Cote, "Atlas of Off-Road Ground Roughness PSD's and Report on Data Acquisition Technique", U.S. Army Tank-Automotive Center, September 1966.

10. Sattinger, I.J., D.F. Smith, "Computer Simulation of Vehicle Motion in Three Dimensions", University of Michigan, May, 1960

11. "Biomedical Research Studies in Acceleration, Impact, Weightlessness, Vibration, and Emergency Escape and Restraint Systems", Civil Aeromedical Research Institute Report 63-30 December, 1963

12. Pradko, F., Theodore R. Orr, and R.A. Lee, "Human Vibration Analysis", 1965. Society of Automotive Engineers, 650426.

13. Pradko, F., V. Kaluza, and R.A. Lee, "Theory of Human Vibration Response", 1966. American Society of Mechanical Engineers, 66-WA/BHF-15.

14. Pradko, F., and R.A. Lee, "Vibration Comfort Criteria", 1966. Society of Automotive Engineers. 660139.

15. Liston, R., "Correlation Between Predicted and Actual Off-Road Vehicle Performance", January 1967. U.S. Army Tank-Automotive Center, Warren, Michigan.

16. Lins, W.F., "Vehicle Dynamics", working paper, OMEGA Study, July, 1968, USATACOM, Warren, Mich.

17. Wollam, J., "Automotive Performance", working paper, OMEGA Study, July 1968, USATACOM, Warren, Mich.

4C. THE TRIPLE INTERFACE BETWEEN MAN AND HIS ENVIRONMENT

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This report grows out of the situation depicted in the findings of the Board of Inquiry, Army Logistic System, commonly called the Brown Board. This board investigated, among its concern, the rate of faulty diagnosis in the Army Maintenance System, its causes, and its impact on repair parts supply.

(Figure 1) In essence, the results in my area of concern--the Automotive Electrical System--are that there is excessive replacement of good parts and disuse of technical manuals and test equipment. This points out the need for improving test equipment, technical manuals, training, and maintainability (Figure 2). In considering the improvement of this situation, a primary concern is that original equipment designs must be such as to permit easy diagnosis and replacement or repair. Furthermore, troublesome areas, no matter how accessible to diagnosis and replacement, must be designed to increase life and reliability.

Broadly stated the problem becomes: (Figure 3) "How Do We Relate the Vehicle Electrical System to the Soldier-Mechanic."

In order to work toward the solution of this problem in a logical manner, we had to characterize man in a simplified practical way. Just as the electrical system--no matter how complex--can be simplified to Ohm's law (the relationship between voltage, impedance and current), man (Figure 4) can be simplified by Plato's law into a being with a thinking, feeling, and willing or doing nature, a triad relationship, as the simplest practical characterization of man. To carry this thinking a little further, Ohm's law must be balanced within design limits or it will be balanced outside design limits, catastrophically. The nature of the balance of Ohm's law within the design limits determines efficiency and performance. In like manner, we assume that relative to the capabilities of a given man, the elements of thinking, feeling, and willing must be balanced for maximum human motivation, efficiency and performance. From this it follows that maintaining this human balance at the interface between man and machine requires the threefold connection of thinking, feeling, and willing or doing. Hence our reference to the triple interface between man and his environment. In other words, man must be given an opportunity to understand and perform so that in the long run, his feelings can more easily carry him nobly through the pain of drudgery and creativity according to his abilities. This is the model of man we hold before us in our work to develop an electrical system in hardware which is readily conductive to diagnosis and component replacement by the soldier-mechanic, in a way that conforms to his basic nature.

(Figure 5) To liven up knowledge, it must be experienced by the man. He must relate to the knowledge so that it becomes integrated within him. We must concern ourselves with what percepts the soldier-mechanic takes in through his senses when he encounters the electrical system and the concepts he associates with them, such as Ohm's law, related phenomena, and characteristics of functioning and malfunctioning systems. The electrical system should present itself as a logical process which appeals to the soldier-mechanic's feelings, by virtue of the directness with which its logic, laws, and functioning may be followed or interrogated, as in the use of a finger to detect rejected heat, as I will explain later; and by the use of color to any extent that will not negate camouflage.

(Figure 6) To digress a little, the soldier of old had color, plumage, music, and decentralized control to excite the triad. He attacked the enemy with a flourish. But the modern soldier is camouflaged; he lives under the protective environment of dull colors and silence, and ideally attacks from an uninteresting position. As necessary as this is for the combat soldier, we must not unthinkingly paint everything with that uninspiring olive drab color, so that when one looks under the hood it takes several seconds to orient shapes out of the haze. At least we are exploring putting color back in the hardware.

(Figure 7) Getting back to the logic, we will make it easy for the soldier-mechanic to probe subsystems by permitting easy isolation of such systems as battery, generator, and starter. (Figure 8) Indications of faults in one of these systems will permit quick, logical interrogations of its components. (Figure 9) The complexity of diagnosis in the M151 vehicle is apparent in the multiplicity of diagnostic considerations. To simplify diagnosis, the use of human senses and greatly simplified portable instruments is receiving increased emphasis in the engineering designs. We are exploring ways of making the thinking that goes into the system amenable to extraction in the diagnostic procedure so that it will speed up diagnosis and enhance on-the-job training in the process.

Far greater emphasis has been placed on visual and tactile inspections with good standards. this will be enhanced by designing with this in mind as well as by capitalizing on its use in specific hardware. For example (Figure 10), in the M151 vehicle, the driver is so situated that we have said, "if an engine cranks poorly, hold finger over battery post--if it is hot, you have a poor connection;" or (Figure 11) "loosen starter switch, short its terminals with a screwdriver and depress switch--if cranking improves, you need a new switch." (Figure 12) As an example of improving visual in-

BROWN BOARD FINDINGS:

- EXCESSIVE REPLACEMENT OF GOOD PARTS
- DISUSE OF MANUALS & TEST EQUIPMENT

Figure 1.

BROWN BOARD RECOMMENDATIONS:

IMPROVE:

- TEST EQUIPMENT
- TECH MANUALS
- SCHOOLING
- MAINTAINABILITY

Figure 2.

OUR STATEMENT OF THE PROBLEM

"HOW DO WE RELATE THE VEHICLE ELECTRICAL SYSTEM TO THE SOLDIER MECHANIC"

Figure 3.

THE TRIAD RELATIONSHIPS IN MAN

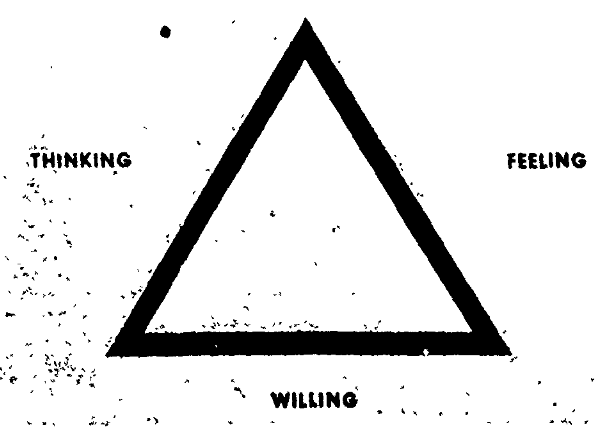

Figure 4.

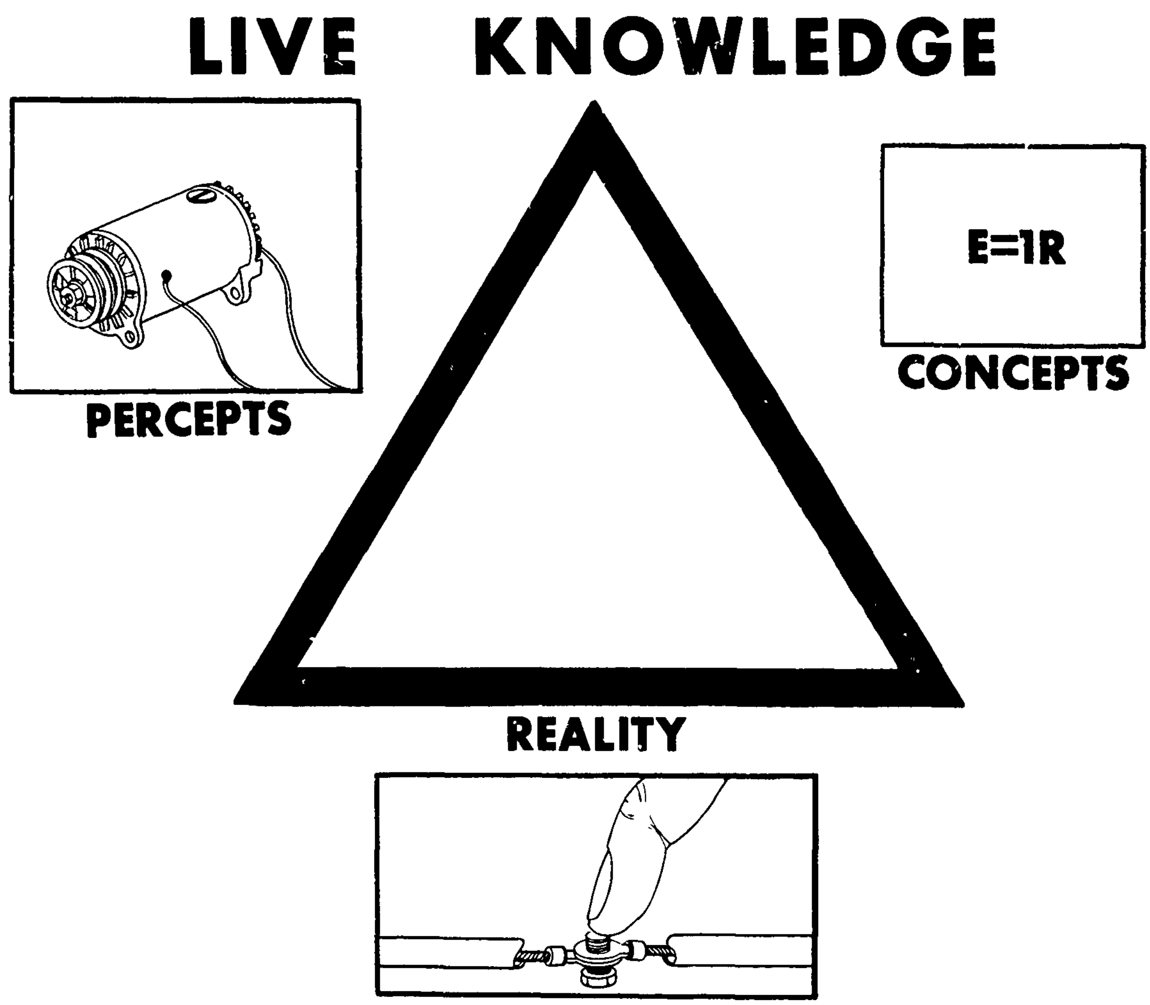

Figure 5.

Figure 6.

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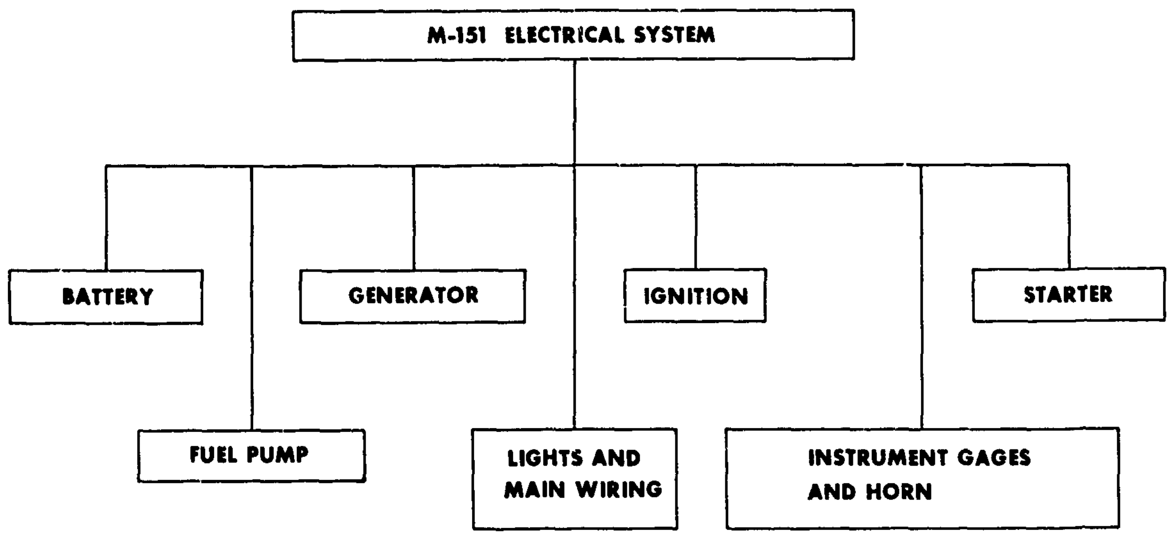
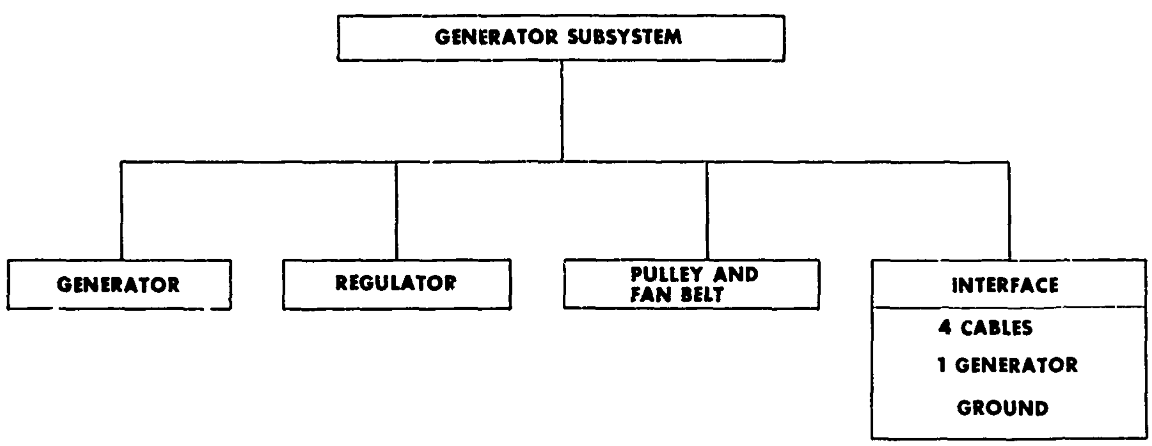


ELECTRICAL SUBSYSTEMS

Figure 7.

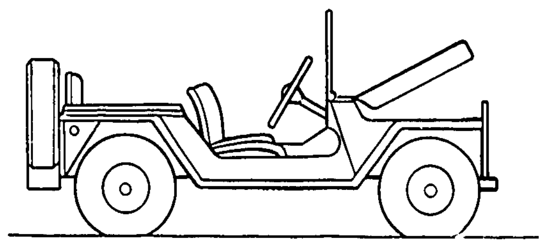
GENERATOR SUBSYSTEM COMPONENTS



TYPICAL ELECTRICAL SUBSYSTEM (10 COMPONENTS)

Figure 8.

DIAGNOSTIC CONSIDERATIONS



ELECTRICAL SYSTEM

12 SUBSYSTEMS & ASSEMBLIES

136 COMPONENTS

DIAGNOSIS REQUIRES

21 INSPECTIONS

78 TESTS

140 ACCESS POINTS

18 DISASSEMBLIES

Figure 9.

Figure 10.

Figure 11.

INSPECTION & INSTRUCTIONAL NOTE

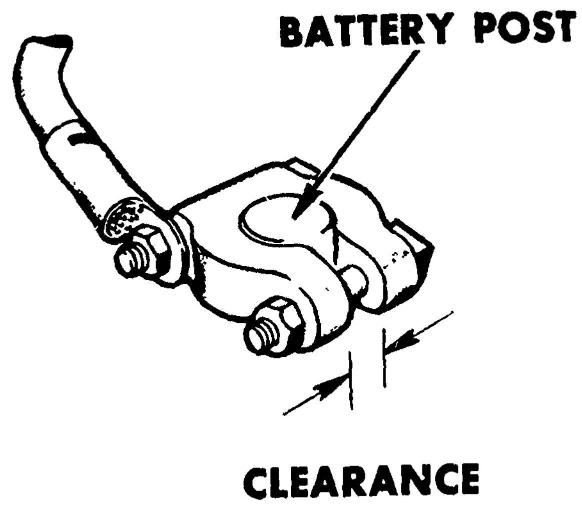


Figure 12.

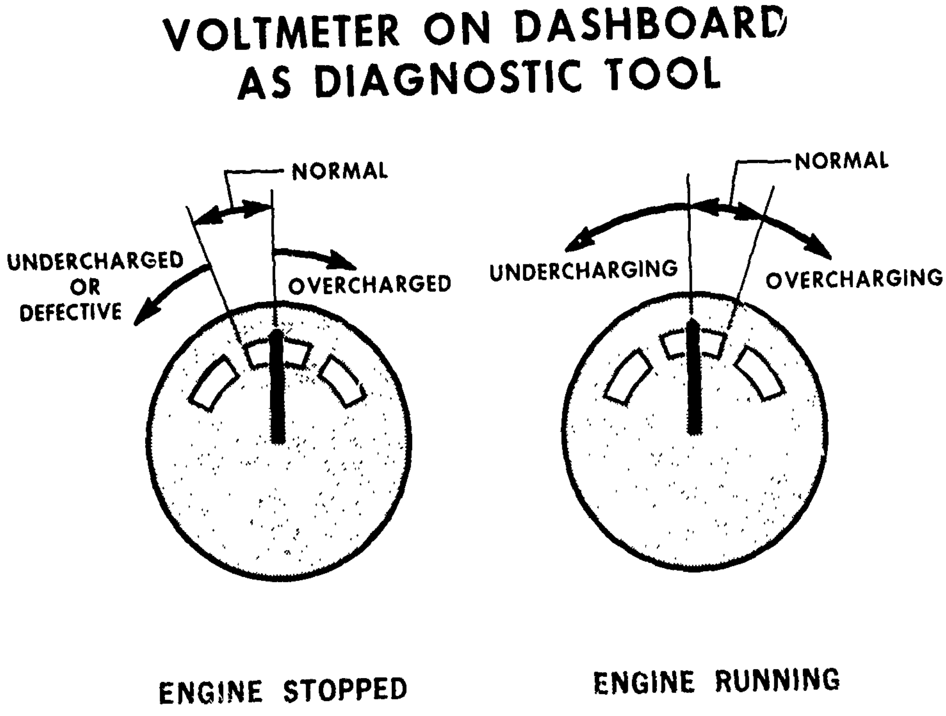


Figure 13.

IGNITION SENSOR CONCEPT

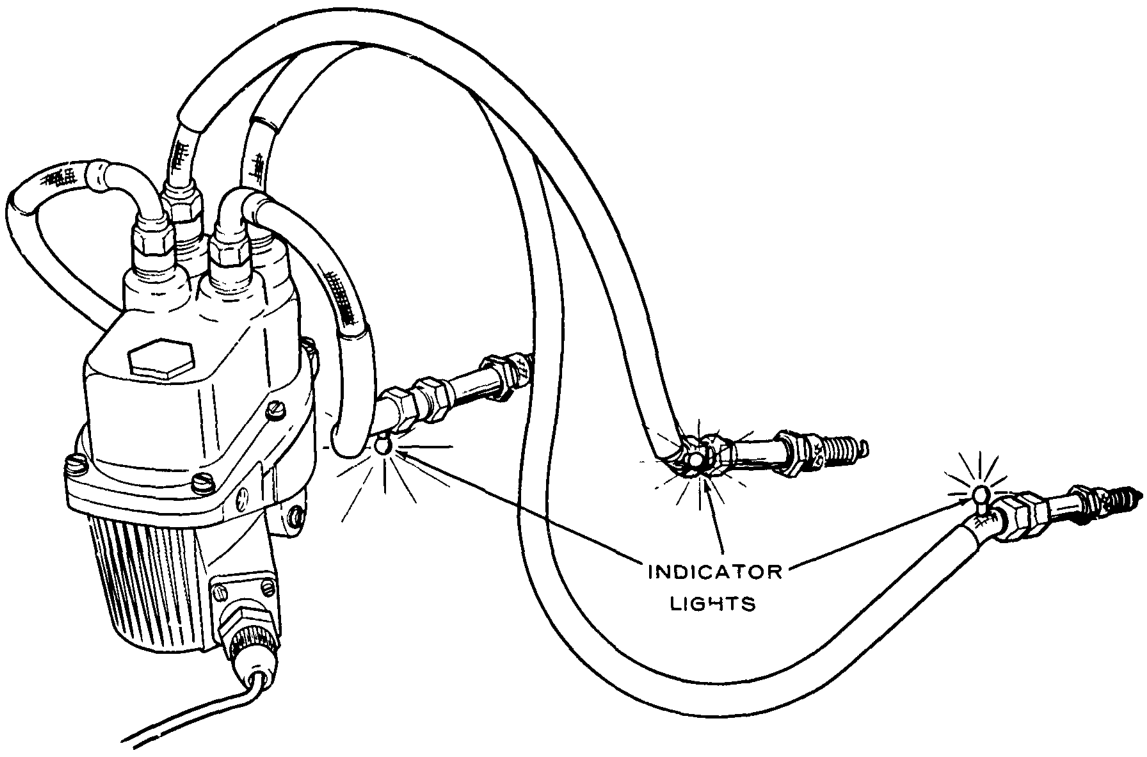


Figure 14.

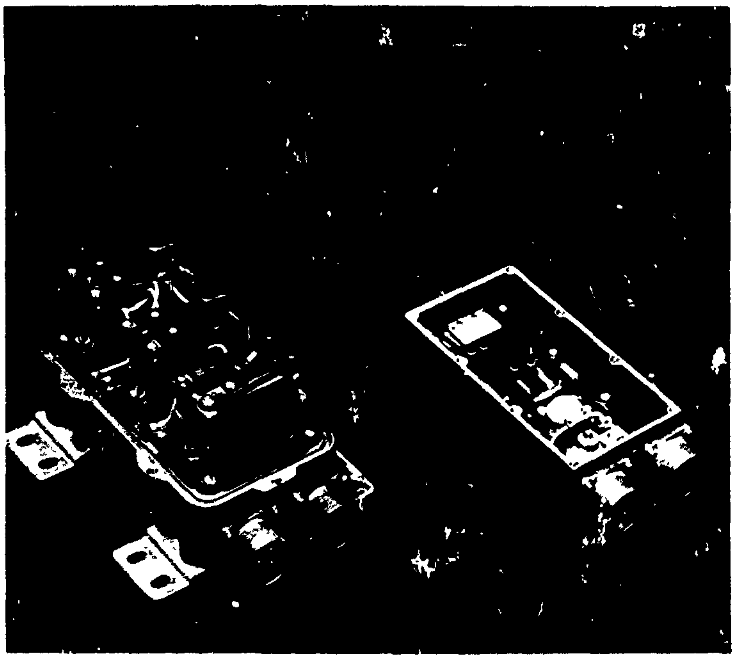


Figure 15.

TECHNIQUE OF ELECTRICAL SHORTING

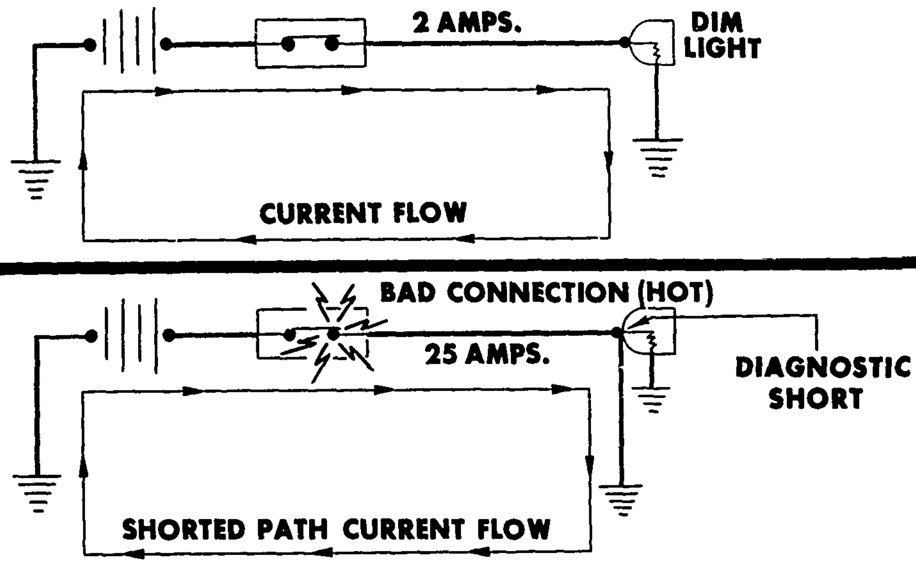


Figure 16.

FAILURE FROM ELECTRICAL SHORTING

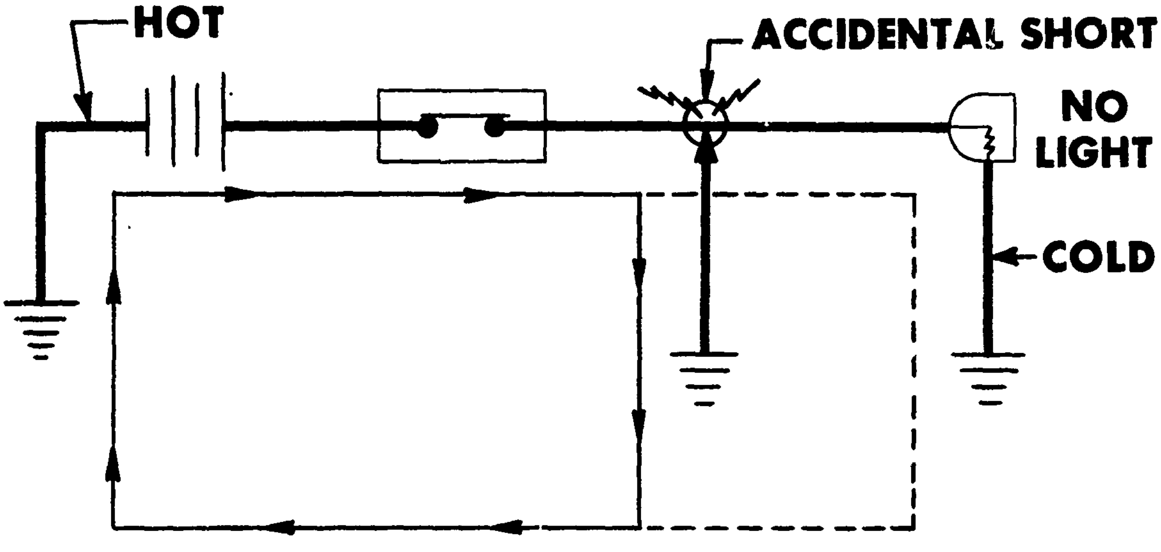


Figure 17.

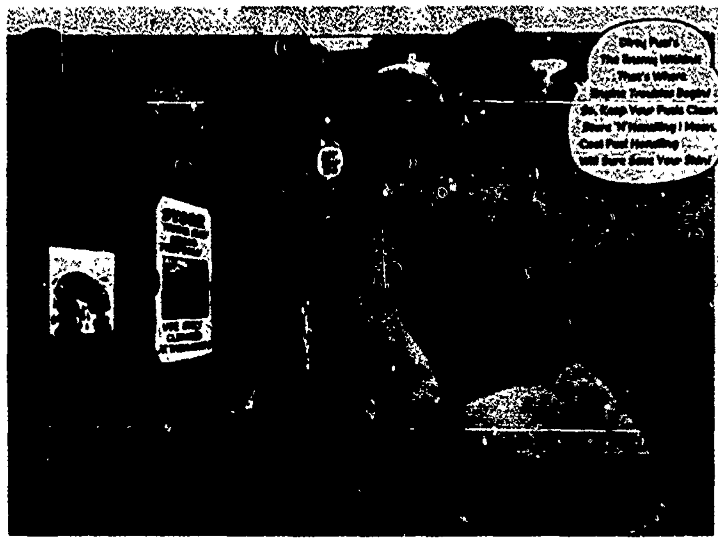


Figure 18.

TM 9-1726A
92-93

ECLIPSE DIRECT CRANKING ELECTRIC STARTER TYPE 404-1-B

Description	Clearances
Ball bearing in intermediate housing	0 0008T–0 0000L
Ball bearing on intermediate gear shaft	0 0000T–0 0007L
Ball rings on barrel	0 001L–0 003L
Bushing in sun gear	0 0015T–0 003T
Crank collar bolt in crankshaft	0 001L–0 005L
Crank collar on crankshaft	0 005L–0 0020L
Crank gear on crankshaft–double D wear limit	[illegible]-in rotation of gear at outer edge
Crankshaft ball bearing in housing	0 0000T–0 0008L
Crankshaft ball bearing on crankshaft	0 0001T–0 0006L
Crankshaft OD	0 6240-in –0 6245-in
Crankshaft roller bearing race ID	1 000-in –1 001-in
Double row ball bearing in intermediate housing	0 0004T–0 0004L
Drive pinion in double row ball bearing	0 0001T–0 0006L
Front ball race in housing	0 003T–0 000L
Motor housing ball bearing in housing	0 0008T–0 0000I.
Motor housing ball bearing on armature	0 0000T–0 0007I.
Movable ratchet on splined collar	0 003L–0 906L
Planetary pinion ball bearing on stud	0 0002L–0 0007L
Rear ball race in housing	0 002T–0 0015L
Roller bearing race in housing	0 0005T–0 0020T
Splined nut bushing on splined nut	0 001L–0 004L
Sun gear on barrel shaft	0 0005L–0 0015L
Sun gear thrust washer, large (thickness)	0 062-in –0 066-in
Sun gear thrust washer, small (thickness)	0 060-in –0 064-in

T–tight L–loose

Figure 19.

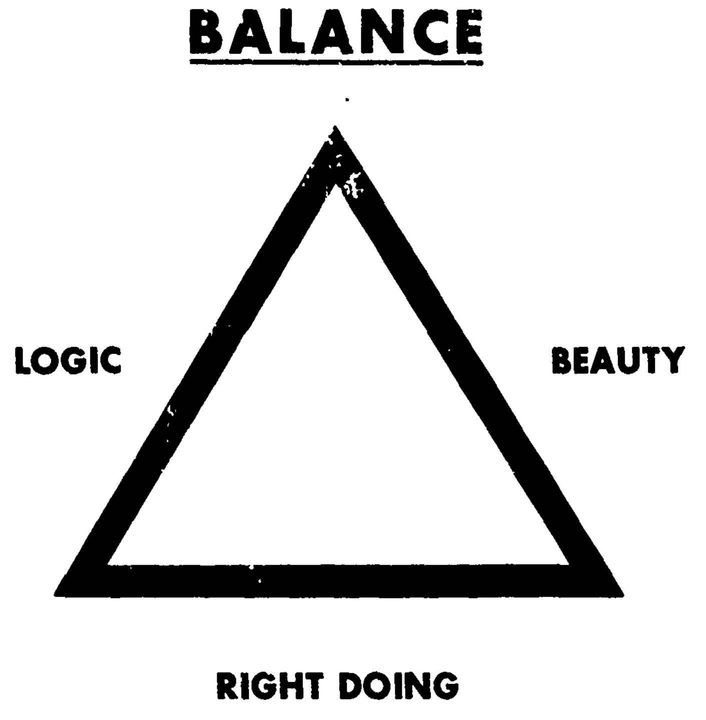


Figure 20.

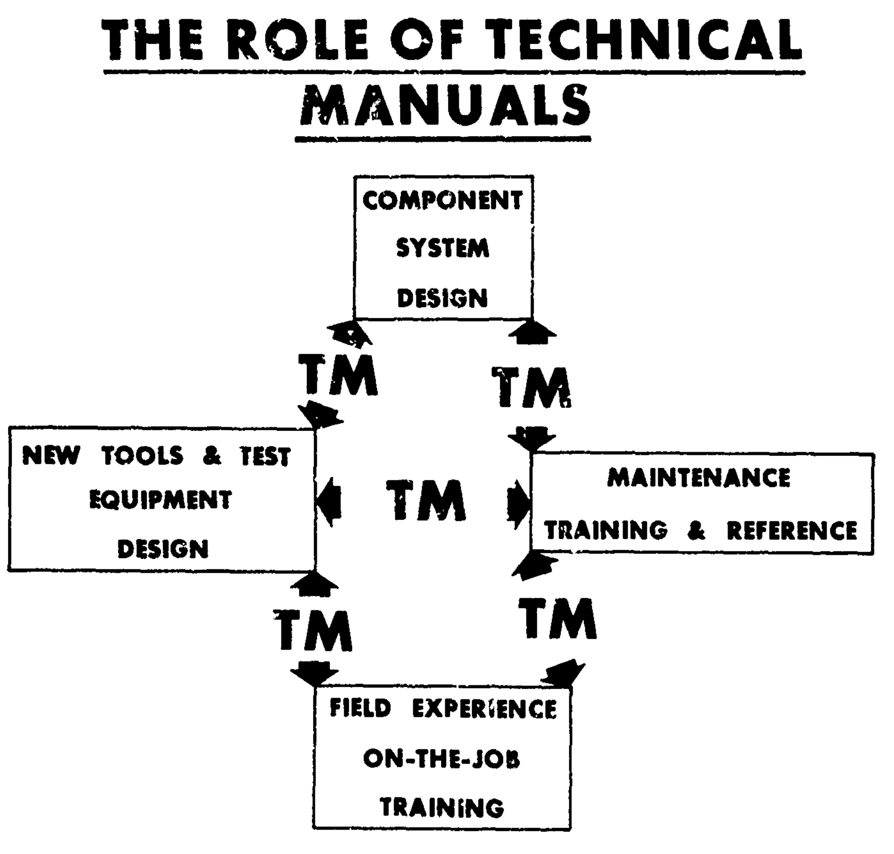


Figure 21.

UNBALANCED TRIAD

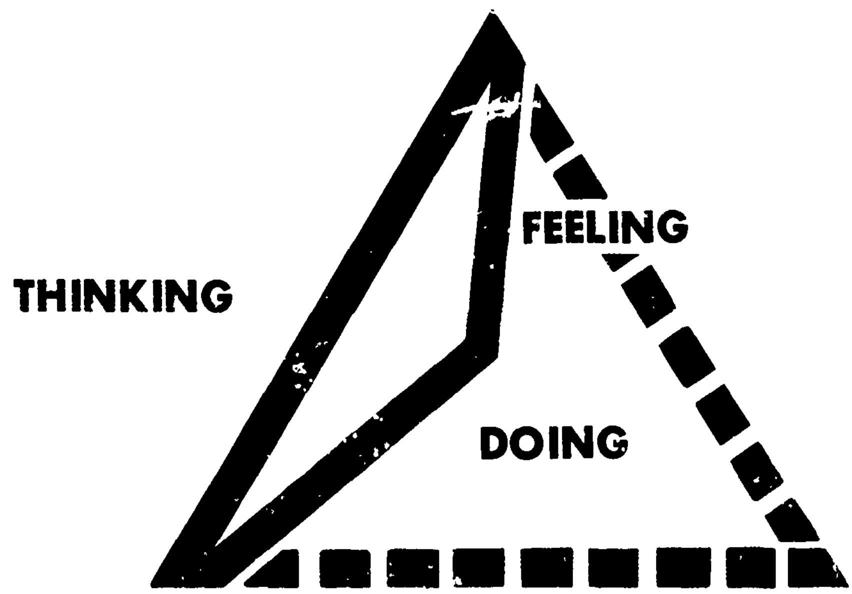


Figure 22.

TRIAD TO START

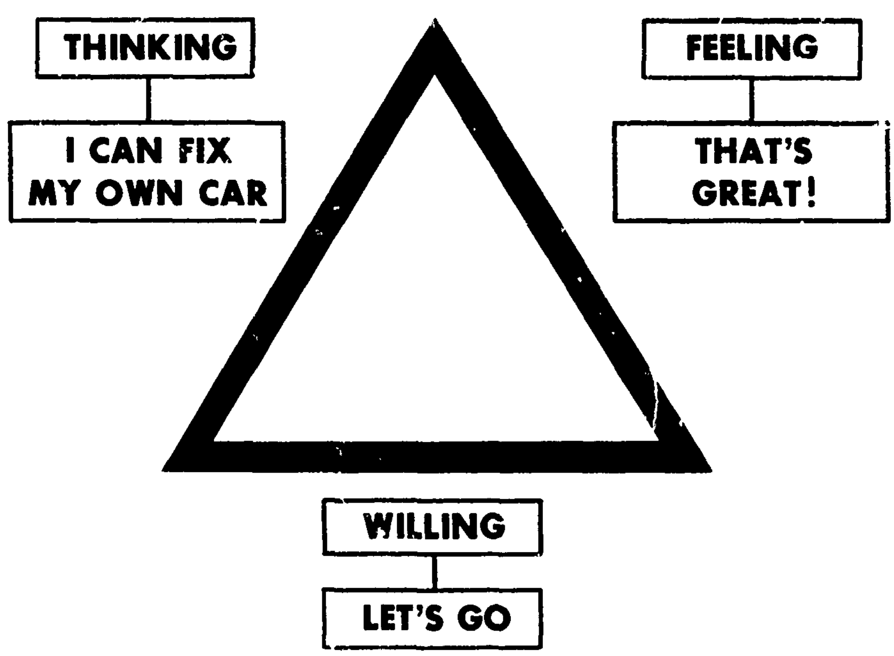


Figure 23.

TRIAD TO KEEP GOING

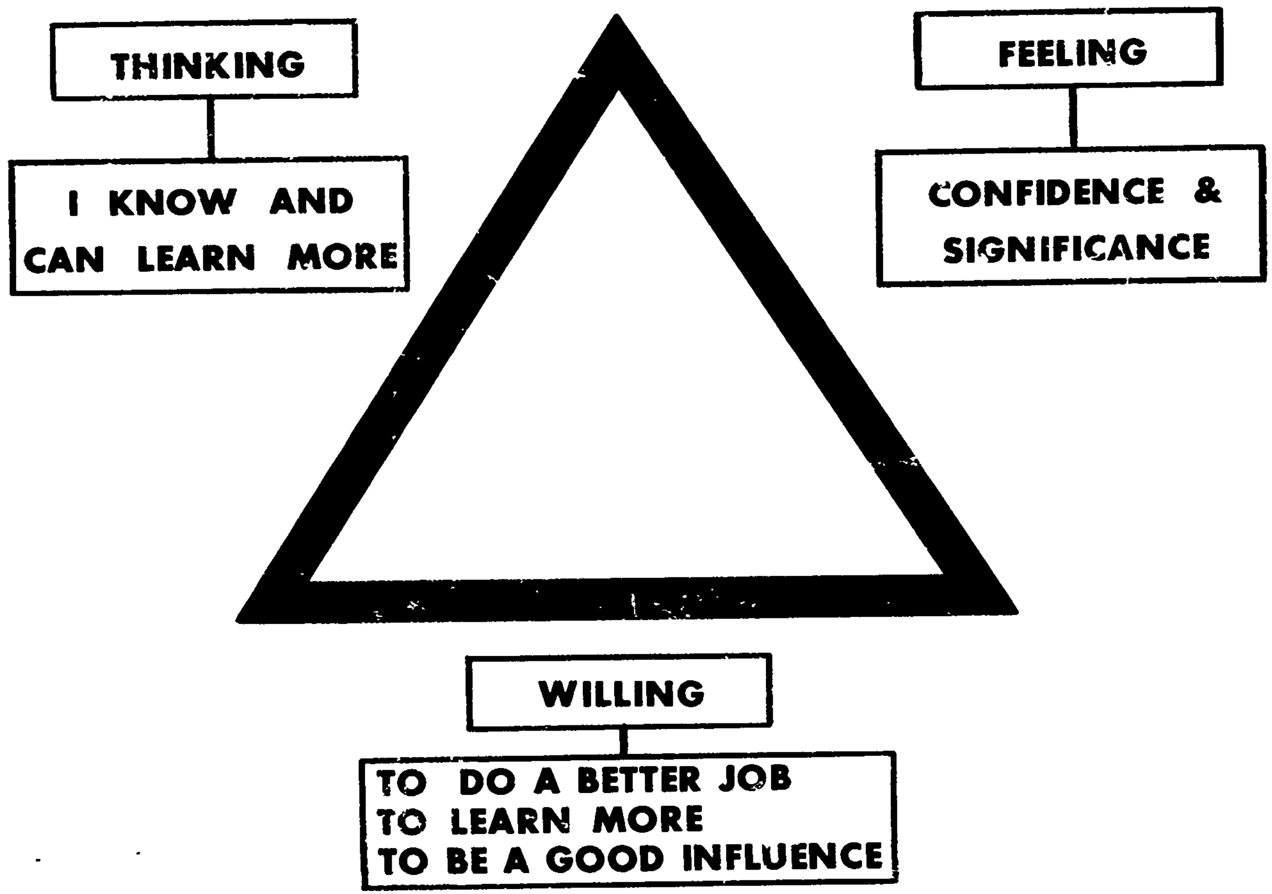


Figure 24.

spection, the caution, "if battery post clamp ends touch, they will be replaced," becomes an instruction for tightening as well as a guide for visual inspection. (Figure 13) The voltmeter which has been standard on the instrument panel of military vehicles for years, has been emphasized as a diagnostic tool in the manner shown here.

These examples, which have been included in the recent rewrite of the M151 Manual, give an experience of the logic of electrical circuits, permit an immediate direct action resulting in a satisfying feeling of experiencing knowledge. Life is full of paralyzing delays between desire and doing; we are concerned with getting rid of delays wherever we can. (Figure 14) Sometimes we introduce obstacles to diagnosis by militarization of components, as when we sealed the ignition system to make it waterproof. This resulted in discouraging the convenient test used in commercial vehicles of disconnecting the high tension leads and watching for the spark. To overcome this impediment we are experimenting with a neon lamp at each spark plug which will continuously monitor the high voltage system. In a more extensive way we are exploring the possibility of achieving similar performance of the ignition system with simpler sealing and intrinsic corrosion resistance.

(Figure 15) We are also extending component life by replacing electro-mechanical devices, such as the regulator on the left of this picture, with solid state devices such as the regulator on the right which has no moving parts. This is resulting in far less irritation to mechanics and considerable cost savings. Components with short adjustment or functioning lives not only cost money and impact reliability, but have a direct bearing on our goal of relating the electrical system to man. Who wants to relate to a temperamental electrical system?

(Figure 16) In general, to check for loose connections, techniques of electrical shorting to increase current flow, and feeling for hot spots will be utilized. These are techniques used by master mechanics who have integrated their theory and practice into an attractive confidence. Needless to say, the technician who doesn't understand will not have the confidence to stick his fingers in anywhere.

(Figure 17) One of our engineers tells the story of troubleshooting the blinking lights on the car of a friend one night. He simply ran his finger along the wire until he experienced a change in temperature from hot to cold. That was the point it grounded out. He pulled the wire away from the chassis, and presto, the lights came on and he was an instantaneous hero.

We have put similar master mechanic experiences into the technical manuals and used the language of experience, like hot and cold, along with the abstract language of science (like $225^{\circ}F \pm 10F$) so that the manuals will become more alive. (Figure 18) I hope we can influence a change so that the approach of PS Magazine (language of pleasant experience) is metamorphosed into a beauty that will be added to the cold, abstractions (Figure 19) in the Technical Manuals, as shown in this example, a table of mechanical clearances. Our aim should be to provide the soldier-technician with a manual (Figure 20) of logical, clear thinking wrapped in beauty to enhance the right doing.

The existence of the technical manual with its relatively lifeless thinking brought PS Magazine with its color, cartoon, and sex appeal into being; but, man cannot be given the triple interface in a disintegrated way without retribution. Each manual that he receives should have clear thinking wrapped in beauty to excite the right doing. Not: Here are your abstract, cold, dry facts within a limited time plus exam; now (a little later), as a postscript through PS Magazine, here is your supplemental easy-to-take fun pill. (Figure 21) The logic and the beauty of the manuals must be improved and the impetus must come from a more lively way of considering system design, diagnosis, and repair. With all this emphasis on canning the best fruits of our collective experiences with test equipment and procedures in the TM's, we will be enhancing the development of automation of diagnosis because we can only automate what we know; which, essentially, reduces to automating that which is in the technical manuals.

The technical manual is a bridge between the engineer, the instructor, and the mechanic and needs our wise attention. Greatly improved technical manuals will make the training of soldier-mechanics easier at all levels and is one of our greatest concerns. We have integrated the perceptual with the conceptual and added the characterizations of functional and malfunctional systems so that it is less of a cookbook and more of a text book. We have added successful techniques, so that its use enhances progressive learning. There will be more uniformity in the vehicle technical manuals to be consistent with standardized electrical systems and greater emphasis has been placed on inspection by observation at the gross and detail levels.

(Figure 22) To this impetus towards improved hardware and manuals must be added our best efforts to improve the balance in the training of our soldier-mechanics. This is the greatest challenge of all that I've mentioned: How to make the curriculum alive so that it grows like a seed as the soldier-mechanic encounters his on-the-job experiences. This problem in various forms is pervading educators at all levels as schools everywhere dispense more abstractions and less wholesome realities in attempts to keep up with mountains of facts and definitions to be dispensed within a fixed learning period. We intend to take more intensive looks at the TACOM new vehicle school to coordinate the teaching methods with the improved technical manuals and with a view to developing some new training methods that are good enough to pass on to CONARC for consideration in its most complex job of improving the effectiveness of the service schools.

(Figure 23) In this connection, one of our technicians who has gone through the service schools and is a master mechanic with good insights into human nature, has suggested that recruits be trained on standard passenger cars first, and then study the military vehicles. Just look at the wisdom of this proposal. A recruit goes into the Army and his first task is to learn to fix cars--real ones that people have, not just Army vehicles. What better motivation, "I'll be able to fix my own car." Then we make the next step of teaching the military version for which the recruit will have been logically and psychologically prepared.

(Figure 24) Our automotive mechanic schools could have such a reputation that any one in our civilian economy would welcome one of its graduates. He in turn will re-enlist more readily and induce others to enlist. At the very least we will have given the soldier-mechanic a chance to make a necessary contribution with dignity and return him to civilian life a far better man, thereby helping to meet a critical social need.

The problem of relating the electrical system or more comprehensively, the whole vehicle to the soldier-mechanic is one of the most challenging, cooperative rewarding ventures in the Army.

4F. SYSTEMS DESIGN PROCESS IN DEVELOPMENT ENGINEERING

James Winkworth
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Warren, Michigan 48090

CREATIVE EFFORT

Most creative effort is aimed at understanding, explaining and improving on an existing order. The Artist, the Doctor, the Mathematician, the Housewife, in fact most normal people are trying to create a more orderly pattern of existence. (See Figure 1)

CREATION OF DISORDER

In contrast with this, but with the same intent, the Systems Design Engineer is required to inflict the greatest possible disorder on an enemy and at the same time maintain the greatest possible order in his own organization. While he is doing this he must be able to withstand the cataclysmic threat of an order out to destroy him. Finally, he must intend to impose a more compatible order on the enemy. I guess this could be called a Tri-lemma and at best is a very disorderly process. (See Figure 2)

THE HUMAN ELEMENT

The interesting part of the challenge is that the human element of the system is the element that can become disorderly, remain orderly, create a new order, or accept the imposition of a new order. The final judgment of system design is in how it affects the human being. This includes maintaining an effective and orderly circumstance for the system operators, under disorderly conditions and proving the means to inflict the greatest possible disorders on the operators of the enemy system. (See Figure 3)

ELEMENTS OF ORDER (OR DISORDER)

To effectively destroy order or to design a system which will remain orderly (see Figure 4) implies that the System Design Engineer must understand the elements of "Order" and have some facility in the use of these elements. Unfortunately, Order is not a Science; it is a practice and the elements of order are not well defined. For example, today there is a popular desire for peace and most people are willing to fight for it. This implies that orderly systems should provide for orderly change and must be dynamic rather than

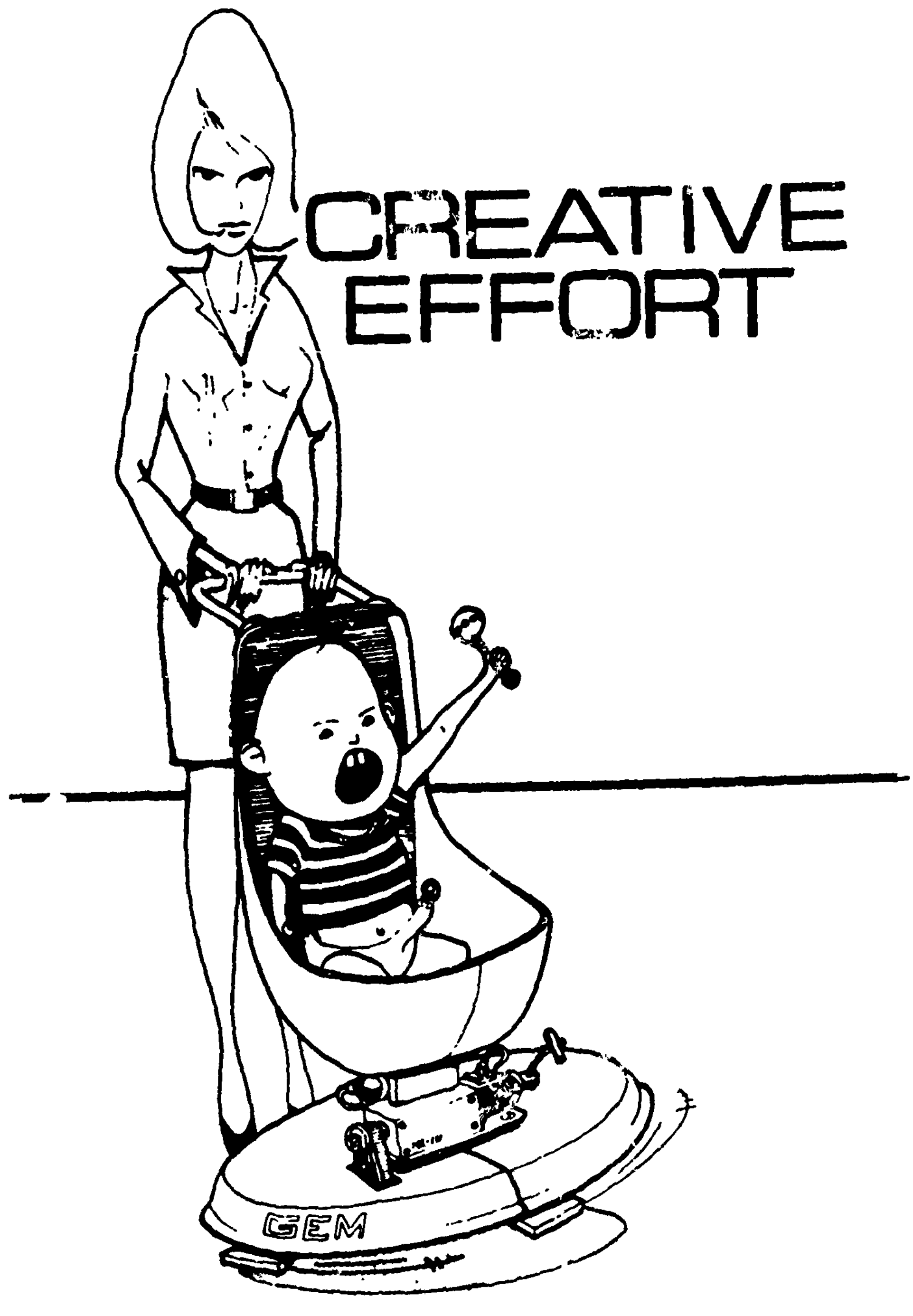


Figure 1.

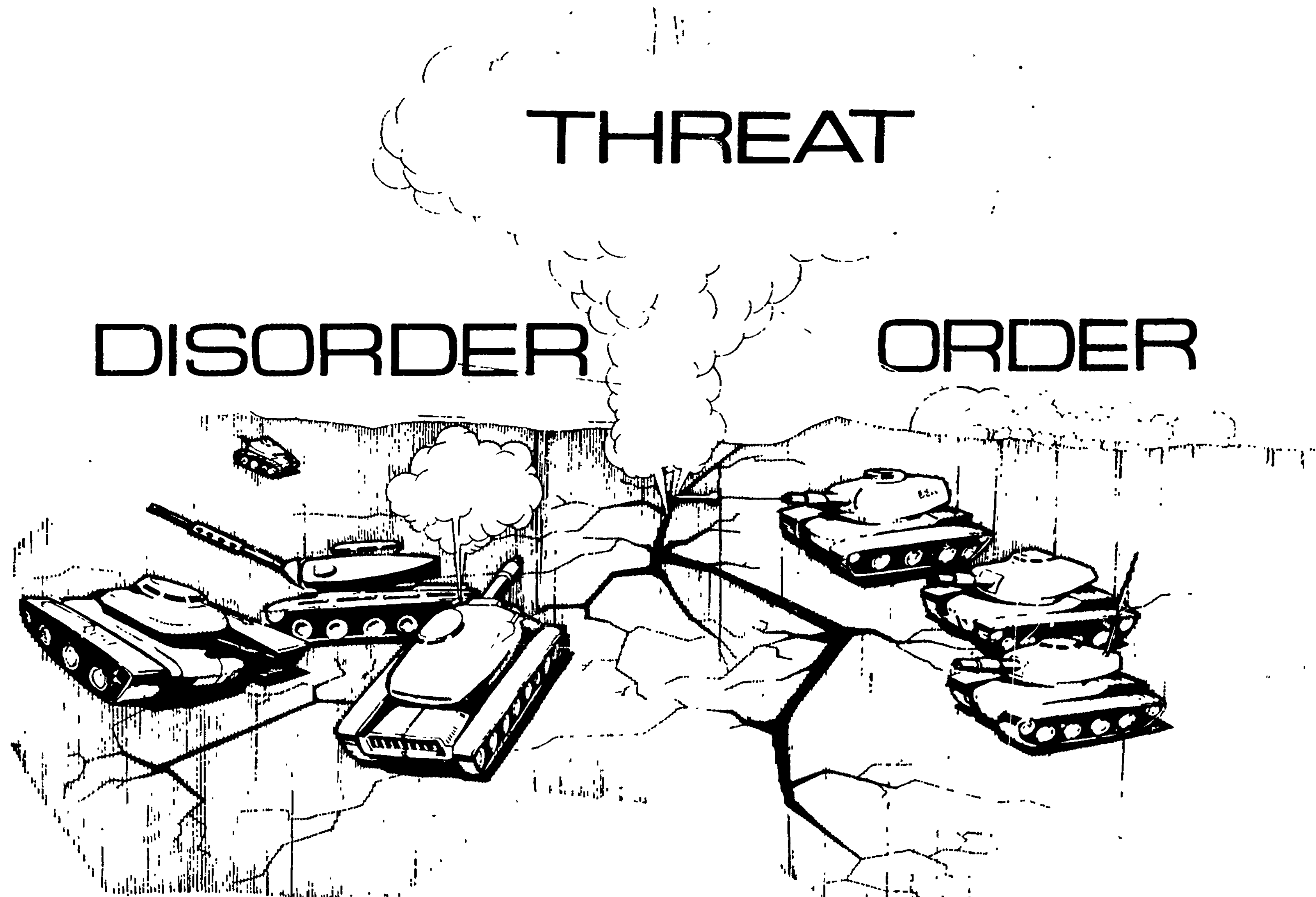


Figure 2.

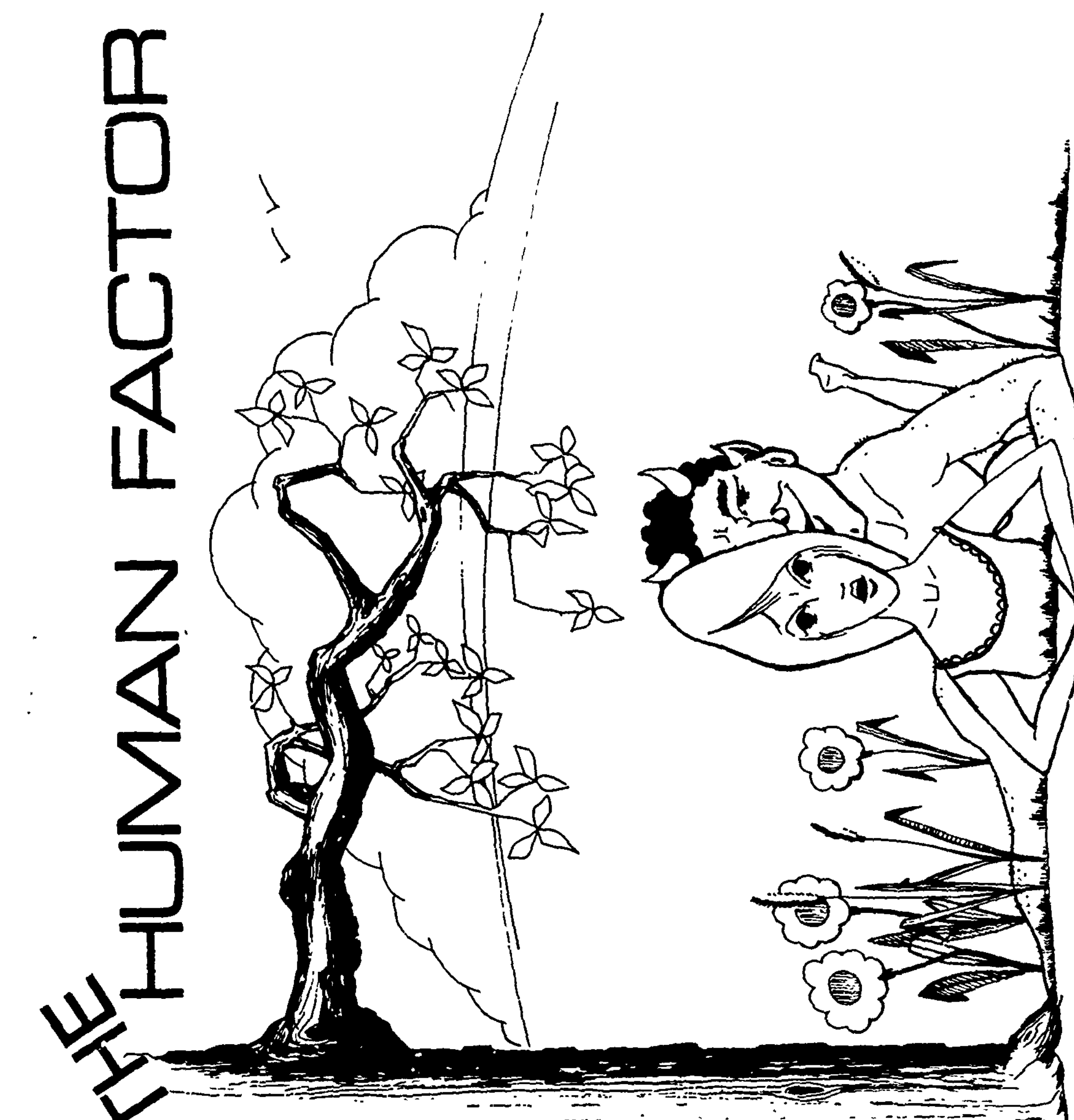


Figure 3.

333 404 O-69 - 14

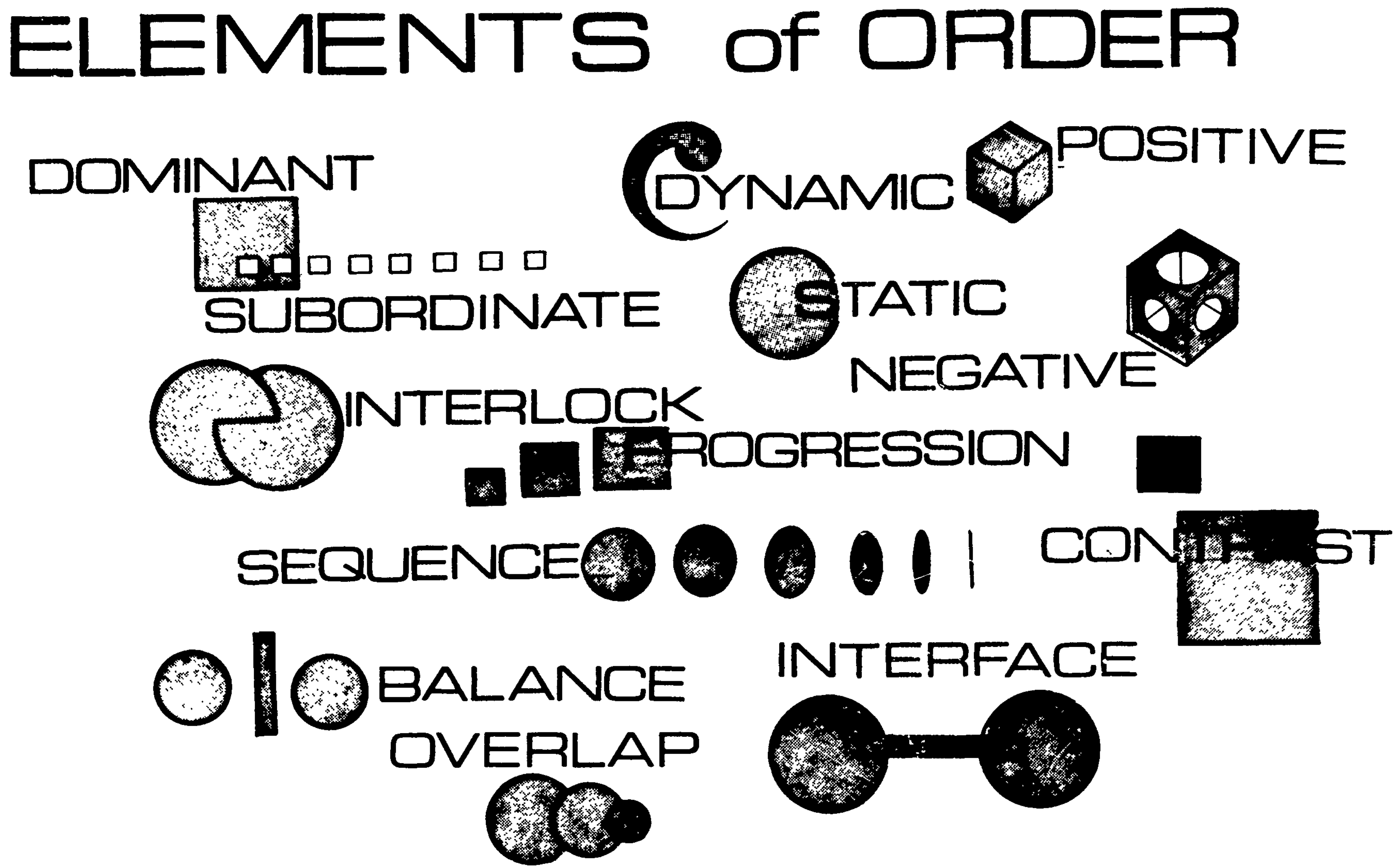

ELEMENTS of ORDER
DOMINANT
SUBORDINATE
DYNAMIC
POSITIVE
STATIC
NEGATIVE
INTERLOCK
PROGRESSION
SEQUENCE
CON ST
BALANCE
OVERLAP
INTERFACE

Figure 4.

static or they are subject to disorderly change.

NEGATIVE AND POSITIVE SPACE

To provide a more explicit example (Figure 5), I choose to talk about only one element of Order which is of great importance to the System Design Engineer and of paramount importance to the Human Factors Engineer. This is the concept of negative and positive space.

Here are spaces. How many are there? Are they negative or positive? At the moment there could be two or three or more spaces, both positive and negative. The box could be solid or "positive". It could be an empty box, therefore both positive and negative. It could be filled with other solids and it exists in space, a large negative space. At least we know it is static and not very interesting.

Let's change it a little and make the spaces work. Now we begin to see that the box is both positive and negative and the inside and outside spaces are related and begin to work. (Fig. 6)

Now there is a sequence from positive to negative. Egress and ingress is better. (Fig. 7) There are contrasts, dominants, subordinates, tensions, progressions, interlocks, balance and many dynamic elements of order (or if we did it badly - disorder) which make the whole circumstance much more interesting and meaningful.

APPLICATION

How does this apply to a System Design Engineer? Let's start with a seat designer.

Normally a seat is considered as a positive space design problem (Fig. 8). It is usually static except for adjustment up and down, back and forth, and tilt. Many designers concern themselves with the mechanics of this problem. The real problem, however, is a negative space problem. How does the space in and around the seat work?

Egress - Ingress, support, restraint, and motion limits related to a broad percentile of men in various work situations and at rest are the real design problems. (See Fig. 9) As a result, the negative space becomes the dominant design problem and the seat or solid space becomes a subordinate design problem. Time, space and motion studies of the duty cycle of crew members of combat vehicle or logistic vehicle systems have not been done in sufficient detail to provide adequate Human Factors Engineering design guidance for in-house or contractor activities. A wide variety of tasks dictate the need for a variety of seat circumstances. Although some basic information

SPACE

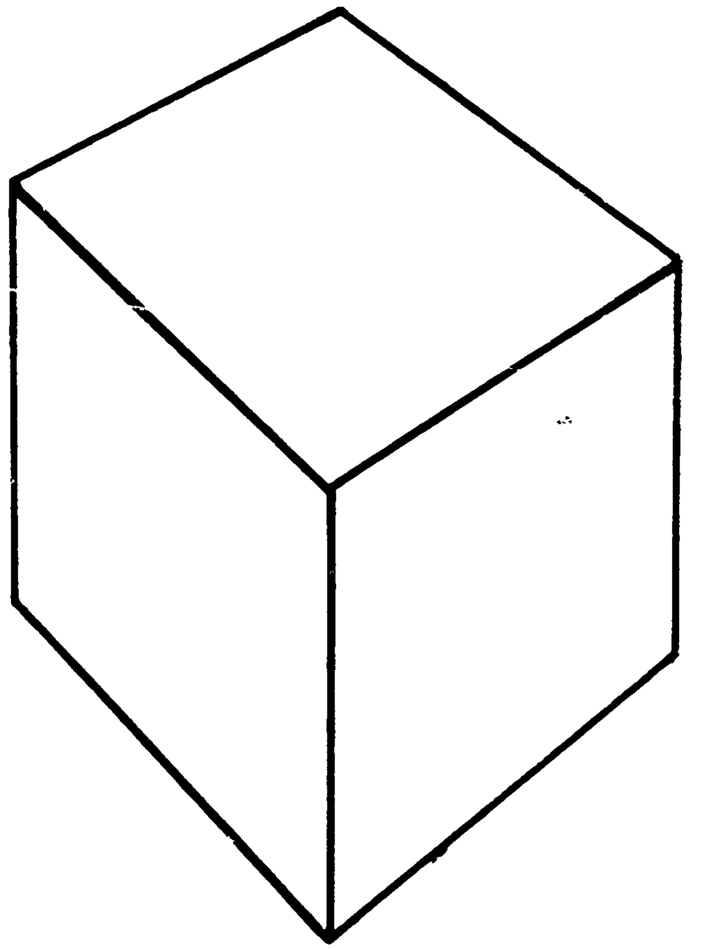


Figure 5.

POSITIVE and NEGATIVE

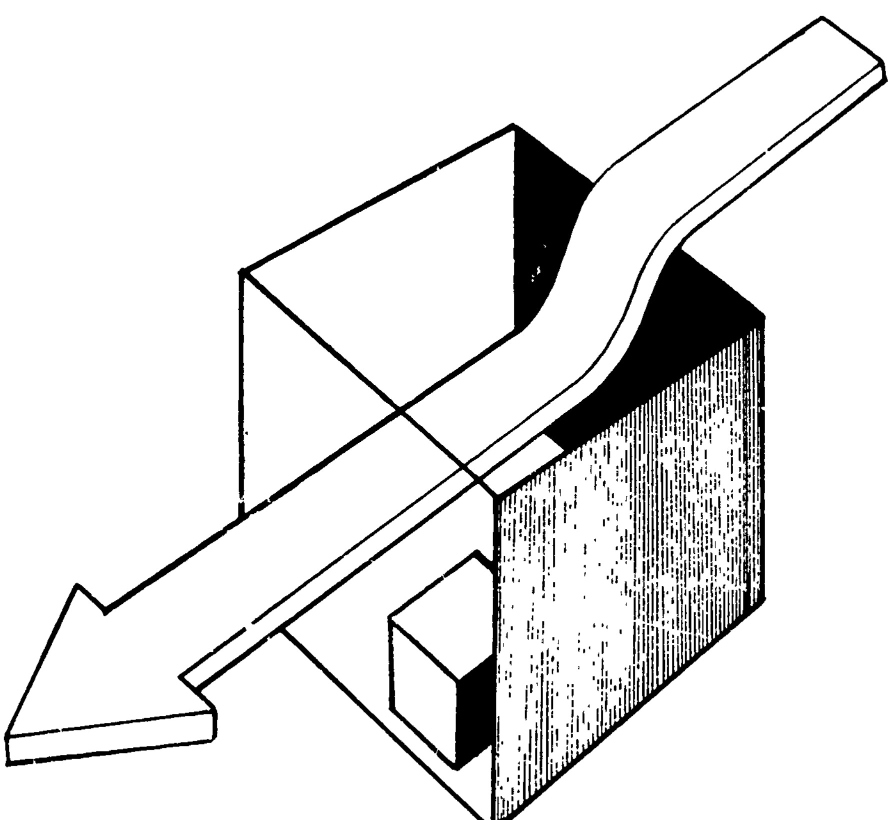


Figure 6.

WORKING SPACE

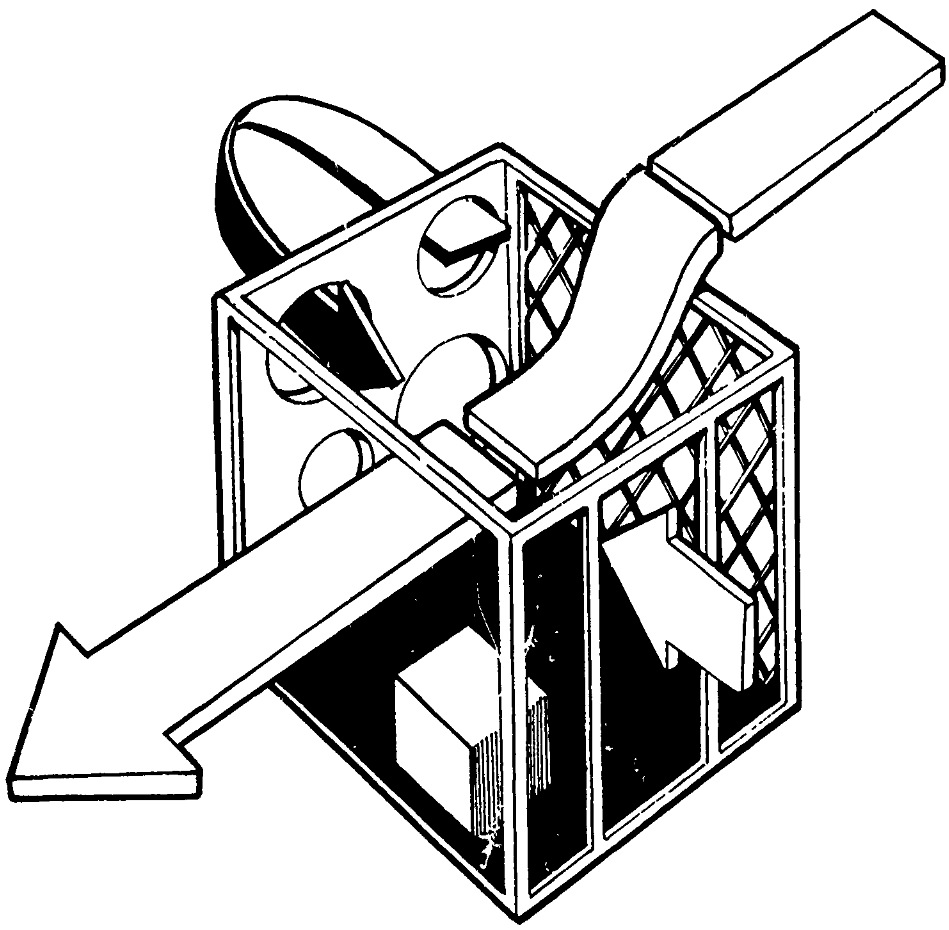


Figure 7.

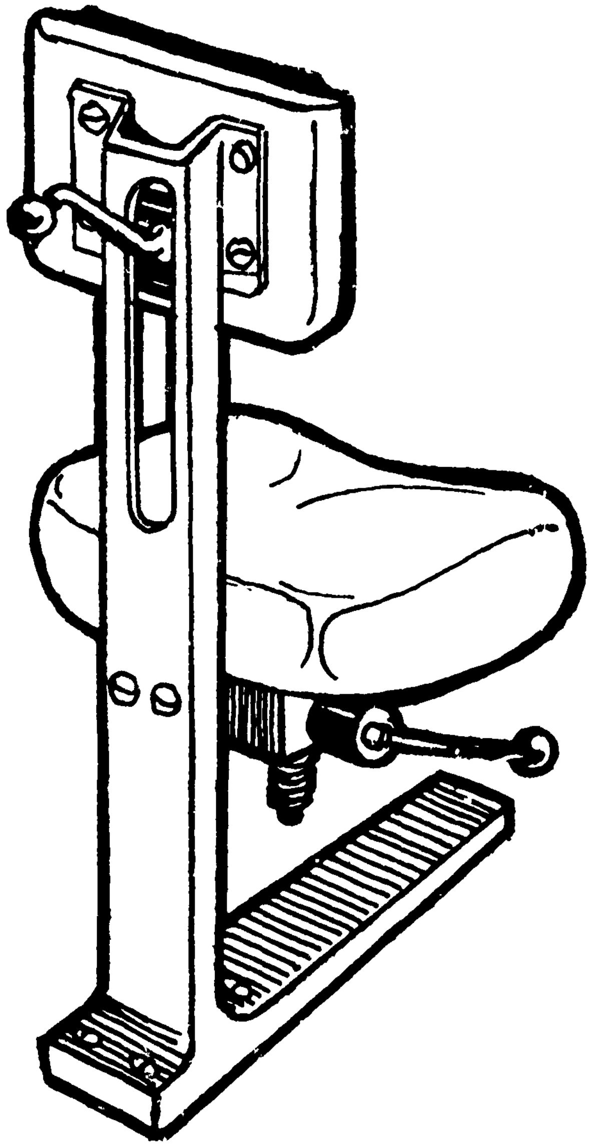


Figure 8.

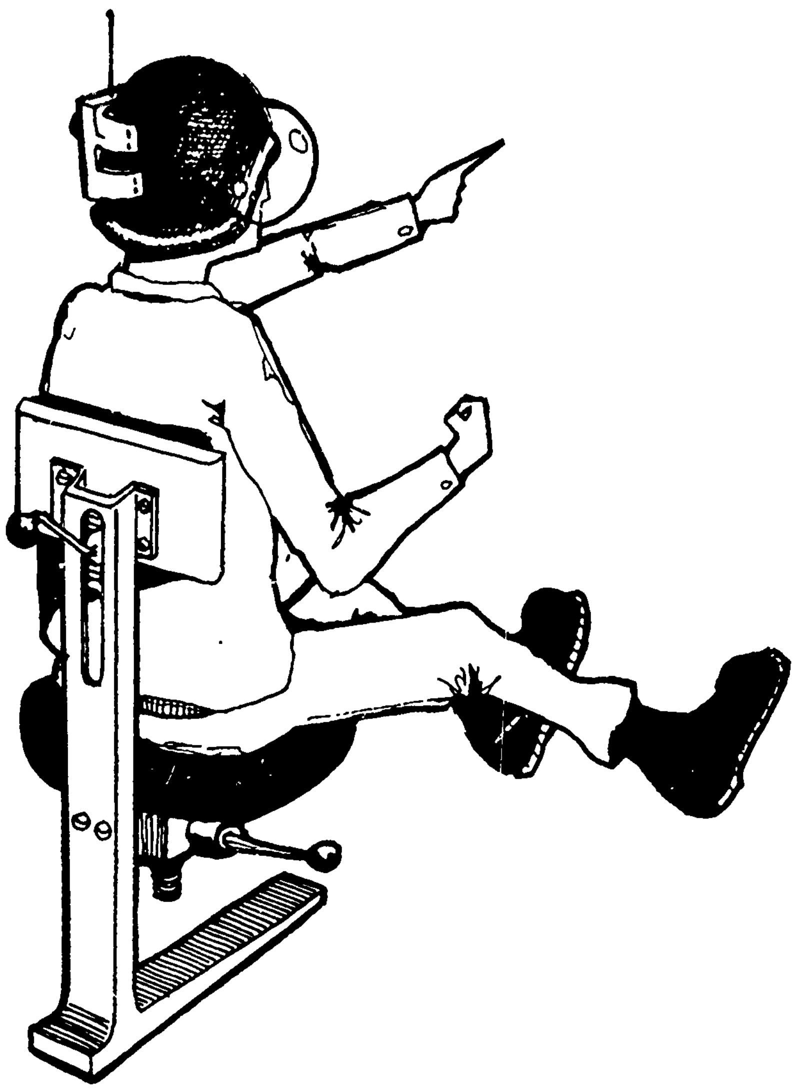


Figure 9.

is available, the direct application to our problem is not readily apparent and a more exact approach is required. We intend to perform such studies and to prepare a design parameters guide for our peculiar problems based, of course, on your good guidance.

If we extend this example by adding controls (Fig. 10), instrument displays and optical systems, we begin to see the direct relationship of these subordinate elements to the seat and especially to the work space, and we either aid or hinder the operator in the performance of his duties. Often, any one of these items (subordinates) will control or seriously influence the design of the others. They are designed in different Commands and the interface problems become difficult.

Add stowage, protective armor, another related negative space with all its subordinate elements and you begin to see the problem (Fig. 11). All of these elements are interrelated to such an extent that they must be integrated into an entity. In the case of some high-performance aircraft, the situation reverses and the human becomes a monitor of the machine or the dominant becomes subordinate to the system. Some of our newer equipment is beginning to have this characteristic.

(Oops! Sorry - Figure 12 is upside down! It doesn't make much difference really - look at Figure 13 and it's easy to see why).

OTHER AREAS

The Systems Design Engineer and the Human Factors Engineer strongly influence other factors of the total problem. For example, an operator costs about \$10,000 per year after training. The life of a typical vehicle is 10 years. Therefore a single operator cost is \$100,000 for the vehicle life cycle. In a standard tank there are four (4) operators. Total operator cost becomes \$400,000. Add 25% for personnel to maintain the vehicle and the figure becomes \$500,000. The cost of a tank is about \$250,000. These are nice round numbers. If it is possible to reduce operator and maintenance functions by 25% a saving of \$125,000 per tank would accrue. If the fleet has 10,000 vehicles the total saving would be \$1,250,000,000. This could increase the support base, or the fleet size, or manpower availability and therefore influence not only economics but strategy, tactics, logistics, manpower utilization, casualty rates, training and other important areas of the total picture. All this reasoning against all vehicles in all fleets and the gross possibility is monumental. (See Fig. 14)

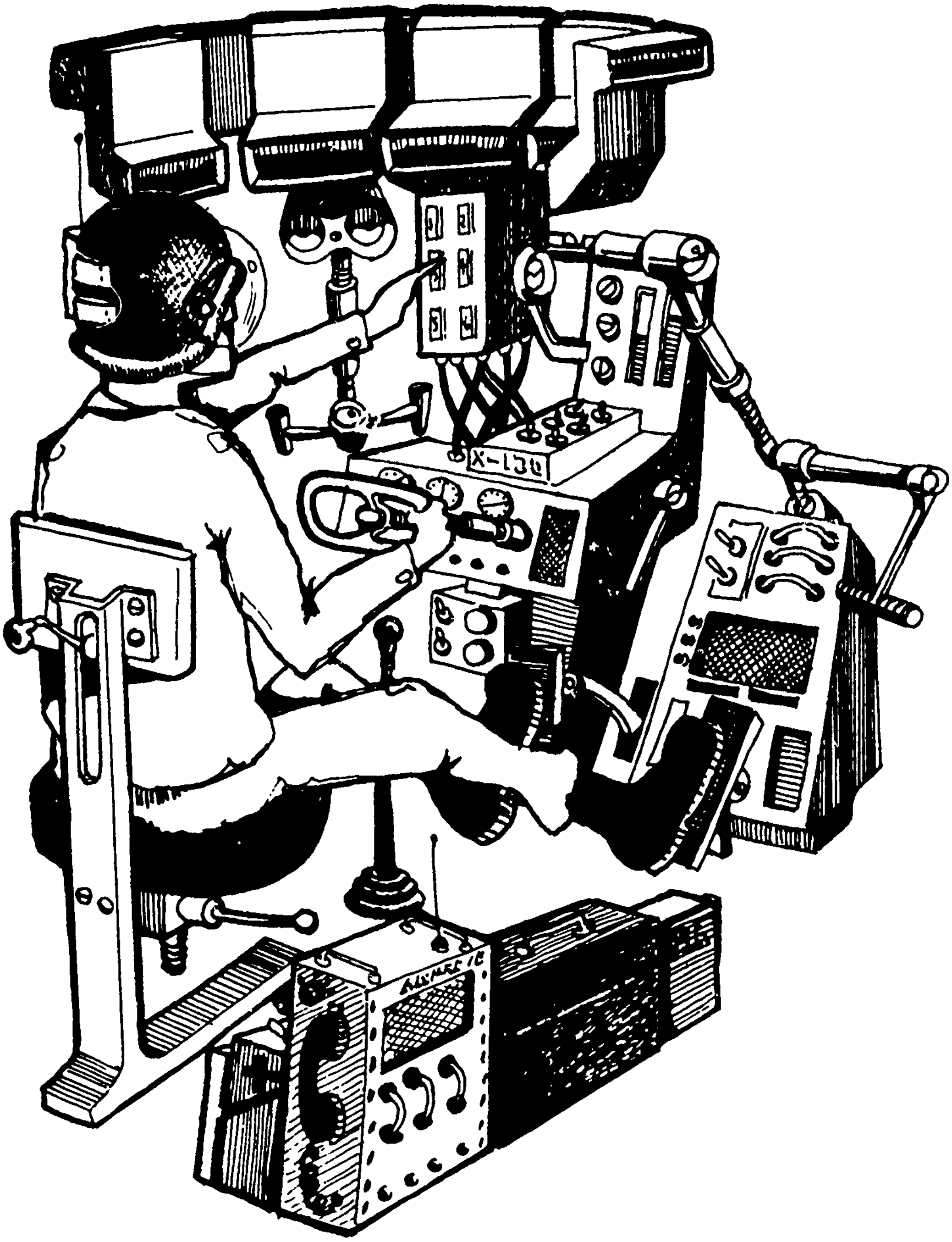


Figure 10.

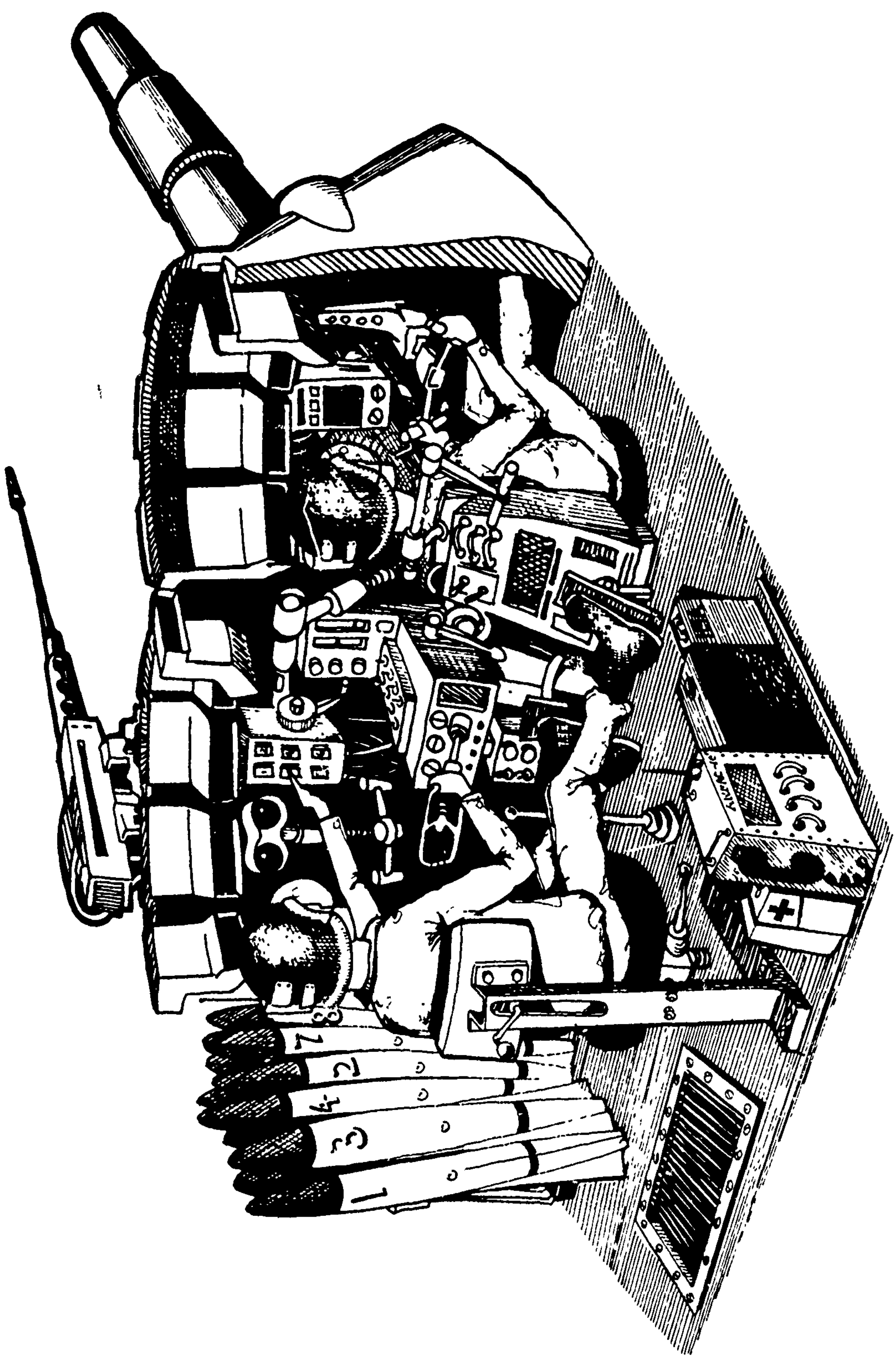


Figure 11.

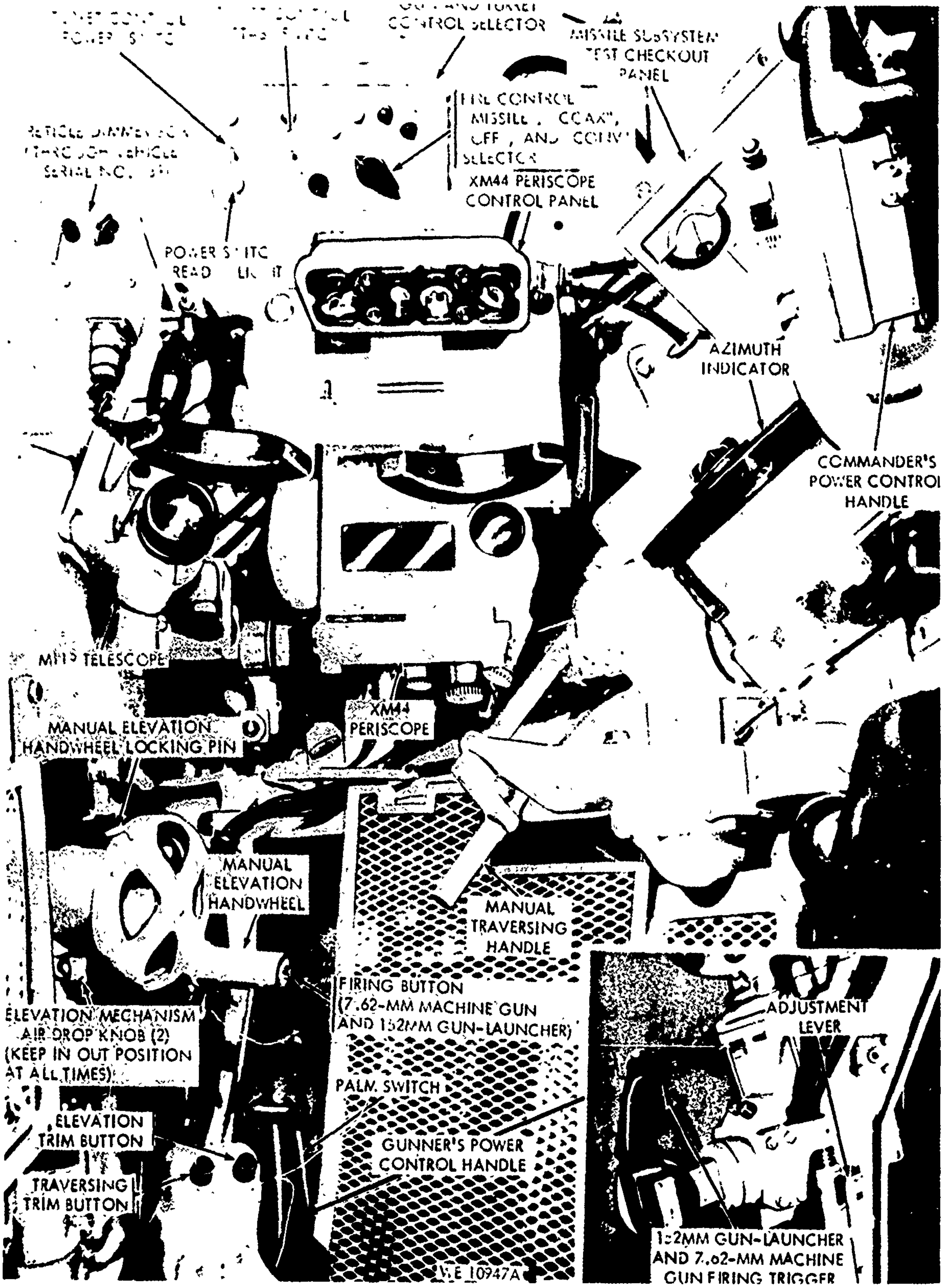
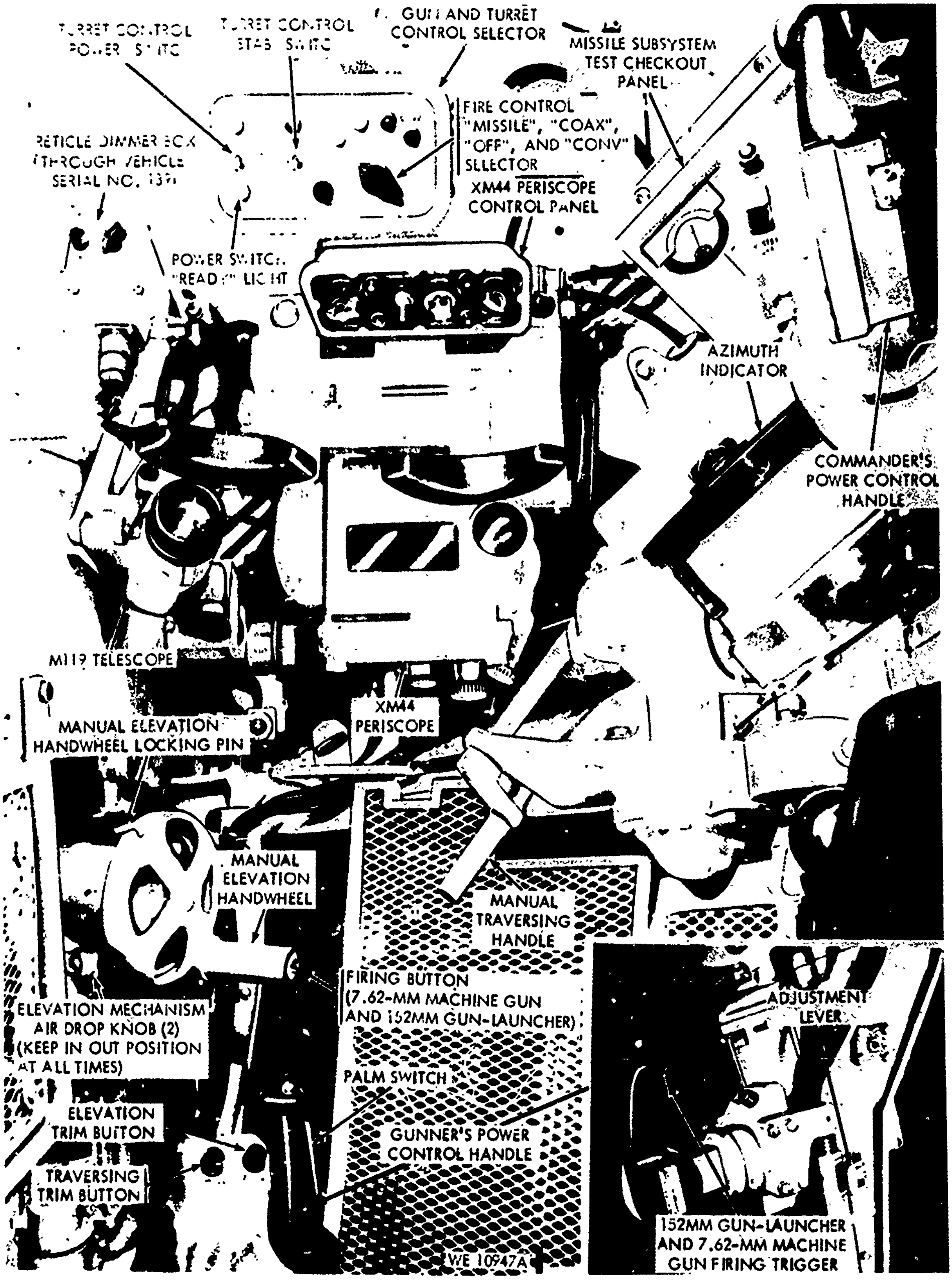

XM44 PERISCOPE
CONTROL PANEL
AZIMUTH
INDICATOR
COMMANDER'S
POWER CONTROL
HANDLE
MANUAL ELEVATION
HANDWHEEL LOCKING PIN
XM44
PERISCOPE
MANUAL
ELEVATION
HANDWHEEL
MANUAL
TRAVERSING
HANDLE
FIRING BUTTON
(7.62-MM MACHINE GUN
AND 152MM GUN-LAUNCHER)
ADJUSTMENT
LEVER
ELEVATION MECHANISM
AIR DROP KNOB (2)
(KEEP IN OUT POSITION
AT ALL TIMES)
PALM SWITCH
GUNNER'S POWER
CONTROL HANDLE
ELEVATION
TRIM BUTTON
TRAVERSING
TRIM BUTTON
GUN-LAUNCHER
MACHINE
GUN FIRING TRIGGER

Figure 12.



TURRET CONTROL POWER SWITCH
TURRET CONTROL STAB SWITCH
GUN AND TURRET CONTROL SELECTOR
MISSILE SUBSYSTEM TEST CHECKOUT PANEL
FIRE CONTROL "MISSILE", "COAX", "OFF", AND "CONV" SELECTOR
XM44 PERISCOPE CONTROL PANEL
RETICLE DIMMER BOX (THROUGH VEHICLE SERIAL NO. 139)
POWER SWITCH "READY" LIGHT
AZIMUTH INDICATOR
COMMANDER'S POWER CONTROL HANDLE
M119 TELESCOPE
MANUAL ELEVATION HANDWHEEL LOCKING PIN
XM44 PERISCOPE
MANUAL ELEVATION HANDWHEEL
MANUAL TRAVERSING HANDLE
FIRING BUTTON (7.62-MM MACHINE GUN AND 152MM GUN-LAUNCHER)
ADJUSTMENT LEVER
ELEVATION MECHANISM AIR DROP KNOB (2) (KEEP IN OUT POSITION AT ALL TIMES)
PALM SWITCH
ELEVATION TRIM BUTTON
GUNNER'S POWER CONTROL HANDLE
TRAVERSING TRIM BUTTON
152MM GUN-LAUNCHER AND 7.62-MM MACHINE GUN FIRING TRIGGER
WE 10947A

Figure 13.

HUMAN FUNCTION COST REDUCTION

$10,000	Cost per operator per year
x 10	Years per vehicle life cycle
$100,000	Life cycle cost per operator
x 4	Operators per tank
$400,000	Live cycle operator cost
x .25%	Maintenance time
$100,000	Maintenance personnel cost
+ 400,000	Crew cost
$500,000	Total life cycle per personnel cost (per tank)
x .25%	Reduction in human functions
$125,000	Savings per tank
x 10,000	Tanks in fleet
$1,250,000,000	Possible life cycle saving

ONE BILLION TWO HUNDRED FIFTY MILLION
(DOLLARS, THAT IS!)

CONCEPT FORMULATION

Vehicles are designed by a great number of people, by circumstances, restraints, policies, state-of-the-art, directives and procedures. A truck might have 5,000 peculiar drawings and a tank from 10,000 to 15,000 peculiar drawings. An engine could have 3,500 drawings. How are these conceived and integrated?

The procedures used to arrive at these many integrated drawings involve the same elements of order - and although the integration appears to be complicated - it does flow. First is the collection of all possible "pertinent" data related to the problem. This is then collated and coordinated into a matrix of design possibilities. By now the static characteristics such as dimensions and weight, the dynamic characteristics such as performance, the mandatory componentry such as a gun and ammo, and the project state-of-the-art have been established. (See Figure 15)

Integration of all elements begins with selected configuration studies - time - cost - performance, weight studies, subsystem trade-off analyses, the detailed design and development of peculiar or high-risk componentry, the conduct of total system effectiveness studies, all of which leads to the selection of preferred concepts. These are refined and lead to the preparation of a Systems Description which is used to disseminate the Concept Formulation Base Line to all parties concerned with the particular development. (See Figure 16)

CONTRACT DEFINITION

This Concept Formulation paper is used to prepare the Request for Proposals for the Contract Definition Phase. In this phase concepts are modified and refined and a total contractual proposal for conduct of Design Development and Production of the Item or System evolves.

DESIGN DEVELOPMENT AND PRODUCTION

Note that once a contract for a fixed price with incentives for the total package has been negotiated, there is little that can be done to change the contract without seriously jeopardizing the cost or guarantees. It is imperative, therefore, that the System Description contain precise requirements in the Concept Formulation stage to ensure an effective product.

It is true that the government monitors the action of the Contractor and visibility is obtained through IPR's. The

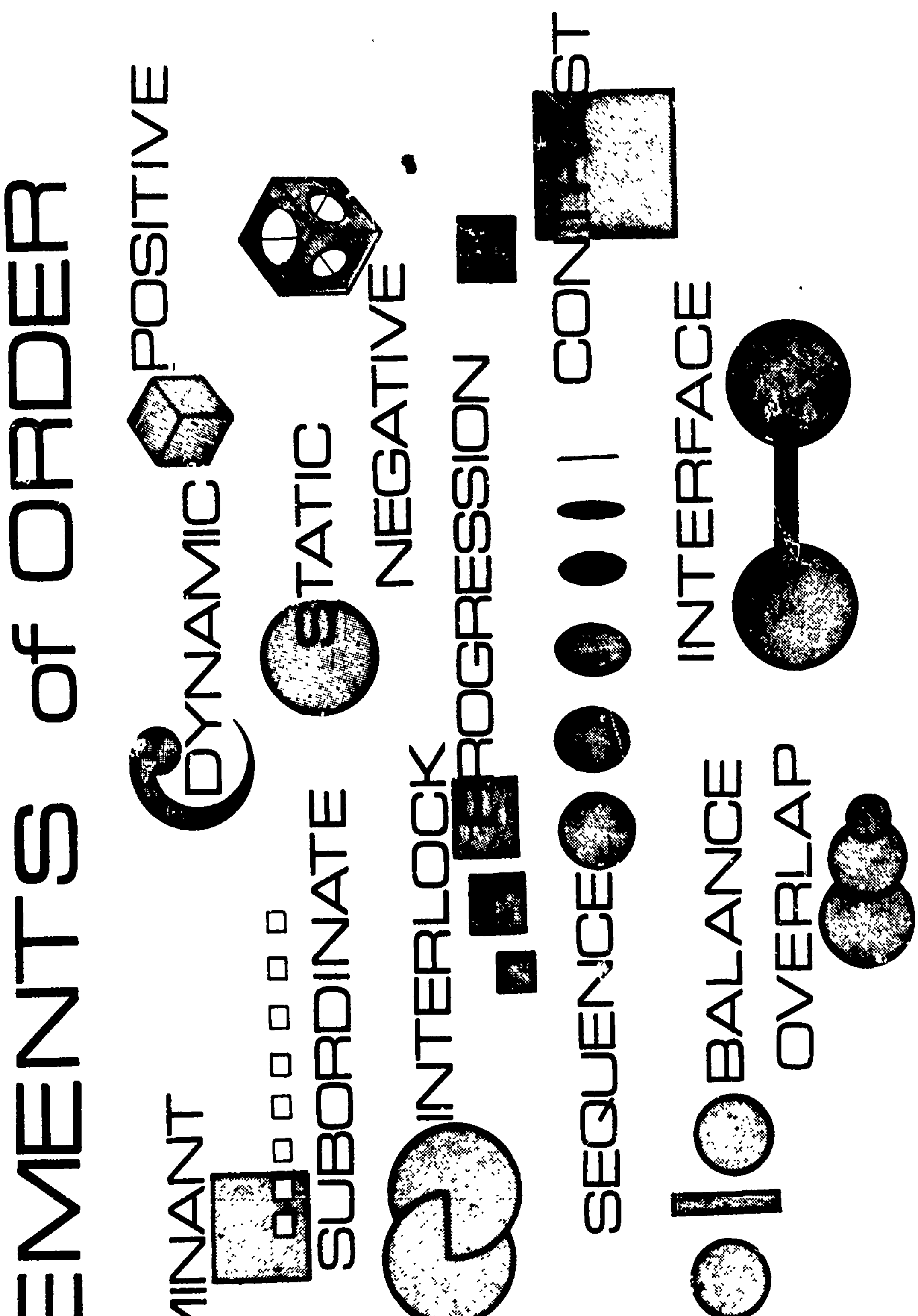

ELEMENTS of ORDER
DOMINANT
SUBORDINATE
INTERLOCK
SEQUENCE
BALANCE
OVERLAP
DYNAMIC
POSITIVE
STATIC
NEGATIVE
PROGRESSION
CON
ST
INTERFACE

Figure 15.

THE PROCESS

1. CONCEPT FORMULATION

   Collect
   Collate
   Integrate
   Disseminate

2. CONTRACT DEFINITION

   Competitive Refinement
   Total Planning
   Shared Risk Contract

3. DEVELOPMENT

   Design
   Develop
   Test
   Production Engineer

4. PRODUCTION

   Produce
   Test
   Guarantee
   Support

Figure 16.

contract can be stopped or modified but it is difficult to impose second guesses on this management system. If we are going to make mistakes, they should be well planned, as you might have noticed. The check and balances of multilayer management tend to avoid major mistakes.

HUMAN FACTORS ENGINEERING

As you can see, the Human Factors Engineer can strongly influence the System throughout its life cycle. The System Design Engineer needs education and guidance in the application of more specific Human Factors principles and parameters related to his problem. He thinks he has always given consideration to Human Factors, but he basically is a solid space designer. He needs a ready reference handbook which will help him integrate time, space and motion - and the concept of orderly arrangements into his assignment and relate it to the total system. This is especially true of contractor personnel who are often working in an unfamiliar environment when dealing with Army System Design. I don't think it would hurt any of us to better understand what the elements or order are and how to use them and to better understand disorder.

NEED TO KNOW

Systems Designers need to know (in addition to time, space and motion parameters) more about factors affecting fatigue such as noise, shock, vibration, ventilation, temperature, lighting, color, support, restraint, force exertion, repetitive actions, sequential actions, coordinated action, visual acuity, visual transfer, reaction time, recuperative stimuli, aural acuity, in fact such an endless variety of information that Human Factors Engineers should be in business for a long, long time. We need this in a ready reference form with direct relationship to our local problems.

CONCLUSION

In conclusion, managers as well as designers are becoming more and more aware of the importance of "before the fact" application of Human Engineering Principles and are anxious and willing to apply them in practice. In the final analysis, Systems Design is a Series of the best compromises (or more popularly "trade-offs") that are possible under the particular circumstance. The Human Factors Engineer, like everyone, wants the best circumstance for his own art. Don't set the standards higher than necessary for the job. It may make some desirable system impossible or expensive, or overly difficult.

DON'T FORGET WHO DOES WHAT TO WHOM

SESSION 5. MANPOWER DEVELOPMENT: JOBS, UNITS, PEOPLE AND TRAINING

General Chairman: Franklin M. Davis, Jr., Brigadier General, USA
Office of the Deputy Chief of Staff for Personnel
Department of the Army, Washington, D.C. 20310

SESSION 5A. JOB ENGINEERING AND THE DEVELOPMENT PROCESS

Chairman: W. P. Davis, Colonel, USA, Office of Personnel Operations
Department of the Army, Washington, D.C. 20310

5A(1). JOB ENGINEERING AND THE DEVELOPMENT PROCESS

W. P. Davis, Colonel, USA, Office of Personnel Operations
Department of the Army, Washington, D.C. 20310

INTRODUCTION

Good morning, Ladies and Gentlemen. I am Colonel Warren P. Davis, Chief of the Personnel Management Development Office, Office of Personnel Operations, DA and have the very distinct pleasure of serving as your Session Chairman. I would like, first to welcome all of you to this Session on "Job Engineering and the Developmental Process." We have on our panel, this morning, a number of distinguished persons. Dr. James A. McKnight from the Human Resources Research Office, Alexandria, Virginia. Dr. McKnight has had extensive experience in research work for the Army, particularly in the areas of job analysis, occupational training, and the redesign of training courses. He also served as a consultant to the Brown Board. We are fortunate to have Colonel Charles L. Crain with us. He is currently serving as Chief of the Classification and Standards Division, Deputy Chief of Staff for Personnel. Among other projects, Colonel Crain's office is charged with Project 100,000 and the program for the Utilization of Draft College Graduates. We will hear more about these later in the morning. Mr. David Franklin of Franklin Institute, Philadelphia, whose organization has been doing an interesting study on junior officer duties in the Army. Mr. Harry I. Hadley, who is Technical Director at my office currently, and has had extensive experience with the development of numerous programs, new techniques in the personnel management area, and the conception and design of major projects such as the MOI Data Bank. Also Mr. Louis E. Higgins who is chief of our New Equipment Section, best known for its publication of the projected personnel requirements for new equipment still in the RDT&E stage.

OPERATION OF THE PANEL

I hope that we can make this a very informal panel with full and free discussion both from the panel members and you in the audience. I have asked each of our panel members to give a short presentation in as informal manner as they wish. Each panel member will entertain questions of a specific nature concerning the topic he has presented. We also have a period at the end when we can have a more general discussion of our topic, and will be happy to receive questions or comments from the audience. Each of the topics to be given will be directed at our main theme, "Job Engineering and the Developmental Process." Most will not be as concerned with solutions to difficulties in the personnel system as they will with bringing relevant facts to light, offering problems for consideration by the entire group, and suggesting new avenues of approach to our numerous unsolved problems.

JOB ENGINEERING AND THE DEVELOPMENTAL PROCESS

Job Engineering has many formal definitions, and it is certainly not my purpose today to either promulgate a new one, or indorse any single one. Most of them center around the function of grouping similar tasks into duties and similar duties into an occupation or MOS insofar as the Army is concerned. As personnel management as a science or art, whichever you prefer, came along after we already had a standing Army, many of our jobs developed out of operational necessity or organizational happenstance. MOS as we now know them, came into being along with the onset of World War II. As a consequence, the MOS maker found that he had on hand a great many jobs already engineered. These were documented and written up formally without any extensive attempt to determine whether they were correctly engineered from the standpoint of either the personnel the Army could reasonably expect to have available, or the training facilities which the Army had established. Shortly after World War II, a job analysis program was started to determine the specific skills, knowledges and abilities actually required by the jobs in the field. As these data began to flow in from the field, it became apparent that many MOS were abstractions. While different soldiers in different units were doing combinations of duties which added up to the whole MOS, no single soldier was doing the whole MOS in any single job. This situation, of course, is a fertile field for job engineering or reengineering as the case may be.

As new equipment was added to the Army, often the old MOS were found to be unsuitable, and new MOS were constructed. These MOS can be said to have been engineered in that the MOS maker deliberately put together specific combinations of tasks into duties and duties into an MOS. However, they were obviously prejudiced by the already existing MOS and biased by a lack of detailed job information on the specifics of the job. One of our panel members will touch on this later.

THE MILITARY OCCUPATIONAL DATA BANK

Last year, at the 13th Annual R&D Conference, Mr. Hadley and I reported on the design and development of the Military Occupational Information Data Bank, often called the MOI Data Bank. It is not my purpose today to recover that ground, however, for the benefit of any new people here allow me to briefly explain what it is, where we stand, and then proceed to how it relates to job engineering. The Data Bank is a fully automated system of gathering, storing, consolidating and retrieving relevant job facts concerning all the MOS in the Army. It became operational early this year, and is rapidly gathering momentum. The current status of enlisted MOS, which have the highest priority of the three classes of MOS, is shown on Table 1.

As shown, we have 44 enlisted MOS, or about 1/10th of the enlisted MOS in the bank and output reports are available on them. We have another 126 MOS currently in field administration or in the machine processing stage which follows the filling out of the questionnaire by the job incumbent. That leaves about 250 enlisted MOS left to be administered, and a total of around 600 MOS questionnaires to be developed and administered counting officer and warrant officer MOS.

The primary shortcoming in previous job engineering attempts has always been too little job information which is in easily manageable form. The Data Bank is rapidly correcting this deficiency, and will make possible extensive job engineering at either the MOS level or the duty position level.

Mr. Hadley, our first panel member to speak will go into this subject further and give some examples, ...Mr. Hadley...

STATUS OF THE MILITARY OCCUPATIONAL INFORMATION DATA BANK

October 1968

NUMBER OF MOS IN THE DATA BANK	44
NUMBER OF MOS IN FIELD ADMINISTRATION OR PROCESSING	126
NUMBER OF MOS QUESTIONNAIRES BEING DEVELOPED	600 +

Table 1

5A(2). THE MOS DATA BANK AS A POTENTIAL FOR JOB ENGINEERING

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INTRODUCTION

Good morning. As our esteemed Chairman, COL Davis, mentioned, the current Army MOS is an abstraction which roughly summarizes all personnel or positions subsumed under it, but, in actuality, does not categorize any single position or soldier classified by it. This statement is, of course, more or less true depending upon the particular MOS. I would like to show you some examples drawn from the data gathered by the MOS Data Bank, in two cases, and from AR 611-201, the enlisted MOS Manual, in another. I believe that they will show the potential scope of job engineering in concrete terms, and also will point out some of the constraints needed, if a program of job engineering is going to be useful in improving military personnel management.

EXAMPLES OF POTENTIAL JOB ENGINEERING

The MOS Data Bank collects job information and relevant job facts concerning all officer, warrant officer and enlisted MOS in the Army. Each soldier is asked to fill out a detailed questionnaire on what he does and what he needs to use or know to adequately perform his current duty position. All the tasks performed by all the personnel in a specific MOS, when collated, then portray that MOS, providing the sampling has an adequate level of confidence. The size of the sample, for each MOS, incidentally, is set at the 95% level of confidence as drawn from standard statistical sampling tables. The sample for each MOS is not completely random, however, as the criterion of 6 months experience on the job was found to be necessary in order to gain validity. Other than this single selection criterion, the sample is random, and we feel sure that it has a high level of confidence.

We currently have two standard output reports on an MOS after it has been put into the MOS Data Bank. One is called the Back-Up Data Report, or BUD report, and contains all the tasks in all the duty positions in an MOS. The number of separate duty positions in an MOS can vary from one or two to between 20 and 30, depending on the breadth of the MOS. The second standard report is a Duty Position BUD report and contains all the tasks in a single duty position of an MOS. Tasks are shown by the number who responded to the item, the percent who perform the task, and the frequency with which the task is performed. The MOS Data Bank also has available a catalog of all tasks in all MOS by alpha or numeric coded sequence so you can isolate a set of tasks and then ask the Bank to give you all MOS in which they appear.

JOB ENGINEERING AT THE DUTY POSITION LEVEL

Table 1 shows the duty position titles which were collected by the Bank on MOS 05 B, Radio Operator.

DUTY POSITION, MOS 05B, RADIO OPERATOR

Duty Position Title	Sample Size
Radio Operator	142
Intermediate Speed Radio Operator	42
Radio Operator Supervisor	21
Radio Telephone Operator	5
Radio Teletype Operator	4
Team Chief	3
Platoon Sergeant	1
Communications Chief	1

Examination of these job titles shows that the MOS is a fairly homogeneous one from an occupational standpoint. Furthermore, the three duty positions with the greatest return, the top three, are solidly in the core of the skills and knowledges required by the MOS. Radio Telephone Operator is a somewhat lower skill than radio operator, but as the MOS covers grades E-3 through E-9, this is a trainee duty position. Radio teletype is similar to radio operation and is integrated with the other skills in the MOS. All in all, this looks like a rather well knit MOS in which little job reengineering is needed at the duty position level. The one possible exception would be the Radio Telephone Operator which could be engineered out, so to speak, if you wished to set up a separate MOS for lower level personnel with reduced training.

Table 2 shows the high density duty positions incorporated in MOS 95 B Military Policeman. Note that here again, these duty positions represent skills that are fairly homogeneous. There is some evidence here that the MOS has two clusters of skills, one centering around the "outside" policeman who is patrolling and maintaining order, and one the "inside" policeman who is guarding prisoners. However, one might conclude that these two skill clusters are reasonably related and that there is a good deal of overlap between the skills in any case.

DUTY POSITIONS, MOS 95 B, MILITARY POLICEMAN

Duty Position Title	Sample Size
Military Policeman	584
Squad Leader	88
Security Guard	70
Desk Sergeant	34
Platoon Sergeant	33
Section Sergeant	32
Operations Sergeant	27
Patrol Supervisor	24
Cell Block Guard	21
Escort Guard	18
Detachment Sergeant	16
First Sergeant	15
Tower Guard	13

Table 3 shows the low density duty positions sampled in covering MOS 95 B, Military Policeman.

DUTY POSITIONS, MOS 95 B, MILITARY POLICEMAN
(Continued)

Duty Position Title	Sample Size
Operations-Training NCO	9
Military Police Supervisor	7
Turnkey	6
Security Sergeant	3
Prisoner Guard	3
Chief Clerk	1
Shift Leader	1
MP Traffic Control Sergeant	1
Public Safety Supervisor	1
Light Truck Driver	1
Registration Clerk	1
Radio Telephone Operator	1

Here we begin to see what appears to be either extraneous titles, or dissimilar skills. As all MP's drive and use radio telephones, the light truck driver duty position and Radio Telephone Operator seem unnecessary, and could probably be disposed of. However, such jobs as Public Safety Supervisor, Registration Clerk and Chief Clerk bring up the problem of combining dissimilar skills. The total sample on this MOS was 1025 and represents a total authorized strength of over 31,000. If the sample fairly represents the MOS, this means that there are around 30 Public Safety Supervisors classified under the MOS for MP. This begins to look like a rather good field for some job engineering, as obviously we do not want to have to select, train and pay MP's for clerical, administrative and safety skills as well as the regular outside and inside MP duties.

Table 4 shows an MOS which is currently being processed in the MOS Data Bank. I have included the duty position titles <u>presumably</u> in the MOS as drawn from the OPO 99 Report which covers all duty positions in TOE's and AR 611-201, the enlisted MOS Manual. In the right hand column, I have shown how I would classify the primary skill required of the duty position. As can be seen, this varies widely and presents a picture of an MOS that appears to be entirely too broad for either selection, training, pay, or career advancement.

DUTY POSITIONS, MOS 91 B, MEDICAL SPECIALIST

Duty Position Title	Primary Skill Required
Air Ambulance Aidman	
Ambulance Driver	
Detachment Sergeant	Field Medicine
Platoon Sergeant	
Chief Clerk	Administration
Receiving-Forwarding Clerk	
Dispensary Specialist	
Medical Aidman	General Medicine
Ward Specialist	
Battery Aidman	
Company Aidman	High Physical Skill
Senior Litterbearer	
Medical Instructor	Advanced Medicine
Orthopedic Ward Specialist	Specialized Medicine

The field medicine people are involved in first aid, hasty slings, narcotic injections and like duties. The administrative people are keeping records and don't touch a patient. The general medicine group is engaged in routine hospital care and treatment of admitted patients. The primary requirement for a good Aidman or Litterbearer is good physical strength and courage to assist battlefield casualties, often under fire. The advanced medicine and specialized medicine group get off into narrow, highly technical skills. It will be interesting to see what the incidence count is on these duty positions. If there is any substantial strength in all of these, we are then confronted with a considerable problem in personnel management. We need to select a man with both a high physical and high mental aptitude. We need to train him in not only general and field medicine, but also administration, the skills of the Infantryman, and specialized medical techniques. This would be clearly beyond the capabilities of the average draftee or enlistee, and would tend to strain the Army's training facilities even for those adequately selected. Depending on the findings of the MOS survey, this looks like an extremely fertile field for job engineering.

JOB FNGINEERING AT THE TASK LEVEL

Up to now, I have been talking about job engineering at the duty position level, that is, moving certain duty positions out of an MOS in order to improve its occupational similarity, trainability or selectability as the case may be. Now let me drop down a level, and talk for a moment about job engineering at the task level. For while it is possible to recombine duty positions among MOS, it may be even more important to recombine tasks within a single duty position. Table 5 shows our old friend the Radio Operator, but this time it is an extract from a duty position BUD report and shows the tasks performed by the Senior Radio Operator.

BUD DUTY POSITION REPORT

MOS 058 SENIOR RADIO OPERATOR

TASK STATEMENTS		PERCENT DO	SELDOM	PERCENT OCCAS	FREQU
COMMUNICATIONS EQUIP OPERATIONS					
TRANSMIT MESSAGES BY CW	48	35	25	8	2
TRANSMIT MESSAGES BY VOICE	48	90	10	31	43
RECEIVE MESSAGES BY CW	47	34	23	9	2
RECEIVE MESSAGE BY VOICE	50	90	8	30	52
SEND SINGLE ADDRESS MESSAGES	50	76	16	30	30

The right hand columns show the number of persons who responded, and the frequency with which they performed the task in percentages. Notice the items "Transmit and Receive Messages by CW" or continuous wave. This is what we used to call the Morse Code Operator. It is difficult to select a man for this training, as evidenced by the fact that we have a separate aptitude area based on this requirement. It is also difficult to train a man on these tasks as evidenced by the fact that the training course is long and the attrition rate is high. If you wished to simplify selection and training you could engineer the CW tasks out of the MOS and put them in a separate MOS, leaving voice radio operation which would be simple to select for and train in the old MOS.

CONSTRAINTS ON JOB ENGINEERING

Job engineering or reengineering is not a panacea for all the ills of the personnel management system of the Army, the foregoing material notwithstanding. The more you think about it, the more it becomes involved with other aims and goals of personnel management which serve as constraints on wholesale job engineering. I will name but a few of these which seem paramount to me.

1. Job Engineering can have various purposes. You can group duty positions within an MOS, or tasks within a duty position, so as to promote similarity of physical skill and strength, aptitude area or mental ability, occupational content, or even administrative job requirements such as security clearance or job license. An example of this was the Medical Specialist we looked at.

2. Job Engineering must consider whether it will add additional manpower requirements to a unit. For example, if you split the radio code operator from the voice operator, you may be adding a body to a unit that had only one combined operator to begin with.

3. Job Engineering must consider career progression within a unit, and not isolate a soldier from his most likely avenue of advancement. A good example of this would be the light truck driver in the MP MOS,

if classified separately he must change career fields to get ahead or move to another unit.

4. Job Engineering must be carried on as part of an overall philosophy of personnel management. For example do we want to modify jobs to suit the 2 year soldier, the college graduate, the project 100,000 man, or the Junior officer or construct MOS to suit the training base and the average, long term soldier? I am looking forward to what some of the other panel members have to say on this subject.

Thank you, any questions?

5A(3). PROJECT ONE HUNDRED THOUSAND AND UTILIZATION OF COLLEGE GRADUATES

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INTRODUCTION

The purpose of my presentation is to lay the groundwork for a discussion of the training problems as they apply to the Project One Hundred Thousand man and the college graduate. I will briefly cover four points:

1. Enlisted accessions for this year

2. Background information on the Project One Hundred Thousand man

3. Training of the Project One Hundred Thousand man, and

4. A few words about policy on the utilization of college graduates.

Last year at the 13th Annual Conference I reported in great detail on Project One Hundred Thousand. At that time we were very concerned that the Army was not getting its fair share of talent from the manpower pool. We were concerned about modifying our training programs to accommodate these lower mental and talented men. This year our concern is not only with the lower mental groups but also how we can best accommodate and most efficiently train and utilize the large numbers of college graduates who are entering our enlisted ranks as a result of the change in draft deferment policies.

This Chart (Figure 1) illustrates to some degree the situation. Our accessions for FY 1969 are estimated to be about 420,000. The chart shows that 100,000 will be Category IV men and from 80,000 to 110,000 could be college graduates. During past years our annual college graduate accessions have averaged about 4% of the total so you can see that this number does constitute a very significant spread in mental capacity between the lower mental groups as characterized by the Project One Hundred Thousand man and the college graduate with the attendant reduction of the middle category mental groups.

The problem then is the resultant conflict in training and instruction which must be paced to accommodate both the slow learner and the fast learner.

PROJECT 100,000

To obtain a better understanding of what we are talking about when we speak of the slow learner, I will next turn to Project One Hundred Thousand. You all know the Project started on 1 October 1966 (Figure 2). The purpose was to accept men into the Army who prior to that date would have been rejected under mental or physical standards in effect at that time.

The specific objectives of the Project are:

- to give the lower mental group men who were previously rejected an opportunity to serve in the Armed Forces.

- to train these men as effective soldiers without degrading our military mission or effectiveness and

- to give the men an opportunity to learn skills, aptitudes and habits which they can take back to civilian life to assist them in becoming productive citizens. We have accepted 103,000 (1 Oct 1968) Project One Hundred Thousand men in the Army.

What type of a man is he?

This next chart (Figure 3) shows his educational background and reading ability as compared to a control group consisting of a 10% sample of all other mental categories.

You will note that 58.9% are non high school graduates. The average school grade attained is the 10th grade.

84.6% of the men read below the 8th grade level and 36.3% of these read below the 5th grade level. In round figures this means that about 20,000 men will enter the Army this year who are so called functional illiterates. Another notable fact is that some of the control group also have a reading problem.

Because of this reading problem, it has been necessary for CONARC to establish formal remedial reading instruction at all the training centers. This formal program was started 1 April 68 and 2,000 men completed the instruction during April, May, and June. This fiscal year we are programming 12,500 men. We can further discuss this remedial reading program later if you prefer.

The next charts (Figures 4 and 5) show how the men score on the Armed Forces Qualification test and the Aptitude Area tests as compared with others. The significant point here is 67.6% of the Project One Hundred Thousand men score between AFQT 10-15. In the Aptitude Area scores (Figure 5) you will note the significantly lower percentage of Project One Hundred Thousand men who score above 90. The most significant is in the General Technical aptitude which measures reading and arithmetic reasoning where only 3.6% score above 90 as compared with 80.3% for others. Remember that 90 is the minimum score for most training courses.

TRAINING ATTRITION

Now the question may be asked are we satisfactorily training the men? This next chart (Figure 6) shows the training attrition rates.

The attrition rates for basic and combat Advanced Individual Training are not much different from the average. This is not true for the combat support training courses at the service schools where the attrition rate is 14.9% for Project One Hundred Thousand as opposed to a 5.1%

average. This can be expected because these courses are more difficult, there is more reading and studying required.

The attrition rates shown on this chart really do not give the whole story. We know from statistics that the Project One Hundred Thousand and Category IV man makes a lower passing score on his intermediate and end of course tests. In other words, he learns and retains less yet he does make the minimum passing grade to qualify for the MOS. In this respect we can say that we are satisfactorily training the large majority of the men.

TRAINING

Perhaps on the good side of Project One Hundred Thousand, the presence of these men have caused some needed improvements in many of our training courses. Specifically, five courses (Figure 7) have been revised and modified as a direct result of Project One Hundred Thousand.

Time does not permit me to go into great detail about the specific revisions of the courses but they were generally redesigned to (1) teach the man only what he needs to know to perform his MOS mission, (2) teach as much as possible by practical exercises and (3) test by performance exercises rather than written. The next chart (Figure 8) quickly shows techniques used in the course redesign:

1. Actual job requirements were determined by interviewing and questioning job holders as well as observing their performance. An analysis and evaluation of this information and reviewing job specifications resulted in arriving at desired training requirements.

2. Instructional methods were adopted so that the purpose and the need to perform an operation were explained through practical application. Theory was presented only when no other method of instruction was applicable. Instructional methods were developed which engulfed all the mental groups.

3. As information was gathered, assembled and analyzed, the results of performance and achievement were frequently fedback to the students so that they could be aware of progress, proficiency or problems which may have been developing. Of course feedback to the instructor and planners was just as important so that class revision could be continuously upgraded.

4. Practical hand-on-training, using actual equipment and procedures was the ideal training technique, especially if it incorporated immediate feedback to the students.

5. Extensive use of training aids, carefully selected and used stimulate learning and retention by the student.

6. Utilizing performance testing rather than written exercises proved more conducive to the lower mental group personnel. We have found that many men can satisfactorily pass performance tests but can not pass a written test.

7. Equipment/instructor to student ratio must be increased for lower mental groups because of the required hands-on type of instruction as well as more personal attention.

8. Generally, additional time

PROJECTED FY 69 ACCESSIONS

INPUT 420,000

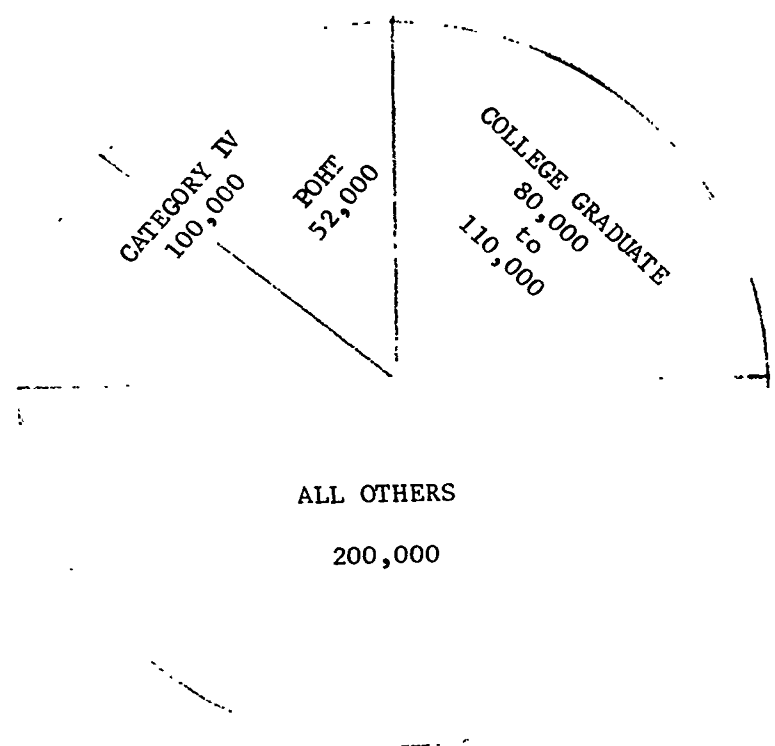

Figure 1

BACKGROUND

STARTED 1 OCTOBER 1966

ACCEPT 100,000 ANNUALLY

OBJECTIVES

THE OPPORTUNITY TO SERVE

TO TRAIN AS EFFECTIVE SOLDIERS

TO LEARN SKILL FOR CIVILIAN LIFE

Figure 2

	PROJECT 100,000	CONTROL
EDUCATION		
H S GRADUATE	41.1%	71.9%
NON H S GRADUATE	58.9%	28.1%
READING COMPREHENSION		
8th GRADE AND ABOVE	15.4%	81.4%
BELOW 8th GRADE	84.6%	18.6%
BELOW 5th GRADE	(36.3)%	(3.3)%

Figure 3

ARMED FORCES QUALIFICATION TEST

SCORE		PROJECT 100,000	CONTROL
93-100	CATEGORY I	0	5.9%
65-92	CATEGORY II	0	30.8%
31-64	CATEGORY III	0	44.9%
21-30	CATEGORY IV	7.2%	10.4%
16-20	CATEGORY IV	25.2%	6.9%
10-15	CATEGORY IV	67.6%	1.1%

Figure 4

APTITUDE AREA TESTS

		PROJECT 100,000	CONTROL
MOTOR MAINTENANCE	(MM)	49.8%	86.6%
GENERAL MAINTENANCE	(GM)	43.4%	82.5%
ELECTRICAL	(EL)	38.4%	82.2%
ARMOR, ARTILLERY, ENGINEER	(AE)	36.8%	84.6%
CLERICAL	(CL)	28.4%	87.6%
INFALTRY - COMBAT	(IN)	20.6%	69.8%
GENERAL TECHNICAL	(GT)	3.6%	80.3%

(PERCENT SCORING 90 AND ABOVE)

Figure 5

TRAINING ATTRITION RATES

	PROJECT 100,000	ALL OTHERS
BASIC COMBAT TRAINING	3.0%	2.1%
ADVANCED INDIVIDUAL TRAINING		
COMBAT MOS	2.4%	1.8%
COMBAT SUPPORT MOS	14.9%	5.1%

Figure 6

333-404 O 69—16

PILOT REVISED COURSES

SCHOOL	COURSE	MOS
ENGINEER	ENGINEER EQUIPMENT MAINTENANCE	62B
ORDNANCE	WHEEL VEHICLE MAINTENANCE	63B
QUARTERMASTER	SUPPLYMAN	76A
SOUTHEAST SIGNAL	TELEPHONE SWITCHBOARD OPERATOR	72C
TRANSPORTATION	MARINE HULL REPAIRMAN	44K

Figure 7

KEY TECHNIQUES

JOB ANALYSIS AND TASK INVENTORY

FUNCTIONAL CONTEXT OF TRAINING

ACCOMPLISHMENT FEEDBACK

PRACTICAL TRAINING

TRAINING AIDS APPLICATION

PERFORMANCE TESTING

EQUIPMENT/INSTRUCTOR TO STUDENT RATIO

TIME LENGTH

HOME STUDY MATERIALS

AVOID EARLY RECYCLING

DETECT STUDENT PROBLEMS

INDIVIDUAL TREATMENT

QUALITY CONTROL

Figure 8

was required to attain teaching objectives for the lower mental groups and may be variable with changes in class mix.

9. Home study materials must be at the students' level of accomplishment, and of appropriate length of time.

10. Early recycling should be avoided when possible, since it tends to create a defeated attitude. Early success should be provided.

11. Early detection of student problems or difficulties, and adequate personal and academic counselling is important.

12. The lower mental ability man must be treated as an individual who can succeed.

13. Quality control and redesign must be continuous in order to detect and correct problem areas.

In fact you can see that systems engineering techniques were used, and in this respect CONARC has started a program to redesign every training course in the inventory. This is a major undertaking as you well know and it will take years to accomplish. The experience we are having now with Project One Hundred Thousand and the development of the MOI Data Bank will certainly assist in this effort.

TRAINING AND UTILIZATION OF COLLEGE GRADUATES

In closing I will say a very few words about training and utilizing college graduates.

We cannot design jobs specifically for these men - they must be used to fill valid Army requirements.

From the training viewpoint there are no plans to reduce the length of Basic Combat Training or combat Advanced Individual Training or to revise or redesign any course strictly for the college graduate. There are plans to accelerate as many of these men as possible through our service school training courses. We do plan to utilize the leadership and technical skills which these men have gained through their college work. We have examined our training courses and MOS and we have established priorities in both for the assignment of these college graduates. Our objective is to derive the maximum benefit from the background and talents of these men and to assign them to the most stimulating and challenging duties we have to offer.

CONCLUSION

During this presentation I have merely scratched the surface on our experience with Project One Hundred Thousand and our plans to efficiently train and effectively utilize college graduates. Time has not permitted me to mention the good work now being carried out by the Army Behavioral Science Research Laboratory and HUMRRO to find better ways to classify and train our men, or the work being done by USAFI and our educational directors in the reading and general educational development field. We do have problems as I have indicated but we are moving forward in our search for solutions as indicated in all the presentations you have heard. We have a long way to go and we have by no means found all the solutions. Perhaps as Colonel Davis stated we can find some new avenues of approach to some of these problems during our panel discussion today.

5A(4). NEW EQUIPMENT PERSONNEL REQUIREMENTS SUMMARY (NEPRS)

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The purpose of this paper is to describe The New Equipment Personnel Requirements Summary or NEPRS as it is more popularly known and the methods that the Office of Personnel Operations employs in developing information for inclusion in the NEPRS.

The NEPRS was originally conceived, designed and published to assist elements within OPO to determine the quantitative (strength) and qualitative (MOS) personnel requirements of selected items of new equipment/weapons systems scheduled to enter the Army inventory in the current and succeeding four fiscal years. However, it turned out to be an almost instantaneous "best-seller", and OPO has been forced to increase both the coverage of material items/systems and distribution of the report far beyond original plans. For example, the original edition of the NEPRS contained less than 20 items of equipment with personnel implications, and fewer than 10 copies were distributed. In the 1968 edition, however, the number of items addressed is approximately 500 and the number of copies distributed has grown to approximately 175.

The manner in which information is presented in the NEPRS is as follows:

a. <u>New Materiel Items List</u>

A listing of materiel items/systems being developed by materiel development agencies, an indication as to whether an item or system has personnel implications, either qualitative or quantitative and when affirmatively so identified, the page on which the item or system is described in the main portion of the document.

b. <u>New Equipment Personnel Requirements Summaries</u>

An individual report on specific items of new equipment involving significant qualitative or quantitative personnel implications. Each report contains a summary description of the item of equipment, the planned utilization and deployment of the item and the probable organizational, training and qualitative/quantitative personnel implications in terms of MOS and numerical requirements.

NEPRS information is used by the DA Staff as input into the Army Force Development Plan and for computing enlisted, officer and warrant officer personnel and training requirements by MOS. Other recipients use the information for guidance in advance training plan and program of instruction development and for classification of duty positions in TOE. Additionally, NEPRS is used as a general reference on personnel, training and organizational implications of new materiel systems.

The methods used for the development of the information to be included in NEPRS are essentially three in number. The first is the QQPRI process, the second the NEPRS input system and the third visits to various members of the Army staff and to materiel, training course and manning table development agencies and commands, each method is described in some detail below.

The QQPRI process is established by at least three regulations, AR 11-25, The Management Process for Development of Army Systems, AR 350-12, The New Equipment Training Program and AR 611-1, MOS Development and Implementation. Although, the first two AR's establish the QQPRI as a fixture in materiel development and the development of New Equipment Training in support of new materiel items, it is AR 611-1 that sets up the procedures for the information to be contained in the QQPRI and when such information is to be provided. Under the provisions of AR 611-1, the QQPRI is scheduled in accordance with the materiel development time schedule. The first submission, the Provisional QQPRI is developed during QMDO studies and is provided to all agencies responsible for QMR review. The second, the updated QQPRI is submitted to OPO approximately 2½ years prior to system fielding and the Final QQPRI approximately 15 months prior to system fielding. The type of information to be included in the QQPRI is as follows:

a. A brief description of equipment to be operated and maintained.

b. Maintenance man hours per component of the end item for each echelon of maintenance, that is, organizational, direct support, general support.

c. The quantity of the new materiel item/system to be fielded by fiscal year quarter.

d. A listing of duties and tasks to be performed in operation and deployment, organizational, direct support and general support maintenance.

e. Suggested MOS from which personnel can be obtained.

f. Listing of knowledges, skills, abilities and physical and mental qualifications.

g. Additional qualifications such as academic subjects, specialized degrees, security clearance, etc.

h. The number and MOS of personnel materiel qualified through contractor training.

i. Identification of positions to be filled by military and civilian personnel.

The QQPRI system was first established in March 1963 and has been improving since that time.

The QQPRI information is then updated between submission by means of visits of action officers of OPO to materiel development, combat developments and training commands, and agencies to obtain the latest information on organizations, training, and materiel. Additionally, these same organizations, in accordance with provisions of AR 611-1, provide OPO with selected documentation developed in support of materiel development. These documents are not developed expressly for OPO, but are developed for internal usage within the agency or command or for other elements of the Army staff. Illustrative of the types of documents to be provided OPO are the following:

a. Master Plans and Schedules for Development.

b. Preliminary Design Materiel Status Review Minutes.

c. Personnel and Training Requirements and TOE Structures.

d. New Equipment Training Plan.

e. System Development Plan.

f. Logistical Support Plan.

g. Maintenance Support Plan.

h. TM's, FM's.

Although the system has been established for the development and exchange of materiel and related personnel, training and organizational information there is still much to be done. The problems are shortage of personnel at all echelons to develop the required information and the timing of the information submissions so that it can be employed effectively in the decision making process. The manpower problem is gradually being overcome, particularly within materiel development agencies, and the timing problem is being overcome by the development of Regulations and procedures supporting the materiel life cycle management process.

In conclusion, it appears reasonable to assume that in the not too distant future we can anticipate that the statement "trained personnel properly identified by MOS and in the requisite quantities will be available concurrent with delivery of new materiel items" will not only become a goal, but become a reality.

5A(5). ANALYSIS OF JOB QUALIFICATIONS

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The title of this session makes it clear that a job is something to be designed -- to be planned and developed in a systematic manner. A job doesn't just "happen" the way it once did. The rapid rate today's technology is generating new and different things for people to do simply doesn't allow time for a job to evolve. Rather, work activities must be thoughtfully and systematically molded into an efficient job structure. And, as Mr. Hadley has pointed out, this process cannot take place until we know what the activities are. A data bank such as that which he describes is an indispensable first step in the process of job engineering

IMPORTANCE OF JOB QUALIFICATIONS

However complete it is, a catalogue of work activities is only a first step in job engineering for it is not primarily on the basis of the activities themselves that jobs are created. Rather, it is the pattern of individual qualifications that are needed to perform the activities that largely establishes the optimum job structure. What is a job, after all, but a set of activities to be performed by a single individual? To constitute a reasonable job, one person must be capable of performing the activities. Were a job to require highly dissimilar qualifications, difficult to find, or costly to produce in one individual, we would consider it to be an inefficient one.

What are the characteristics of an individual that define his "job qualifications"? First, of course, the individual must know what to do -- he must possess a knowledge of the procedures, facts, and concepts that enable him to select and perform the required activity. Some activities also require special skills: perceptual skills such as distance judgment, motor skills such as two-hand coordinations, and mental skills such as verbal reasoning. Further, some activities call for a particular type of personality such as an aggressive individual, or one who is attentive to detail. Naturally, motivational factors play an important role in the adaptability of an individual to a job. Finally, moving from the psychological to the purely physical, certain work activities will pose specific requirements for height, visual acuity, endurance, or other physical characteristics.

This rather narrow focus upon individual qualifications as the basis of job engineering is certain to stimulate objections. What about characteristics of the work situation itself? What about the number of personnel to be supervised, the exposure to hazardous conditions, the criticality of the activity to an organization's mission? Are not these important to job design? Certainly they are. However, I would maintain that their importance lies in what they demand of the individual, not in their sheer existence as working conditions. Take for example the "hazard" factor. Typically, activities that involve potential hazard are assigned to senior, experienced personnel. Certainly this is not done to debilitate the people who are most valuable to the organization. Rather, the assignment is made because the experienced worker is more likely to possess the knowledges, skills, and judgment that enable him to avoid injury. The higher salary that this individual draws is compensation for his qualifications, not simply the risks involved in the job.

The systematic analysis of job qualifications is a topic that has concerned the military services for some time. Back in 1950 a committee of prominent personnel consultants was impanelled under the auspices of the Department of Defense to study methods of job qualifications analysis and make suitable recommendations. In 1959 the panel chairman, reviewing the findings of another conference on the same subject, was forced to conclude that "relatively little progress has been made in the development of a qualifications analysis methodology during the past nine years" [1]. He went on to note that job qualifications were still generally inferred from job descriptions on a wholly subjective basis. I doubt that this individual would be any more encouraged by the developments of the nine years that have intervened between his statement and the present time. If anything, we've lost ground, for the burgeoning job structures of the military services have driven job analysts further and further away from the jobs under their surveillance and forced them to become more and more dependent on remotely gathered job data for their "inferences". Nor is the trend likely to be reversed.

We must expect that some type of job data will form the major bridge between military activities and the people who study them, and that our picture of the qualifications needed to perform activities will arise out of inferences drawn from that data. Yet, the picture is not all that bleak. There is nothing basically wrong with inferences. After all, a "qualification" is an inference to begin with; you can't actually observe a knowledge or a skill. It has to be inferred from performance. The problem is not so much avoiding inference as it is improving the ability of job data to permit accurate inferences to be made.

DETERMINATION OF JOB QUALIFICATIONS

What steps are now being taken to improve the quality of data for job engineering? A review of the job-engineering literature is not promising. Most studies concerned with grouping tasks into jobs seem to have bypassed the problem of identifying job qualifications by simply grouping tasks according to the way they are currently performed in the field. Advancement in methodology has been largely concerned with the mathematical techniques and computer programs by which the tasks are grouped [2]. The bland acceptance of current field practice as a basis for task grouping does not appear to constitute a sound approach to job design. This does not mean that the voice of experience should be ignored. The way in which work activities are configured in the field may indeed reflect the optimum division of available talent. On the other hand, it may simply accommodate local needs -- or worse still, represent an unfortunate mismanagement of personnel that is hardly worth perpetuating. Field data must be an input to, and not a substitute for, a systematic job engineering process.

There are many steps that could be taken to improve the utility of job data for the identification of job qualifications. The step with which I am concerned in this brief presentation, and the one that seems to be a most important next step, is to increase the level of detail at which job activities are described. The more clearly we can glimpse the behavior that is required in any situation, the more surely we can pinpoint the qualifications that personnel must possess.

Let me provide an example. In dividing a set of supply tasks between a supply clerk and his helper, we came upon one task which involved the picking up and signing for supplies from a supply depot. At first glance this activity seems to require quite a degree of responsibility, particularly in the business of "signing for" something. It certainly looked like a task that required the supply clerk's attention. Yet, as we reduced the task to its elements, we found that the activity was rather routine, that it involved a lot of leg work and consumed a great deal of unproductive waiting time. The most challenging aspect of the task was simply comparing the stock numbers entered on supply documents with those printed on containers. Yes, it was a "responsible" task in the sense of financial accountability. However, it was not particularly demanding of the individual in terms of knowledge, skill, or judgment, and certainly would have been an inefficient use of a trained supply clerk's time.

Take another example, this time from maintenance. The diagnosis of malfunctions in a piece of electronic equipment required a troubleshooter to "interpret symptoms". In some tasks the interpretation demanded an understanding of the theoretical relationships underlying operation of the equipment. But for another whole series of tasks, it involved nothing more than comparing a set of meter readings with a set of normal values provided in a technical manual and then proceeding as directed. While each set of tasks required a different constellation of qualifications, the qualifications could be reckoned only when the tasks were inspected in detail.

ANALYTIC METHODS

The detailed analysis of tasks is a process that is central to a wide range of military personnel programs, including the development of training courses, construction of proficiency tests, preparation of technical manuals, and even the design of equipment. Each of the military services has devoted considerable energy to the generation of methods for analyzing tasks. Examples are the Personnel Requirements Information System Methodology (PRISM) developed by the Naval Personnel Research Activity [3], the several programs being carried out by the Aerospace Medical Research Laboratories [4], and the procedures spelled out by USCONARC in connection with "systems engineering" of training [5]. While the various methods differ somewhat, they all involve the reduction of tasks to their fundamental elements, task elements consisting of an action to be carried out, the object toward which the action is directed, and any relevant qualifiers such as printed aids, to assist the individual, or particular circumstances under which the action takes place. The emphasis is on detail. The actions must refer to concrete behaviors such as "depress" or "lift", and not vague terms such as "check" or "be responsible for". The objects must be similarly specific; they must, for example, identify the particular levers or switches on a piece of equipment that must be manipulated, and not simply refer to the equipment end item as a whole.

It should be obvious that the analysis of tasks can be carried out only by someone who is technically well versed in the nature of the work. For tasks associated with new equipment, the manufacturer is typically best qualified to provide this service. For other types of tasks, schools and training centers are in general the most likely source of competence, particularly when schools are staffed by instructor personnel who have recently returned from field assignments. As the tasks are analyzed into their constituent elements, the analyst should identify as completely as possible the qualifications required of an individual to perform the task. As he details an activity to be performed, he should ask himself, "What tells the individual when and how to do this?"; "Does this activity require the development of a perceptual or motor skill?"; "Does it involve problems to be solved, decisions to be made, or some other exercise of intellectual skill?"; "Does it call for a particular temperament?"; "What are the physical requirements?". Is this process time consuming? Certainly. Yet, it will require far less time, in the main, to identify qualifications while a job is being analyzed than it will for someone else to attempt to do it from the results of the analysis at a later date. In this application, a job or task analysis should be viewed as a process <u>during</u> which qualifications are identified and not a product <u>from</u> which they are identified.

The final step in the process is the application of qualifications data to the design of jobs. This process has not, so far as I can tell, been the object of lavish attention. As mentioned earlier, the systematic techniques that have been developed for weaving activities into jobs have been based upon current field practices and their primary input has been field frequency data. Unfortunately, the qualitative descriptions that emerge from an analysis of job qualifications are far less amenable to procedural handling than are simple frequencies. Yet, systematic procedures can be developed. The availability of computers places a powerful tool at the disposal of those who wish to tackle the problem. While it is true that human judgment will probably continue to play an important role in any job engineering process, computers, if properly utilized, can greatly extend the realm of man's judgment.

SUMMARY

This brief treatment of job engineering has attempted to make but two points. The first is that the primary basis for grouping work activities into jobs is the pattern of individual qualifications required to carry out the activities. These qualifications include knowledges, skills, motivational and personality factors, and physical characteristics. The second point is that in order to draw precise and valid inferences as to the qualifications that underlie a set of work activities, these activities must be analyzed in great detail. Only when we can identify the actual behaviors involved in the work can we determine the qualifications needed to carry it out.

REFERENCES

[1] Dreese, M. An Analysis of the Present Status of Qualifications Analysis in the Military Departments with Some Principles and Recommendations for Future Development. ONR Report ACR-41, Office of Naval Research, Washington, D.C., May 1959. p. 55.

[2] Silverman, J. A Computer Technique for Clustering Tasks. Technical Bulletin STB 66-23, U.S. Naval Personnel Research Activity, San Diego, Calif., April 1966.

[3] Campbell, G.M. A Standardized Task Format for Personnel Requirements Information System Methodology (PRISM). Research Memorandum SRM 68-17, U.S. Naval Personnel Research Activity, San Diego, Calif., March 1968.

[4] Potter, K.W., Tulley, A.T., Reed, L.E. Development and Application of Computer Software Techniques to Human Factors Task Data Handling Problems. Report AMRL-TR-66-200, Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio, December 1966.

[5] Systems Engineering of Training (Course Design). CON Reg. 350-100-1, Headquarters, U.S. Continental Army Command, Ft. Monroe, Va., February 1968.

5A(6). CAREER MOTIVATION OF ARMY PERSONNEL

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STUDY DESCRIPTION

The Franklin Institute Research Laboratories (FIRL) study described in this paper focused on the career motivation and subsequent retention of company grade Army officers with five or fewer years of service. The study was sponsored by ODCSPER, Personnel Studies Division.[1] The interdisciplinary study team included retired senior military personnel of the Army, Navy, and Air Force, psychologists, statisticians, applied mathematicians, computer scientists, a political scientist, and a systems engineer. The main result of the work with respect to job engineering was to provide constraints and offer guidelines for the engineering of officer's careers.

The thrust of the study's analytical processes was to model the Junior Officer as a decision maker with internal states manifested as feelings which are manipulable or controllable by variations on the input or stimulus variables (the environment). The desired output is the decision to participate (retention) and the change of state to a feeling of wanting to perform effectively (motivation). Junior Officer's duties were considered as principal components of the environment, but many other environmental elements also were included, for example:

Personal and family socioeconomic and demographic background;

Service status—source of commission, branch, MOS;

Compensation and benefit policies;

Housing and family-oriented factors;

Motivations for entry into service;

Education and training;

Interpersonal relations—senior officers, peers, DACs

Personal reference group—wife, parents, friends;

Social environment; and

Career counseling.

Of these elements, those over which the Army had some apparent or possible control were classed as <u>extrinsic</u> variables:

1. Retirement
2. Promotion policy
3. Housing
4. Medical Care
5. Dental Care
6. On-post schools
7. PX
8. Commissary
9. Pay
10. Frequent relocation
11. Geographical location
12. All fringe benefits
13. Travel opportunity
14. Educational opportunity
15. Type of duty assignment
16. Number of additional duties
17. Civilian educational opportunity
18. Opportunity to use Army training

[1] However, the views expressed in this paper are the author's and not necessarily those of the United States Army or the Franklin Institute Research Laboratories

19. Job content
20. Family separation
21. "Red tape"
22. Officer efficiency reports
23. Variety of duties
24. Free time
25. Opportunity for lifetime career

The internal states expressed as feelings were called intrinsic variables:

1. Sense of responsibility
2. Feeling of authority
3. Feeling of independence
4. Sense of achievement
5. Feeling of prestige
6. Sense of service
7. Sense of pride in Army
8. Feeling of adventure
9. Sense of challenge
10. Feeling of excitement
11. Sense of creativity
12. Diversity of experience
13. Order and system

Duties were a specific type of extrinsic variable and were handled differently. The problem is in understanding the multivariate relationships implied by Figure 1.

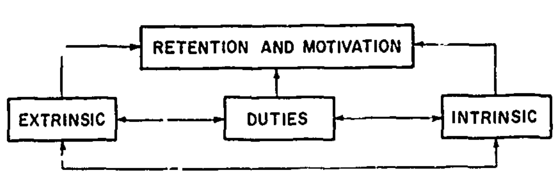

Figure 1. Integrated Retention and Motivation Models

The study process involved collection of data through an extensive questionnaire administered to nearly 4,000 Junior Officers throughout the Army (except RVN) and analysis of the data with techniques like stepwise regression, canonical analysis, multiple discriminant function analysis, Principal Components, Hotelling's T^2, various non-parametric techniques, and a specially developed heuristic Resource-Allocation or policy selection computer program. In addition to generating specific recommendations which have been submitted for Army action, the study created a well documented, integrated, extensive data base from which a large number of motivational and military compensation questions could be answered.

IMPACT ON JOB ENGINEERING

This background information on the study leads to the impact the study results have on job engineering. The study's major duty-related findings are presented here as guidelines and constraints on job engineering for the junior officer. The statement of these findings is followed by some overall conclusions drawn from these findings.

1. Except for the wife's attitude, representative of the ensemble effects of the hardship tour, relocations, and long hours, duties and duty-related factors are the most important predictors of career intentions; or, in terms of the discriminant function models, duties are the most important discriminator.

2. The concept of an officers MOS code is viewed, overall, as highly inconsistent with the junior officers' occupational interests and their civilian or Academy educations. The responding junior officers view the MOS as a means for classification and assignments. This is important in the light of comments as to the function of the MOS, and because much of the duty-related dissatisfaction was expressed as emanating from misassignment caused by the failure of the MOS to represent accurately an officer's education

and training.

3. Non-utilization of talents, especially for officers with advanced and technical degrees, was an important source of dissatisfaction. This is either an allocation problem or indicates a lack of the need of specialized talent for many duty positions. This question of talent utilization relates closely to the definition of an officer's functions and also may have some impact on the utilization of the drafted college graduate.

4. Generally, the officers who have firm commitments to either stay or leave have formed firmer preferences as to which duty positions are desirable for sound career progression, than have the officers who are as yet undecided. In order of preference, these duties are of a command, operations, or technological nature. Duty positions perceived to be of an administrative and/or clerical nature are generally undesirable duties for these officers. We suspect (the hypothesis has not been tested but the data are available) that a strong relationship exists between the officers' actual duty experiences and their career intentions, and that the officers committed to a career have had more than one tour in the command and operational level and thus see a bright career for themselves; the hypothesis suggests that a large number of the "leaving" officers have been devoid of command or operational experience.

5. These same preferred duties were also rated as satisfiers of intrinsic needs. For those officers who expressed duty satisfaction in this regard, the economic trade-offs of a military versus a civilian career were not important. However, in many cases the nature and extent of additional duties—described as meaningless and sometimes onerous—detracted from the satisfaction and motivation of even the more intensely committed officers.

6. Frequent relocation and movement from position to position—deemed necessary for career development—was said to detract from a sense of accomplishment or achievement.

7. Because of oversupervision, adherence to regulatory procedures, and the many meaningless and often onerous tasks, many junior officers lacked a feeling of challenge and accomplishment. Many felt that authority was not being delegated and that this decreased the prestige and status of the junior officer. If anything, the book, the supervision, and so forth, created an atmosphere in which the "challenge" existed in performing well in spite of the system.

8. Nevertheless, when present duty position was treated as a retention variable by itself, it was not a good discriminator of career intentions, but when present duty was treated in a career-related context it became a most important element in the decision-making process.

9. Finally, the officer who is committed to an Army career appears to understand how his present duty, cross training, the sometimes onerous task, a tour in the RVN, and the necessary frequent relocations play a part in shaping his career.

However, one of the problems is

that the supply of these officers is limited. Therefore, FIRL recommended to the Army that it undertake a multifaceted campaign to inform its people about itself. But beyond this, job engineering can engineer some of the clerical and administrative "sign for" tasks out of officers' duty positions.

But the definition of the officer's function remains the key issue. We talk of job engineering through the MOS, and that may be good for Army manpower management, especially enlisted, draft-induced manpower, but we should talk about career engineering for officers. An officer's primary function is managerial or, in the Army context, leadership. Let's engineer that back into duty positions. This task is a responsibility of the individual commander more than personnel managers, for leadership is developed by allowing the young officer to make decisions and judgments, and by delegating the authority by which these decisions and ideas may be implemented. But personnel management has a role in "career engineering" beyond that of information dissemination and assignment. Personnel management systems must consider the officer as an officer first and a specialist second. To this end, the MOS system, which apparently by accident has become a classifier of talent, must be modified so that it identifies an officer's talents but does not classify him to the point that his career progression is channeled along restricted paths or gives him the feeling that he has the right to be excluded from certain duty positions. And if adequate career counseling goes along with the suggested modification to the MOS system for officers, the misassignment dissatisfaction and the allocation problem will be diminished.

Of course, the risk is that the Army will fail to attract specialists into the officer corps, but since an officer's function is primarily that of a generalist, the Army will not lose much by losing the man so willing to "pigeon hole" himself. If officers' duty positions really call for specialists, than perhaps these positions can be engineered for the drafted college graduate or enlisted man. If then there are unfilled leadership positions which require special skills, the Army can train and educate the generalist into special skills. I suggest that the Army would do better teaching special skills to generalists (who may already possess other special skills) than making generals out of self-proclaimed specialists.

SESSION 5B
INDIVIDUAL DIFFERENCES, TRAINING AND THE DEVELOPMENT PROCESS

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5B(1). INDIVIDUAL DIFFERENCES, TRAINING AND THE DEVELOPMENT PROCESS

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Army response to the Brown Board report provides a foundation in regulation and procedure for significant improvements in manpower, personnel and training actions during major weapon system and materiel developments. These improvements are the somewhat indirect result of research efforts about which you are aware and in which many of you participated. The conceptual basis for these improvements is the notion of a personnel development subsystem operating as an integral part of the materiel development system. This concept was the result of human factors research and training research conducted by the military services in the early 1950's.

In specific terms these improvements in personnel development will be achieved by implementation of the regulation concerning the management process for development of Army Systems, AR 11-25, in general and regulations such as AR 602-1 and AR 611-1 in particular to name just two which are relevant to our discussion this morning. AR 602-1 establishes a human factors engineering program for man-materiel systems while AR 611-1 provides for MOS development and implementation as a part of personnel selection and classification. Crucial to achieving in practice the guidance provided by these regulations will be the policy and procedures established and followed by AMC, CONARC, and CDC. Coordination meetings on AR 602-1 have been held and the process diagrams or flow charts of activities presented in draft form in June at a conference sponsored by Army Research Office could be regarded as a draft personnel subsystem diagram or model to complement the rather complex diagram called the life cycle management model for Army systems. This latter model was developed by the Army staff to provide a basis for implementing the Brown Board and other recommendations concerning the development system.

Our two papers this morning relate to the personnel subsystem concept. To provide perspective for these papers and subsequent discussion consider Figure 1. The weapon system or materiel system under development will follow the management model for Army systems. The personnel subsystem for this development is a part of this model but must be expressed in greater detail as a model in its own right to define the manpower personnel and training actions which are essential to meet requirements of the management model. Training activities for the personnel subsystem can be spelled out in detail and depicted as another subsystem which can be represented by another model.

If the Army had several developments underway in a specific period of time, several system and subsystem diagrams could be shown to represent this condition. In any case these developments must interface another more general system which I will call the Army forces. Operation of the Army forces produces results to accomplish the Army missions and functions. The organizational elements making up the force and their capabilities, readiness, operational performances, or in general terms, their life cycles, represent primary management goals of the Army. Specific developments are only a part of this more general system. Supporting this more general system are still other systems, one of these is the general personnel system consisting of its major functions: procurement, training, distribution, sustainment and separation. This general personnel system, as well as systems representing other general staff management perspectives of the Army such as logistics and operations to name just two others, support the Army forces.

Our objective this morning is to examine and discuss the way the general personnel system and the training system feedback information into major developments and hence influence them. My paper aims at the more general personnel feedback factors, especially those resulting from individual differences while Harold Schulz presents USCONARC's systems engineering of training procedures and traces their feedback to the development cycle.

Our panelists are experts in Army selection and training research who will comment upon the papers and seek to provoke your discussion. Howard McFann has been conducting very valuable research in Army training, research often sensitive to the influence of individual differences among soldiers upon effectiveness of training. Ed Fuchs, as most of you know, is one of the Army's leading experts in classification research with extensive experience in aptitude testing.

Hopefully, we will identify rather specific information feedback requirements which should be available to development agencies and influence design. We intend to bring Army policy, procedure and research findings into the discussion as they are relevant.

333-404 O-69—17

5B(2). SYSTEMS ENGINEERING OF TRAINING: FEEDBACK TO DEVELOPMENT CYCLE

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PURPOSE

My purpose is to describe how training interacts with the development of new systems or materiel. While this presentation will emphasize the relationship of training to the development cycle, training is nonetheless considered an element of the more general personnel subsystem. Training is one of the specific elements in which the individual and his uniqueness receive deliberate attention. Recognizing and making accommodation for these differences in military weapon system development and training is a necessity if we are to utilize our manpower resources in the most effective and efficient manner. To that end I hope to describe and assess the evolving system life cycle management process as it exists today and review some potential improvements.

CURRENT SITUATION

A review of the current CONARC procedures for systems engineering of training and some of the Army regulations related to system management can serve as a base for our general assessment of the official guidance applicable to the feedback of personnel and training information. This assessment will establish areas associated with current directives that suggest a need for improvement.

The CONARC procedures for systems engineering of training were developed over a period of years. Two years ago an ad hoc committee was established to bring together in one volume as much of the then existing curriculum engineering knowledge and experience as was possible into a directive on course design. Last February the regulation was published. It is currently estimated that full implementation will require 5 years for the current 775 courses CONARC conducts.

The systems engineering procedure developed has seven elements. The first is the foundation on which the remaining actions rest - job analyses. It identifies all the jobs that must be performed in operation and maintenance of the weapon system. The source of this information is the QQPRI for new systems and military occupational information data bank for existing systems. The second element requires an evaluation of the task list developed to select those tasks and skills which require school training, those which can be anticipated as prerequisite and those appropriate for on the job training. Criteria are available to guide these judgmental activities. The third element is the step that bridges the gap between job requirements and the classroom. It is in this step that job and task requirements are converted to specific training objectives. These objectives are expressed in terms of the action to be performed by the student at the completion of the training period, the conditions under which he will perform the task and standards of performance he must meet. This step also includes sequencing and grouping these objectives. The next two steps are performed simultaneously by two different groups. One group prepares for the conduct of training by analyzing the training objective to determine the specific teaching points, and how they will be taught. It is in this step that the selection of method and media to be used is made. The need for part task trainers to be procured by the weapons systems manager would be identified here. Note how far we have progressed and the amount of data required to come to this decision point. It is in this process that the program of instruction and other training documents are produced. It is also the segment of the system where provision is made for individual difference. At present the Army has total courses which are individually paced. The other step which is being performed simultaneously is called testing. The criteria which are used to evaluate student achievement of the performance objectives previously described are developed in this step.

The next element is the conduct of training in accordance with the materials prepared. The final element in the system is quality control in which the product and process are evaluated by internal and external evaluators. The results of the quality assurance program are fed back into the system as required to improve the product and process within the existing constraints. This has been a brief and generalized review of the systems approach to training.

The systems approach has utility in upgrading existing courses and contributing to the development of new systems. We should note the differences between the two applications.

While upgrading existing courses with the hardware produced, the MOS and TOE established, the training literature published and the training devices in place may appear to limit improvement, but this has not been the case to date. Even under these circumstances significant improvements have been achieved in applications of educational technology, quality of graduate as well as reductions in training time. The potential for feedback to the weapons system manager from existing courses that are systematized is somewhat limited when compared to what can be accomplished for courses being designed for systems under development.

The contributions and feedback which training can make to weapons system development will be greatly facilitated by the Army Management System which is currently evolving. After the management process for the development of Army systems is fully established and implemented, the feedback from the Personnel Subsystem and its training element can have a significant impact upon the design of the system itself as well as upon organization, personnel, and training. For example, the personnel element would determine the kinds and numbers of personnel available and the final MOS and TOE structure to be used. With these initial personnel estimates and design concepts, the trainors can determine the initial dimensions and requirements for the training program; the feasibility of training the proposed kinds of people to operate and maintain a particular system concept; as well as estimating the lead time necessary for the training component. Based upon these considerations, interactions would take place - trade off studies would be made - and hopefully a balance would be struck between design, personnel, and training. To achieve the optimum benefits from such interactions, planning for training must commence in the initial phase of the development cycle which is the Concept Formulation Phase. Delaying authorized participation by personnel and training elements (as opposed to permissive participation) until the Advanced Individual Training Plan is about to be drafted in the Development and Production Phase is too late. The key decisions have been made by then and the irretrievable lead time needed for reaction is dissipated causing not only the training program to suffer but the total weapon system as well! While time constraints limit the number of specific examples, one is needed to illuminate this point. In a major weapon system the cost of the training program was expected to exceed 200 million, the cost of the major trainers approached 100 million. Because of delay in obtaining involvement it was necessary for the weapons system manager to appoint an ad hoc committee to evaluate the trainer program to see how its cost could be reduced and how the requirement could be fitted into the total production schedule at that late date. Trainors sat down with engineers to explore courses of action open. An outside consultant who evaluated the program made the observation that the exercise seemed to indicate that the question being asked was - what can the engineer produce in the lead time available? - rather than - what are the training requirements that the trainers must meet? Needless to say the trainers could not be made available for training the first classes.

The concept of providing for training feedback into the management process for the development of Army systems has been recognized for a long time, but finally received considerable impetus from the Brown Board. CONARC's recommendation that it be given a coequal status with CDC and AMC in System Status Evaluation has been approved. As a result, CONARC will be able to contribute a training dimension at these evaluations, a condition that has not existed in the past. Concurrently with the foregoing, the decision was made, to establish the management process for the development of Army systems, AR 11-25, as Dr. Hersh has mentioned. This regulation will be supported by a DA Pamphlet, Life Cycle Management Model for Army Systems, which will provide overall procedural guidance at the program manager level. This pamphlet is now at the printers and is expected to be available in the near future. Sequentially, the next documents required for system management are those related to systems engineering management. They are most significant because all subsystems must be related to and interfaced with systems engineering management.

To provide for both personnel and training feedback into system development, it is essential that documentation similar to that being developed for the Life Cycle Management System be provided for the personnel subsystem. Such guidance and direction should provide for personnel and training inputs early in the Concept Formulation Phase and describe the subsystem procedures. This is a summary of the current situation.

ASSESSMENT

What assessment can the present situation be given? How should engineering of training be assessed? First it must be clearly recognized that the evolving Life Cycle Management process is a major improvement and proceed from there. If a short range view is taken there is reason for concern. This is due to the lack of guidance in key areas and it will not be forthcoming for some time. For example, we cannot expect to see the System Engineering Management Procedures Manual until early 69. And presently the lack of a documented personnel subsystem precludes the full consideration of personnel and training considerations in the Concept Formulation Phase where the overall system requirements are established.

In the longer view however, there is justification for optimism which stems from the desire to improve the current system. At all levels those concerned with the development of system management procedures have a keen awareness of the scope and breadth of the problem and a recognition of the fact that the first round of directives will leave much to be desired. ACSFOR, CDC, and AMC are already providing for a complete reevaluation of the directives as soon as they have been given an adequate field test.

The same positive point of view is also being taken by the personnel and training components of the system. They are actively engaged in following the development of this new management system. The need for a Personnel Subsystem Management is recognized as you can determine from the two papers presented this morning. The task that remains is one of preparing the management procedures for a personnel subsystem that can properly interface with system engineering managemenc.

A POTENTIAL SOLUTION

It is not intended to create the impression that we have found a new problem. The problem of introducing new equipment into the Army, Navy and Air Force is a long standing one with each service experiencing similar problems in the training element. The Secretary of the Army recognized the problem and in 1965 approved a research requirement to investigate Human Factors Development Program Procedures for New Army Systems. The contract was awarded to the Systems Development Corporation by OCRD, and the study was conducted during the period 1 July 1965 and 31 July 1966. The report of this study is titled - "System/Project Management, Procedures for Integrated Management of the Human Factors (Personnel-Related) Aspects of Army System Development."

The specific problem investigated by this study was that of the management of the human performance or the personnel subsystem development process for large Army systems. It developed the interrelated, time-phased activities necessary to insure that human performance aspects of Army system development are planned and accomplished as an integral part of overall system planning, development, test and evaluation. This is depicted in flow diagrams supported with a narrative of each activity or event for the necessary human performance development activities, their relation to one another and to the major project management functions, in four phases of the system life cycle. In addition, the study includes the identification of data items needed to define necessary contractor-furnished information as well as proposed Army regulation to establish a policy of integrated development of the personnel subsystem elements of Army systems being managed under the provisions of AR 70-17, System/Project Management. The following are excerpts from the recommendations in the study. I will present the excerpt and comment where appropriate.

• Develop an integrated set of project management procedures, including a detailed treatment of system engineering management.

Comment: This recommendation is now being implemented.

•Insure that educational programs for potential Project Managers emphasize that his responsibilities include that of support planning.

Comment: The qualifications of the Project Managers staff is covered briefly in AR 602-1, "Human Factors Engineering Program."

•Training - No major changes are recommended in the manner in which New Equipment and Resident Training are carried out. The following recommendations are aimed toward assisting the commands by creating new opportunities for planning and coordination:

a. An Advanced Individual Training Plan would be prepared for each new project.

b. Because of the existence of a Human Factors Team in Project Managers Office (recommended elsewhere in the study) those responsible for resident training could have virtually continuous access to information about engineering, production and schedule plans, and changes.

Comment: This concept is consistent with AR's 70-17 and 602-1.

c. Training requirements studies would be accomplished in the Concept Formulation Phase by in-house personnel and in subsequent phases by contractor personnel. Initial training device requirements would be established during the Concept Formulation Phase.

Comment: Today we are paying the price for the lack of such studies and the early determination of requirements.

d. Training requirements studies would be closely coordinated with and would be supported by Qualitative and Quantitative Personnel Requirements Information.

e. The principal impact of Personnel Subsystem Team within the Project Managers Office would fall on the developmental aspects of training and on the quality of contractor training assistance. Competence in this area would be assured by the preparation of contract work statements by professionally-qualified individuals, by requirements for adequate contractor human factors staffs, and by monitoring of contractor technical performance.

•Organization and Personnel Requirements

a. Establish standardized procedures and documentation for use in developing Qualitative and Quantitative Personnel Requirements for the Army.

Comment: Several of our regulations refer to QQPRI but nowhere do we describe it. An Air Force Military Specification is available and could be used as a starting point in preparing an Army specification.

b. Standardized procedures should be formalized for the determination and coordination of manpower requirements, training considerations, unit manning, and organizational changes between the appropriate agencies and commands; such as AMC, OPO, CONARC, and CDC. These procedures would be implemented by the Personnel Subsystem Team recommended for establishment within the Project Managers Office.

The depth, detail, and logic of this study make it a suitable reference and point of departure for the development of an Army personnel subsystem.

CONCLUSIONS

In conclusion it must be reemphasized that people are a significant factor in each weapon system. Thus in the management process for the development of systems, a personnel subsystem must be identified and utilized throughout the total system life cycle to provide for the necessary personnel and training contribution. The system life cycle management process is now evolving, and provision for personnel and training feedback is anticipated at this time. Procedures for such participation and interaction are not yet established. Indeed a complete personnel subsystem with supporting documentation that ensures the inclusion of the personnel and training feedback throughout the entire life cycle management process is required to achieve effective and efficient manpower utilization.

REFERENCES

(1) McGuire, Kester, Parsons and Douglas, System Project Management, Procedures for Integrated Management of the Human Factors (Personnel Related) Aspects of Army System Development, System Development Corporation, TM 2908/000/01, 27 July 1960. (AD 487243)

(2) United States Air Force "Data, Qualitative and Quantitative Personnel Requirements Information (QQPRI)", Military Specification, MIL-D-2639A (USAF), 14 April 1961

(3) United States Continental Army Command "TRAINING Systems Engineering of Training (Course Design)," CONARC Regulation 350-100-1 with Change 1, 1 February 1968, change dated 28 May 1968.

5B(3). CAREER DEVELOPMENT OF INDIVIDUALS: FEEDBACK TO DEVELOPMENTAL PROCESS

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PURPOSE

My purpose is to identify the types of organizational, personnel and training factors which should influence major new system or materiel developments. I aim to highlight the Army as individual people and as small operational teams or human groups in contrast to the mechanistic view often expressed by hardware experts. Differences among soldiers in their social background, aptitude, training, performance capability, motivation, morale, and career objectives should influence system design. Individual differences take on added importance when men perform missions together as members of small units or teams. These group factors should influence system design also since they contribute so much to successful combat performance.

ALLOCATION OF TASKS

To provide a framework for discussion, assume a materiel or weapon system development is underway. Basic decisions assigning tasks to man or to machine are made rather early in concept formulation in connection with trade-off analysis and unit structure. Consider a small Army unit, say platoon size, and the enlisted jobs to be established in the new system or new materiel development. To achieve a set of specific operational capabilities called for by doctrinal considerations, a list of unit missions must be stated. To achieve one of these missions a specific set of performance capabilities is needed. Various sets of tasks, actions, or performances, call them what you will, can then be designed to obtain each performance capability. For each specific set of tasks considered in the early stages of design, decisions must be made as to what performances to assign to a human and what performances to assign to a machine or item of equipment. Some of these human performances are then grouped to become requirements for one proposed duty position, others for another. The several duty positions are grouped into squad or team requirements and soon we have the rudimentary human requirements for an organization, ideally, with performance standards for each individual or group performance.

Allocating tasks to man rather than machine, grouping human performances into duty positions and duty positions into military occupational specialities, establishing standards for individual and group performance, and all similar decisions have significant influence upon subsequent personnel and training activities of the Army. The question for us this morning however, is: What factors should be taken into account as these decisions are made? This question implies the need for a feedback system from operation of the general personnel and training systems to the new system research and development cycle.

AVAILABLE SKILLS

The new Army policies resulting

from Army response to the Brown Board call for more systematic consideration of personnel and training factors during the development cycle. These factors are in addition to standard anthropometric, safety and health considerations. The policies force researchers and human factors engineers to focus their interests and activities on a wider horizon. This movement within the Army is part of a general trend.

Eckstrand, Askren and Snyder (1) reviewed the historical development of human factors activities in the military and concluded we are entering a new phase, that of controlling the determination of human resources requirements during the earliest stages of system development. They anticipate that the developer will require information on the present inventory of human skills available in the Army for example and on those expected to be in the inventory in the future. Such information would include kind, proficiency and quantity of human skills as well as the cost of producing and sustaining them. This information would be used in design considerations and influence the allocation of tasks to machine or human so as to establish human requirements achievable within the manpower or personnel system and within prescribed limits.

As I understand the Army life cycle management model, a feedback of such information from the general personnel system to the development system is now expected. Without it the trade-off analysis and unit structure determinations could not be made during the concept formulation phase. Subsequent development phases permit successive improvements to add greater detail and certainty to such considerations. The procedures and quality of performance of these steps may be rough-and-ready at first but as experience grows, the long run benefits can be substantial in contrast to the earlier types of human factors programs which Eckstrand called the reacting phase when personnel and training planning occurred only after hardware development was complete, and its successor the predicting phase when personnel and training planning occurred during development but had little or no impact upon development. It is far better to seek to use our knowledge of present and planned future force structure and available human resources to guide weapon system and equipment design than merely to develop the hardware first and react in haste to provide the human resources or merely to follow the steps of hardware development to sum up whatever future human requirements happen to accrue.

The Office of Personnel Operations is establishing a military occupational information data bank which can supply part of the necessary feedback. The Department of Defense is developing a personnel and training cost model which should result in more systematic Army cost information to provide the developer. The Army staff will be in a position to provide more useful summary statistical data upon the personal characteristics of available human resources and those which can be allocated for a specific new system as planned ADP systems are achieved. In general, however, we need to establish practical means for accomplishing this information feedback.

INDIVIDUAL DIFFERENCES

There are additional factors to take into account in design of materiel or systems, Gagné (2) identifies five factors for actually establishing in the field the performances allocated to humans during design of a system. Each factor influences the establishment of the desired human performance in the behavior of the individuals who are to use the system. Ideally, any set of required tasks should be analyzed by each of his factors. These are: the steps required to learn the task, the motivation needed to perform the task, the degree of attention needed to determine when to perform the task; adequate individual capability to perform the task, and sufficient environmental influences to tell a man when to perform the task. These factors are somewhat broader in scope than the usual viewpoint of human factors engineers.

This list of ways of analyzing tasks identifies important kinds of information about the personnel and training subsystems which should feedback into, and control, design decisions during development. For each of these factors, individuals constituting the available human resources or those anticipated for the future will vary widely in their ability to be trained and used in the field to establish the desired man-machine performances. Percentile distribution of these factors among individuals and explicit standards for system design may be within our technical grasp provided researchers and human factors people close in on these types of factors.

DESIGN OF PRIMARY GROUPS

Janowitz and Little (3), among others, point out the significance of primary groups in obtaining effective military performance in combat. Individuals obtain motivation to perform their assignments from values based upon associations with their squad or team members. HumRRO has conducted studies of Infantry, Armor and other types of squad operations and small unit operations. They have also examined leadership within such small primary groups in the Army. BESRL has conducted laboratory research on individual and group performances in small team operations with a view as to how primary group behavior should influence equipment design in target acquisition and image interpretation.

In Army developments the Combat Developments Command should use the results of this type of research as its doctrinal input and as a basis of control during the early phases of concept formulation. As the development progresses there should be constant review, simulation or trial, and ultimately test and evaluation of the primary group design for the system to be sure that group performance under field conditions meets the operational capabilities set for the system.

Revision of the allocation of tasks to man or machine, to one duty position or another, to one MOS or another should be made to produce a high level of primary group performance. On-the-job training standards for individual performance, standards for unit performance and similar team or squad standards, if determined early enough, should influence design of equipment, tools and job aids. Planning is needed to produce an environment within which primary group personal relationships essential to combat success can be established.

If the primary group structure is not sound the personnel system cannot sustain the force units effectively from the human resources available, no matter how well individuals are trained or assigned. Morale and retention problems may have their roots in inadequate attention to the design of the squad and unit social and psychological structure. Of paramount concern in an organization as large as the Army with such a broad spectrum of individual members is the ability of the work groups to utilize the kinds of individuals available. High rates of personnel turnover must be anticipated.

New accessions under Project 100,000 and the current influx of college graduates illustrate the flexibility needed in new system planning. The mix of military and civilians in certain types of support units illustrates another dimension of this problem. The unit structure must be planned to absorb these kinds of variations among individuals and the personnel turbulence usually found in field conditions.

CAREER DEVELOPMENT

A Defense Department military compensation study (4) has recommended a new pay structure for career soldiers. By June of 1969 the Army, as well as the other Services, must anticipate the number of career soldiers needed in each occupational area (5). Very likely, there will be continuing efforts to provide more effective career management of individual soldiers in the future.

Job analysis, job evaluation, and MOS decisions during new system development should anticipate the system's impact upon the career structure of the Army and require design of duty positions which will fit into a viable structure.

The performances required of soldiers in duty positions designed for a new system should include the necessary military duties within the unit. The total of all the duties should provide a challenge to the kinds of soldiers available for duty since job satisfaction is one of the key variables in individual development.

As individuals are reassigned, retrained, and educated as NCO's the sum total of duty position requirements in an MOS group must sustain a segment of the enlisted career force. There must be consideration of losses and gains and the transition from military to civilian occupations, as well as the initial transition from civilian to military life.

The Army's long range best interest is to provide a way for individuals to develop to their full potential. The design of new systems should be controlled to assist us toward this goal. An intensive and specific flow of information between the research and development cycle and the general personnel and training system should be devised to make this control possible.

CONCLUSIONS

In conclusion, I want to point out to you that there should be no arbitrary separation or compartmentalization between human factors or human engineering of new systems on the one hand and the continuous operation of the career development system or the general personnel and training system which sustains the operating force on the other.

Human factors experts and personnel experts will have to broaden their horizons and include the results of Army research in manpower, training and personnel in their thinking. Findings in social psychology are as important as findings in individual psychology. We must design and plan for an Army which is much more than the summation of all the man-machine performances of our hardware.

REFERENCES

(1) Eckstrand, Askren, and Snyder, "Human Resources Engineering: A New Challenge", Human Factors, Vol. 9, pp 517-520 (Dec 1967).

(2) Gagné, Robert M., "Factors in the Establishment of Human Performances", in W. N. Jessop (ed), Manpower Planning, New York: American Elsevier Publishing Co., 1966.

(3) Janowitz and Little, Sociology and the Military Establishment (revised ed.), New York: Russell Sage Foundation, 1965.

(4) Department of Defense, Modernizing Military Pay, Washington DC: Govt Printing Office, 1 November 1967, Volume I Active Duty Compensation.

(5) Department of Defense Instruction Number 1300.10, Enlisted Career Development and Grade Management Information Program, June 15, 1967.

5B(4). DISCUSSANT ON PAPERS BY C. M. HERSH AND H. A. SCHULZ

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In the presentations by both Dr. Hersh and Mr. Schulz, I was impressed not only by the calibre of the presentations but more importantly by the breadth of material covered. I would like to speak of two areas that Dr. Hersh emphasized. First, the need for a much broader scope of human factor considerations in the development of new systems; and second, the effects decisions of one part of the manpower personnel system has on other parts as well as on the development of new weapons systems. As indicated by his summary slide, he made the case for human factors influencing the development of new weapons systems and equipment design in a variety ways. To influence design by considering in addition to anthropometric, safety, and health factors, the kind and quantity of skills required, the primary group requirements as well as individual difference characteristics and capabilities. He posited these factors have to be considered not only in allocation of tasks to men and machines, and in allocation of tasks to jobs, but also they must be related to the manpower pool, to training, and to career development.

Although I endorse and recognize the desirability of what Dr. Hersh has sketched out, I do feel uneasy about our present capability to undertake such an enormous effort. Possibly, my stating some of the reasons for my feelings of uneasiness will serve as a catalyst for further discussion.

One area of concern centers around the state of knowledge, the technical competence, and the number of we human factors types available to meet the commitments described by Dr. Hersh. The other area of concern centers around the recognition of the fluid ever-changing system proposed. My concern here is one of management process to insure timely information flow of human factor data and flexibility to changing requirements during the 'life cycles' of new development. Some specific examples may help. In Mr. Schulz's description of the systems engineering approach, he covered some of the management procedures that need to be developed and implemented. He also pointed out how effectively the systems engineering approach has been used to date in upgrading systems in being and its potential contributions and feedback possibilities to new weapons system development. He mentioned that the foundation of systems engineering is job analyses which is based upon the QQPRI. He also stated "the personnel element would determine the kinds and numbers of personnel available and the final MOS and TOE structure to be used." I wonder: By whom and on what basis does the QQPRI get established, and by whom and on what basis will it be decided that tasks or performances will be assigned to man or machine; what criteria do we have to offer on grouping tasks into proposed duty positions and MOS; on what basis can we state the characteristics of the primary groups which should be formed; in what manner and how does one describe the kinds of personnel available. I am not talking about directives or procedures here, as important and critical as they are; I am talking about psychological knowledge and technology. It appears to me that much attention needs to be given to systematizing and codifying the state of knowledge and technology which bear upon the above questions so what we do know can be utilized effectively. In so doing, I am confident large lacunae will be exposed which can point the way for undertaking critical research as well as providing support for needed on-going research efforts. As Mr. Schulz pointed out, once training objectives have been determined and performance standards delineated there still exists the problem of developing the instructional program. Although there is much to be learned about the topic, it is apparent that in developing an instructional program individual differences must be taken into account. They type of content to be learned, the organization and sequencing of material, the method of instruction employed, the media used, and the incentive system chosen all appear to relate to ability and aptitude level. The initial allocation of jobs and the determination of who will be trained for what will have a decided impact upon cost and efficiency of training.

Although the trend both in training and in personnel management is toward greater individualization and personalization, I feel much effort is needed in developing strategies to make them more compatible. Strategies to insure that the trainee is cognizant of the consequences of quality performance and that high calibre performance does result in rapid career development and positive consequences to the individual. As new systems are developed, I would urge close contact between those responsible for training and those responsible for career development. Too long we have talked about motivation without employing the more effective management procedures to capitalize on its potential in acquisition and maintenance of behavior.

One point that Mr. Schulz made I feel has particular significance. He stated that the present estimate is that full implementation of systems engineering to the current 775 courses CONARC conducts will require 5 years. Again, I would ask who is going to handle the new systems? It is apparent that quality personnel are going to be required to work on training development to do the human factors analyses of new systems, and to spell out the characteristics and capabilities required for new systems. I wonder from whence the qualified personnel are coming or how they are to be developed. I also wonder who will manage so as to insure that the various operational forces mesh and that there is a profitable interchance between operational and research human factor types.

Although I have raised many questions, may purpose in so doing is in the hope that we can anticipate and possibly reach some resolution on some of the problems that must be solved to insure that manpower considerations are part of new weapon systems design.

5B(5). DISCUSSION OF INDIVIDUAL DIFFERENCES IN TRAINING AND IN THE DEVELOPMENT PROCESS

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The interesting presentations by Dr. Hersh and Mr. Schulz on the developmental process of materiel and organizations reminded me that one of the problems in anticipating personnel requirements is the developmental process which takes place with respect to people themselves. We are all aware that each individual develops with age and experience, but I am referring to development of the population. One of the advantages of continuity of research is that it becomes possible to make comparisons across time spans. BESRL studies indicate that we need to recognize the changes in population parameters when there is a significant time span between the collection of the data on which we base our estimates of personnel characteristics and the projected implementation of the system under development.

EDUCATION AND TEST SCORES

In a broad sense, the population development becomes evident in comparing the relationship of test scores to level of education from World War I to World War II to the 1960's. The total level of education increased considerably from World War I to World War II and has again increased noticeably from World War II to the 1960's. The modal educational group in the World War I draft was at eighth grade with more than one-fourth of the sample at that level. By the time of World War II the enlisted input showed a modal level of twelfth grade, with more than one-fourth at that level. However there were so many with less education that the median was at eleventh grade. By the 1960's the twelfth grade or high school graduation had become the median as well as the modal level with about one-third of the sample. We can clearly expect that the level of formal education will show further increase in future years.

However, the relationship of educational level to test performance shows a somewhat more complex relationship. In the World War I sample, almost all high school graduates achieved test scores above the World War I average. The overall test performance of the World War II sample was somewhat better than in World War I, and so the high school graduates tended to do a little better than their counterparts in World War I in terms of absolute scores, but not relative to the norms of their own time frame.

With the young men of the 1960's we find the shift going farther. The increase in educational distribution is not matched by an increase in the test score distribution. We find considerable variability in the test score distribution of high school graduates with only a little more than half the men with twelfth grade education showing scores above the 1962 average. It seems likely that the projected increase in education will not show an increase in test scores for any given educational level.

TEST VALIDITY IN THE ARMY

A recent set of BESRL studies touches on a more complex development of differences in test significance for enlisted men. This has to do with the interrelations of the Army Classification Battery (ACB) test scores and performance in the wide variety of MOS training programs required by the US Army. In data accumulated about 1955 we found that these interrelations were such that we could develop an effective set of composites or aptitude areas by using only two tests in each composite. The resulting set of aptitude area scores gave very efficient discrimination in the aptitude levels of an individual and yet each composite accounted for most of the validity which we could squeeze out of all eleven tests of the ACB. In 1965 we collected data on about 25,000 enlisted men trained in over 100 MOS courses. This time we found that effective prediction of MOS training performance requires composites of three or four tests and that each composite has a significant general factor included. This general factor is reflected in such tests as the Verbal test and the Arithmetic Reasoning test of the ACB. These results are consistent with comments presented from some Army schools in the past five years on a greater need for general factor measures in the selection of students for their courses. The results show that the comment applies to all schools and training centers.

We still have eight aptitude areas but the indication is that we do not have as sharp a differential in the aptitude levels of an individual. We will get more validity and have less likelihood of error in a particular qualifying score in this new system. This should help to clear up some problems which have arisen in training programs which receive many Project 100,000 or New Standards students who have difficulty in keeping up with their course work. The shift in the validity patterns from 1955 to 1965 suggests that there are variations in the training and development of young men at different time frames.

IMPACT ON PLANNING

These shifts in education and validity patterns are but a couple of instances which suggest that the personnel subsystem elements for systems projected five or ten years in the future might well consider the characteristics of enlisted personnel in the projected time frame. It is especially important to consider factors which change the relevant portion of the population. For example, a peacetime system should consider the characteristics of young men we can get to enlist voluntarily and the environmental factors we would have to consider in the treatment of these men if we want to enlist and retain a more capable segment of the population of young men in this country. More research is needed for projections such as these.

333-404 O-69—18

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APPENDIX 2

CURRENT WORK PROGRAMS, BIBLIOGRAPHIES AND BIOGRAPHICAL DIRECTORIES OF PROFESSIONAL PERSONNEL OF HUMAN FACTORS RESEARCH AND DEVELOPMENT ACTIVITIES OF U. S. ARMY AGENCIES

2A. U.S. ARMY BOARD FOR AVIATION ACCIDENT RESEARCH

Fort Rucker, Alabama 36360

INTRODUCTION

Location at Fort Rucker, Alabama, USABAAR was established and organized in 1957 as a Class II activity of the Assistant Chief of Staff for Force Development. Its mission, as defined by AR 15-76, is to conduct research of worldwide aviation accident and related experience to determine where improvements can be made in aviation materiel, operations, supervision, personnel, and training. Based on this research, the Board recommends appropriate action to enhance the durability, reliability and efficiency of Army aviation, particularly in its combat environment. Unlike most research organizations, USABAAR is not funded by each specific project. Instead, it is given an annual appropriation from Operation and Maintenance, Army funds.

WORK PROGRAM

1. Program includes on-site investigation of Army aircraft accidents and continual review and analysis of accident investigation reports. The purpose of this program is to learn about the human component of accident prevention, since people plus hardware equal accidents. Inherently the accomplishment of this objective encompasses the broad spectrum of human factors indicated by the following areas:

a. Physiological - physical stress in flight; fatigue; sensory organs, vertigo and illusions; physical fitness, injury causation and prevention, and autopsies.

b. Psychological - man-machine relationship, experience and knowledge, psychomotor skills and errors, attention and errors of judgment, training and selection.

2. The data gathered in the cited areas are for the primary purpose of enhancing the mission capability of Army aviation. The data are used widely, including the earliest stages of the life cycle of new aircraft, the modification of existing aircraft, and as a source of feedback of training and operational programs. In addition, the data are used in the preparation of reports, presentations, and justification for new specifications and regulations or revisions to existing ones. Some

of the specific accomplishments of the past year are:

a. Equipment Evaluation

(1) Flight Clothing

(2) Survival Equipment

(3) Fault Location Audio Warning System

(4) Crash Firefighting and Rescue Study

(5) UH-1 Noise Level Evaluation

(6) Disorientation Study

(7) Helicopter Bailout Feasibility Study

(8) Proximity Warning Indicator

(9) Checklists for Crewchiefs and Gunners

(10) Research on Structural Integrity of Aircraft Seats and Cushions

(11) Crash Resistant Fuel Cells

b. Safety Education Media

(1) U.S. Army Aviation Digest

(2) Weekly Summary of Army Aircraft Accidents, Incidents, Forced Landings, Precautionary Landings, and Share-its

(3) Monthly Maintenance Summary of Army Aircraft Accidents, Incidents, Forced Landings, and Precautionary Landings

(4) National Guard Monthly Summary of Aircraft Accidents, Incidents, Forced Landings, and Precautionary Landings

(5) 1968 Aircraft Accident Prevention Survey

(6) DA Pamphlets

(7) Flight Surgeon Letters

(8) Posters

(9) Flight Safety Foundation GASE Bulletins

(10) OV-1 Accident Summary

(11) UH-1 Accident Summary

(12) Emergency Landing and Ditching Techniques in Helicopters

(13) What To Do and How To Report Military Aircraft Accidents

(14) CH-47 Accident Summary

ORGANIZATION

The human factors effort is closely coordinated with the other functions of USABAAR in order to cover the spectrum of human factors as a source of causation in aircraft accidents.

2B. U.S. ARMY MATERIEL COMMAND ELECTRONICS COMMAND

Fort Monmouth, New Jersey 07703

A. Task 1TO 62106 A 121 C3 - Commodity/Materiel Development-Human Factors Engineering.

Establishment of Design Criteria for Communication Equipment Based on Operator Needs.

This survey initially reported in the Thirteenth Annual Army Human Factors Research and Development Conference report has been continued during FY 68. The original questionnaire on operation of portable radios has been modified and amplified as the result of preliminary testing. During FY 68 the revised questionnaire was administered to almost 200 combat soldier-users in Vietnam. The responses have been punched on automatic data processing cards and are now being analyzed. The final report will be issued during FY 69.

B. Human Factors Engineering Support to the USAECOM and other AMC organizations.

The principal effort of the Human Factors Engineering Section, R&D Directorate, continues to be the day-to-day support given to the USAECOM Laboratories and other AMC organizations through 118 reviews of QMDOs, QMRs, SDRs, Development Description and Technical Requirement coordinations, bid evaluations, including membership on Source Selection Evaluation Boards (SSEB) design plan reviews and visits to the contractors' plants to monitor HFE progress. Some of the significant HFE activities were:

1. TACFIRE - Membership on SSEB and HFE monitoring of contract.

2. CEFIRM LEADER - Review of specifications and memberships on SSEB.

3. FATT - HFE monitoring of preliminary contracts and memberships on SSEB.

4. MALLARD - Memberships on SSEB.

5. AN/TPQ-28 - HFE monitoring of contract.

6. STAG - HFE assistance and review of specifications.

7. TADSS - HFE assistance and review of specifications.

8. AN/TCC-25 - Membership on SSEB.

9. Tactical Avionics System Simulator Study of Simulated Landing of the Cheyenne (AH-56A) Helicopter.

C. Task 1H1 3401 D 235 15 - Instrumentation. The following work is being conducted by the Avionics Laboratory.

1. Current Instrument Evaluation.

This sub-task is concerned with the experimental and comparative evaluation of all types of current industrial instrumental developments applicable to current rotary wing aviation through part task and full dynamic simulation and flight evaluation information. The data derived will be utilized to implement selected replacement of instrumentation for UH-1 type missions.

2. Advanced Function Display/Control Components and Techniques.

This covers a program for the functional display/control components and techniques for navigation, flight control, take-off, hover, landing and tactical information for rotary wing aircraft now under development or planned.

3. Integrated-Function Display/Control Systems.

This program covers development of Intergrated-Function Display Panels for the execution of the assigned missions of the next generation of rotary wing aircraft, the missions of which include observation, reconnaissance/surveillance, fire support, cargo and personnel transport.

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2B. U.S. ARMY MATERIEL COMMAND HUMAN ENGINEERING LABORATORIES

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A. CURRENT WORK PROGRAM

1. Systems Research

The work program of the Systems Research Laboratory falls into four broad, related categories:

a. Applied research of a general nature related to a class or classes of Army materiel.

b. Design studies in support of concept feasibility and effectiveness analyses.

c. Direct systems support in the application of existing data and monitoring of industrial contractors' efforts for human factors engineering.

d. Human factors engineering data storage and retrieval, and preparation of human factors engineering standards and design guides.

The work is accomplished within three branches (Weapons; Aviation; Missile, Communications & General Support) and a Technical Specifications Office.

a. WEAPONS BRANCH

This branch is responsible for the accomplishment of human factors engineering of Army weaponry falling the following classes: infantry (such as small arms), antitank guided missiles, artillery (all but missiles), armor, combat vehicles, and fire control equipment. In order to accomplish this mission, the Weapons Branch performs the following functions: (1) conducts applied research necessary to quantitatively describe man's performance associated with the tasks performed in the operation of weapon systems; (2) conducts parametric weapon design studies during weapon systems feasibility or concept stages whereby the performance associated with particular weapon design parameters is described; (3) applies established human factors engineering data to weaponry during the RDT&E cycle and monitors industrial contractors; and (4) conducts comparative evaluations of weapon systems by field and laboratory experiments simulating the more important elements of the combat situation.

Current work is delineated and described below in three basic areas: applied research, design studies, and systems support.

(1) Applied Research

Task	Experimenter(s)	Date Started	Estimated Completion
Stress and Weapon Design	Torre	FY68	FY70

The objective of this task is to develop methodology for the quantitative assessment of longitudinal man-weapon performance as a function of selection, training, environmental exposure, stress, and weapon design parameters. Quantitative descriptions will be made of human performance in the operation of weapon systems under conditions simulating the predominant environmental and psychological aspects of combat situations.

Studies have shown that human performance and underlying physiological measurements changes as a function of stress exposure. The reported changes, however, are often contradictory. The current approach is to establish realistic baseline data on the physical, physiological, and psychological aspects of representative user populations and attempt to establish their longitudinal interrelationships under combat stresses. Combat stressors could take the form of being subjected to the fire from a BB gun (HEL TM 5-66) or probability of exposure to tear gas, etc.

Target Detection Studies	Gschwind	FY67	FY69

The objective of this task is to determine target detection probabilities associated with armor engagements as a function of communications, multiple targets, target signature, target range andother parameters. These data are used as inputs to computer simulation studies and other analyses of weapon systems.

Full-scale field studies using tanks, tank-gun simulators, boresighted movie cameras and trained armor personnel provide the primary data on detection probabilities.

(2) Parametric Design Studies

Task	Experimenter(s)	Date Started	Estimated Completion
Vehicle Fire Power	Gschwind	FY67	FY69

The objective of this task is to provide data on the delivery accuracy and rate of aimed fire for Vehicle Rapid-Fire Weapon Systems and Vehicle-

Mounted Machine Guns.

Field studies have been conducted on the MICV-65 and a 20mm cannon on an M113 to determine small arms accuracy and stabilizer effectiveness. Future studies will examine the effects of vehicle weight, firing impulse and rate of fire on the time to acquire and hit targets.

Laser Safety Research	Mullen	FY68	FY69

The objective of this task is to determine empirically the ability of an optically aided laser operator to detect the presence of troops in his field of view while carrying out simple and complex tracking tasks and, given that a detection is made, to measure the time required to respond to the presence of the troops.

Operational settings will be simulated as realistically as possible. Stationary and moving targets will be employed. Measures of detection time and recognition time will be obtained by means of a suitably instrumented 16mm camera. Independent variables will include intruding target size, intruding target velocity, and ambient light level.

Troop Posture	Gschwind	FY67	FY69

This task is designed to evaluate the audio warning preceding incoming artillery, to determine the troop posture as a function of time after the warning, and to measure the vulnerable area of troops as a function of their posture.

Warning is measured by microphones in the impact area during firing tests. Posture and cover are measured by photography during field tests of troops responding to a warning.

Tracers	Kramer	FY67	FY70

The objective of this task is to determine whether or not tracers provide a measurable benefit to the infantry squad. The amount of improvements and the circumstances under which the improvements occur would then be specified. Performance aspects to be considered include not only effectiveness (i.e., hit probability and rates of fire or engagement), but also signaling communication or target designation.

A thorough literature review will be completed and any pertinent data will be analyzed. Data from recent CDEC field experiments will be reanalyzed, if appropriate, to provide information regarding effectiveness. An extensive series of field studies, probably utilizing only standard tracer ammunition, will then be conducted to provide the data necessary to answer whether or not tracers provide a measurable benefit to the infantry squad.

Pistol Effectiveness Studies	Ellis	FY67	FY69

These studies are designed to determine the effects of pistol design parameters on accuracy and rate of fire. The information will be used to predict pistol effectiveness as a function of such design parameters as weight, noise, center of gravity, sight radius, impulse, overturning moment, trigger-pull force, and configuration.

Both laboratory and field studies will be conducted in a parametric manner to isolate the efferts of various design variables. A three-phase program is planned. Phase I will be a non-firing situation in order to obtain baseline information on the effect of pistol design parameters on hold and aiming errors. Phase II will consist of a firing program in which such design parameters as weapon impulse, overturning moment, etc., will be varied in order to determine the aiming error and rates of fire associated with them. Phase III will consist of quantitatively describing the dispersion associated with firing multiple rounds per trigger pull in order to increase the probability of hit, assuming the aiming errors obtained in Phase II are extremely high even with an optimization of weapon design parameters. As a part of this phase, an attempt will be made to construct a mathematical model which will describe the relationship between pistol design parameters and weapon dispersion.

Operational Assessment of Man/Tank Interaction--MBT-70	Eckles Dickinson	FY65	Continuing

The objective of this task is to assess man/machine performance in an operational situation in order to evaluate the effects of equipment design characteristics on total system performance.

Field investigations under both controlled and free-play quasi-combat conditions will be conducted to assess the influence of various equipment design parameters on effectiveness of mission performance by the total man/machine system. This will require establishment of baseline data against which the effects of equipment design changes on total system performance can be evaluated. Data will be extrapolated to predictions bearing on potential combat performance of the MBT-70.

(3) <u>Systems Support</u>

SEA NITEOPS	Garry	FY68	Continuing

The objective of this task is to insure that effective human engineering is performed on all ground-to-ground SEA NITEOPS systems; specifically, to guarantee that all man-machine interfaces and personnel interfaces are optimized prior to the manufacture of hardware.

Consultation is provided the PMO, SEA NITEOPS and to the contractors. Formal evaluations are made of contractors' proposals. Continual monitoring of contractors' efforts to insure that performance data are obtained as a basis for deciding between alternate approaches. Finally, operational evaluation under conditions similar to those likely to be encountered on the battlefield.

GLAD	Miles	FY68	Continuing

This task is designed to provide human engineering support to the PM, Rifles in his program to develop a 40mm grenade launcher attachment for the M16A1 and XM77E2 rifles.

Consultation will be provided to the PMO and to the civilian developers. The information provided, based on past experiments and field tests and general human engineering principles, will aid the weapons designers and evaluators in building efficient, easily usable, effective launchers. Field evaluations of the launchers will be conducted to determine accuracy, rates of fire, ease of operation, and those problems that reflect on the human engineering design of the weapon.

Vulcan Project	Mullen	FY67	Continuing

The objective of this task is to assure the application of human factors engineering principles in the design of Army anti-aircraft weapon materiel through hardware evaluation, review of proposed design changes, and participation in test and evaluation programs and/or review of findings and recommendations from engineering tests.

The design of the XM163 SP system was firm at the initiation of the human factors engineering program. A hardware evaluation was conducted on an existing system and the recommendations were forwarded to the PM Office. The XM167 (Towed) system was still in the design stage; therefore, human factors engineering recommendations could be incorporated into the first production model. The second part of this program will be to evaluate the man-machine problems found when actual firing tests are conducted.

Human Factors Engineering Support of MBT-70	Eckles Dickinson	FY66	Continuing

Task objective is to assure application of human factors engineering principles to the detailed design of the US/FRG MBT-70.

Establishment of human factors engineering programs for the US/FRG MBT-70 Project Manager to invoke in contracts with industry, informal evaluation of contractor proposals, and participation in test and evaluation programs involving critical man/machine interfaces and interactions. Direct consultation with USAMC and other US Army development agencies such as CDC, TECOM, etc., as well as industrial contractor organizations, concerning application and evaluation of human factors in design of the US/FRG MBT-70 and its associated equipment.

b. AVIATION BRANCH

This branch is responsible for human factors engineering in aircraft and aircraft-related materiel. Preponderance of the effort is devoted to V-STOL and V-TOL systems.

The current work program of the Aviation Branch falls into three broad, related categories: AMC aviation project support, design studies of specific aviation materiel requirements, and human factors research in aviation materiel.

Task	Experimenter(s)	Date Started	Estimated Completion

(1) AMC AVIATION PROJECT SUPPORT

AMC Aviation Systems Support	Staff	FY66	Continuing

The objective of this task is to assure the application of contemporary human factors engineering principles to the detailed design of Army aviation materiel.

Human factors engineering quality assurance programs have been established for the use of AMC project managers in their contracts with industry; formal evaluations are made of contractor proposals; personnel participate in In-Process Reviews (IPR's) and test and evaluation programs involving critical man-machine interfaces; and direct consultation with Army and other military, civil, and industrial contractor organizations concerning human factors in aircraft design are arranged.

SEA NITEOPS Human Factors Engineering Support	Foster	FY68	Continuing

The prime objective of this task is to provide technical support to each SEA NITEOPS project and overall human factors engineering management assistance to the Project Manager. Combat and system requirements data have been accumulated and necessary studies and analyses conducted for subsequent integration into system development and user tests.

Current efforts involve support of approximately half of the items in the overall program. These efforts entail proposal review, inputs to system development plan, contractor negotiation, and plan for tests. Coordination with other AMC and DA agencies is being carried out consistent with the intent of AR 602-1.

Light Observation Helicopter (LOH)	Moreland	FY64	Continuing

The objective of this task is to provide support to the AMC Project Manager during the selection, development, production and verification testing of the aircraft system.

This objective was achieved as follows:

(1) Developed the HFE evaluation criteria and participated in the Source Selection Board evaluation of the aircraft contractor candidates and LOHAP system candidates.

(2) Prepared the HFE requirements for the LOH detailed specifications.

(3) Monitored the contractor's compliance to the detail specification by design reviews and mock-ups of the contractor's proposed design approaches.

Task	Experimenter(s)	Date Started	Estimated Completion

(4) Conducted ad hoc crew station design studies such as:

(a) Development of standardized cyclic control grip.

(b) In-flight measures of crew performance changes with changes in high ambient temperatures and humidities (LOH Environmental Study).

(c) In-flight measures of crew station ventilation systems.

(d) Crew station noise level measurement and assessment.

(e) Mock-up and assessment of aircrew armor (USAHEL Ltr Rpt 52)

(5) Major design changes and field recommendations are monitored to determine possible human factors engineering implications.

(6) Provided consultative services to the contractor and LOH PMO as required.

AH-56A Cheyenne	Cassatt	FY67	Continuing

The objective of this task is to support the AMC Project Manager during in-process reviews and to provide consultative services on an as-required basis.

Participation is continuing in periodic safety design reviews and mock-up inspections and coordination of design requirements and specific technical problems related to human factors engineering with other cognizant AMC and DA agencies. Specific recommendations concerning swivelling gunner's station, and aircraft interior and exterior lighting were submitted as a result of review of the AH-56A lighting mock-up.

Helmet Head-Weight Program	Corona	FY 68	FY69

The task objective is to determine degrading effects on complex tracking and head movements associated with different helmet head-weights and various weight distributions.

Current efforts are focused on target spotting and complex coordinator performance as affected by increasing helmet weights with minimal changes in center of gravity and/or moments of inertia. Laboratory facility and instrumentation have been completed and data collection has been initiated.

Aircraft Crewman Protective Armor Study	Moreland	FY67	FY69

Task	Experimenter(s)	Date Started	Estimated Completion

The objective of this task is to develop a method which will enable quantitative comparisons of aircrew protective armor systems for existing and future Army aircraft.

The study provides for the investigation of the aircraft's mission and performance capability, crew motion envelopes, and the inherent ballistic protection provided by the aircraft structure and components. From this investigation a methodology for designing and comparing air-crewman protection will be evolved. The investigation phase has been completed and a summary of the method is now in the writing stage. A test example of the method has also been carried out on the UH-1C helicopter.

Voice Warning Systems Study	Cassatt	FY68	FY69

This task is designed to perform analyses of current Army aircraft and to establish requirements for voice warning system message content and priority, and to ascertain levels of audio versus visual channel redundancy.

The basic purpose of this study is to determine the optimum voice warning system message content and priority through analysis of operator information requirements, surveys of pilot opinion, and studies of accident data. An ancillary purpose is to determine the feasibility of deleting either visual or auditory displays in existing aircraft in an effort to reduce redundancy. This program was carried out under contract to the Bunker-Ramo Corporation. A final report, HEL Technical Memorandum 6-68, was released in February 1968. Follow-on studies are being conducted as required.

(3) Applied Research

Aircrew Station Environment Studies	Jones	FY67	Continuing

The objective of this task is to include the development of measurement methods applicable to aircrew environmental conditions and improved design standards for aircrew stations.

Current research efforts are focused on effects of light and heat variations on pilot performance with particular reference to night flight conditions and high temperature environments. On-going comparisons of different spectro-radiometric distributions of cockpit lighting will be extended, and a program of study of external aircraft lighting for helicopters is in planning.

Task	Experimenter(s)	Date Started	Estimated Completion
Human Factors Concept and Standards Development for Aviation Materiel.	Cassatt	FY67	Continuing

This study is designed to advance the development of air vehicle concepts feasibility analysis pertaining to critical human performance parameters and to insure the timely application of valid design criteria.

The program involves development of methods for translating human performance requirements into concept feasibility functional allocations and requirement-setting documentation for system development. Studies are on-going in the areas of aircrew station controls, displays, weapons control visual and auditory signals, and personal flight and survival equipment.

Handling Qualities	Waugh	FY 68	Continuing

The objective of this task is to determine and quantify handling qualities and control factors of air vehicles which contribute directly to reduction of human error and to mission success.

The program will use specialized ground and flight equipment to study the effect of varying control elements on the flying performance of pilots with a wide range of skill levels and experience. Approximately 75% of the specialized equipment has been procured, and the experimental design has been formulated.

Display and Information Processing	Barnes	FY67	Continuing

The objective of this task is to develop human factors design criteria for aircrew station displays which will give effective, simple and economical aircraft instrumentation tailored to the skill level and mission tasks of the Army aviator.

Studies are now in progress to determine the effectiveness of the various colored legends and symbols of current instruments when used with the Army's cockpit lighting systems. Required light levels for symbology of head-up displays is also being determined. Anthropometric data has been furnished to the JANAIR-sponsored cockpit geometry study. The 1-CA-1 instrument trainer is still undergoing modifications to add altitude control and readout.

c. MISSILE, COMMUNICATIONS, AND GENERAL SUPPORT BRANCH

This branch is responsible for human factors engineering of air defense missiles, artillery missiles, communications systems, general combat support vehicles, and combat engineer equipment. Work falls into three broad categories; applied research, design studies, and systems

Task	Experimenter(s)	Date Started	Estimated Completion

support.

(1) Applied Research

Investigation of Information Content of Air Defense Radar Symbols	Davis	FY67	FY68

The objective of this task is to capitalize on existing knowledge of symbology and extend the capabilities of information symbols to highly complex, rapidly changing air defense situations to reduce the time required for decision making by reducing potential error or erro contaminants of complex displays.

These studies have been accomplished to relate and evaluate the capabilities of various codes to synthesize a single code which will be further evaluated in an operational context using appropriate simulation equipment.

Potential Use of Holographic Displays in Complex Air Defense and Combat Information Systems	Davis	FY68	Continuing

The task objective is to structure the appropriateness of when and under what circumstances such displays can be used to supplant or supplement existing two-dimensional displays.

The technology for three-dimensional displays is making tremendous progress toward the fulfillment of true three-dimensional displays.

Current emphasis is made on the development of a holographic capability which will permit the assessment of information content of two-versus three-dimensional displays as applied to decision making.

(2) Design Studies

Tactical Automatic Switch for Remote Access Discrete Address Systems	Phelps	FY67	Continuing

The objective of this task is to obtain comparative operator performance capabilities for various configurations of automatic and manual switchboards.

Two studies have been accomplished and data analysis is in progress. The results should provide information on the degree of automaticity required for switching systems.

(3) Systems Support

Task	Experimenter(s)	Date Started	Estimated Completion

Continued support is provided to on-going development projects. The major systems being supported are:

Army Area Communication Systems	Randall	1965	Continuing
Engineer Equipment	Kalen	1965	Continuing
Human Factors Contributions to System Availability	Erickson	1965	Continuing
SAM-D System	Davis	1966	Continuing
Tactical Trunk Communication System	Phelps	1968	Continuing
Truck Series	Kalen	1964	Continuing
LANCE	Emery	1963	Continuing
SENTINEL	Kurtz	1963	Continuing
PERSHING	Emery	1957	Continuing
Marginal Terrain Vehicle	Kalen	1966	Continuing
TACFIRE	Bruner	1967	Continuing

d. TECHNICAL SPECIFICATIONS OFFICE

This office is responsible for providing the technical knowledge and guidance necessary to the operation of a central point within DOD for the acquisition, analysis, exchange, management, storage, and retrieval of human factors engineering information. Further, it is the responsibility of this office to develop, maintain, and revise comprehensive human factors engineering design standards and guides for inclusion in Army industrial contracts.

During FY68, a Human Factors Engineering Design Standard for Communication Systems and Related Equipment (HEL-S-7-67) was initiated and is presently being staffed among AMC subordinate commands for their approval. It will be published in FY69.

HFE Information Retrieval, Analysis and Design Guide Development	Katchmar	FY64	Continuing

The objective of this task is to acquire and analyze human factors data for dissemination in response to the needs of AMC and its subordinate

Task	Experimenter(s)	Date Started	Estimated Completion

elements. The acquisition and analysis of human factors data provides the basis for preparation of new, and revision of existing, human factors engineering standards and design guides. This work highlights those areas of the behavioral sciences wherein research should be conducted to provide the information necessary to design application.

The numberous disciplines comprising human factors engineering present problems in the analysis and synthesis of information Investigations into new techniques for synthesizing and expressing these data to maximize its usefulness into system design are being conducted. Continued responsiveness to information requests from AMC elements and other DOD agencies will be achieved.

Human Factors Engineering Information Analysis Center	Katchmar	FY66	FY68

As directed by DOD, the AMC, through the Human Engineering Laboratories, operates the DID-wide HFE Human Factors Engineering Information Analysis Center. Tufts University serves as the back-up organization to HEL in this regard. By the end of FY68, seven volumes of annotated bibliographies covering the human factors engineering literature from 1940 to 1967 were published.

Approximately 2,000 copies of Volumes I and II were distributed during FY67. In addition, approximately 36 special (on request by DOD agencies and contractors) bibliographies are published annually.

e. HUMAN FACTORS ENGINEERING TRAINING

As part of its mission, the Human Engineering Laboratories performs a training function for the U.S. Army Materiel Command. Two courses are offered--a 16-hour Executive Course and a 40-hour Orientation Course. To date, approximately 900 personnel from the AMC subordinate commands have taken these courses. The scope of this course will be expanded in FY69 to include all aspects of AR 602-1.

2. Basic Research

The Behavioral Research Laboratory conducts all of the basic research within the Human Engineering Laboratories (HEL). This program is designed to establish human capabilities and limitations under a wide variety of operational and environmental conditions.

Six research teams have responsibility for the following tasks:

Relationship of Hearing Changes to Acoustic Inputs	Price	Jul 66	Continuing

The objective of this task is to establish the relationships between

Task	Experimenter(s)	Date Started	Estimated Completion

acoustic inputs, immediate hearing losses, and recovery from such loss.

Efforts in the next year will involve experiments correlating electrophysiological and behavioral measures of hearing decrement. Additional experiments will gather electrophysiological information on the processes of impulse transmission through the ear and the effect of such impulse noise on the various components of the ear. Subsequent years will see attempts to refine the information from the preceding experiments and to develop predictors for changes in hearing resulting from acoustic trauma.

Auditory Threshold Changes in Human Subjects as a Function of Exposure to Impulse Noise	Hodge	Jul 66	Continuing

The primary objective of this task is to develop damage risk criteria for humans exposed to impulse noise as produced by small arms, rockets, and large caliber weapons.

FY69 effort will emphasize three areas: (1) Elucidation of the relation between impulse-noise waveform (intensity and duration) and the risk of temporary threshold shift (TTS); (2) Determination of recovery functions for impulse-noise-induced TTS, and study of the relation between rate of growth of TTS and rate of recovery; (3) Study of the relation between hearing level (a measure of the status of a person's hearing acuity) and the rate of growth of TTS. Laboratory studies of Bekesy thresholds as a function of pulse-tone parameters will continue, as will formulation of an interim damage-risk criterion.

Behavioral and Physiological Responses under Chronic Stress	Levine	Jul 66	Continuing

The major problem involved in this task is a further explication of the effect of "psychological stress" in altering an organism's behavior. Interest here is directed toward situations where changes in behavior endure well beyond the time of the stress.

A comprehensive primate and human stress effects research program has been developed in conjunction with researchers from Walter Reed, Yerkes laboratory, in which physiological changes, performance effects and psychological effects will be carefully examined. Ultimate goal is to derive indices with which one could predict stress effects (ex., combat stress effects) of individual prior to such assignments.

Task	Experimenter(s)	Date Started	Estimated Completion
Endocrine Response to Transient Psychological Stressors	Hudgens	Jul 66	Continuing

The objective of this task is to determine the nature of the involvement of the endocrine systems and of early experience in the organism's response to transient psychological stressors. To accomplish this goal the research involves the study of (1) the influence of past experiences (e.g., exposures to stressors, varying environments, etc., either during infancy or adulthood) on the adult organism's adrenal response to psychological stressors by exposing young subjects being reared under varying conditions to stressors at various ages prior to and into adulthood; and (3) central factors mediating endocrine responses to psychological stressors.

Neural Control of Sensory Input	Oatman	Jul 67	Continuing

The objectives of this research are to measure neural responses from sensory pathways in order to identify the physiological mechanisms involved in attention, where attention to one sensory input modulates or filters another sensory input; to specify the regions of the central nervous system which mediate such sensory interactions; and to assess the stimulus parameters under which such sensory interactions may be modified.

The preliminary phase of experimentation is concerned with the effect of attention to a visual discrimination task on auditory evoked potentials. Preliminary experimental work was completed and report published in which extended neural recordings were made from the auditory pathways on six cats while they were attending to a visual input. Subsequent experiments will attempt to refine the information from the preceding experiments and identify the physiological mechanisms involved in attending processes.

Keeping Track of Sequential Events	Monty	Jul 66	Continuing

The ability of man to follow a changing series of events by keeping track of it in his head is a relatively new field of study. Previous research has indicated that keeping track performance cannot be predicted on the basis of current theories of short and long term memory. The objective of this task is to (a) determine how well man can mentally keep track of the present state of a changing situation and (b) define the short term memory and perceptual processes underlying this behavior.

Task	Experimenter(s)	Date Started	Estimated Completion
The Conditioning of Attitudes to Unfamiliary Items of Information	Carriero	Jul 66	Continuing

This task is to examine the relative effectiveness of several techniques of reinforcement in producing conditioning and also to determine whether the techniques differentially affect a subject's ability to verbalize a contingency between a reinforced response and unfamiliar questions. A third goal is to determine whether conditioning to "uncertainty" engendered in a different context (e.g., a psychophysical discrimination task) will transfer to questionnaire situations.

Psychological Basis For Eye Movement and Pupil Dilation	Monty (Technical Monitor)	1967	1969

The purpose of this project is to determine what psychological factors, if any, affect eye movements and pupil size, and to determine the amount of control a viewer can exert over his reaction to visual stimuli.

Basic Visual Processes	Monty (Technical Monitor)	1967	Continuing

This project is designed to (a) examine the dynamic properties of the eye and the relation of each property to visual sensitivity and (b) determine the degree to which binocular interaction exists in the sensory system.

Parameters of Human Pattern Perception	Hodge (Technical Monitor)	1967	Continuing

This three-phase research program has methodological, empirical and theoretical components: (a) The methodological developments will result in computer systems for generating patternsn which are representative of naturally occurring ones but with control of pattern perception research relevant variables; (b) Empirical developments will build on the methodology by producing a body of data describing performance on various perceptual tasks as functions of pattern-relevant variables; (c) Theoretical developments will evolve from the empirical data base. Theory will be specified in the form of computer simulations which will attempt to predict details of human performance in various perceptual tasks. The research will not only provide information on human performance, but it will also suggest principles for pattern recognition automata.

3. Engineering Research Laboratory

The Engineering Research Laboratory is composed of four branches:

Design Engineering, Electronic Development, Acoustical and the Experimental Shop. The primary purpose of this laboratory is to provide general and specialized support for the Systems and the Behavioral Research Laboratories. Examples of this support are depicted in the following projects/studies in which this laboratory has participated:

a. Gimbaled Helicopter Model for Armor Study

b. Dynamic Evaluation of Various Pistol Configurations

c. Helicopter Seat Vibration Simulator

d. Rear Vision Helmet

e. Vision Box - Crew Task Performance and Tank Evaluation

f. Catalog of Small Arms Noise Characteristics

g. Whirlymite Test Facilities

h. Human Reaction Response Instrumentation

i. Selected Ammunition Signature Study

j. Weapon Attenuation Device Study

k. Noise Limit Criteria for Rocket Systems

l. Noise Evaluation of Communications Shelters

m. Quick-Fire Stress Study - Instrumentation, Controls and Equipment

n. Switchboard Prototypes

o. 40mm Grenade Launcher Concept

p. GLAD Program - Test Equipment

The laboratory also initiates and conducts research projects that require singular and specific engineering applications to the overall human factors engineering mission of the Human Engineering Laboratories. Typical of these efforts is the continuing research in the field of muzzle blast attenuation and small arms silencers.

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2B. U.S. ARMY MATERIEL COMMAND MISSILE COMMAND

Redstone Arsenal, Alabama 35809

A. CURRENT WORK PROGRAM

	PROJECT	CONTRACTOR/ACTIVITY
a.	Advanced Land Combat Technical Concepts Investigation	MICOM

The MICOM human factors engineering (HFE) element is participating in this effort, the objectives of which are to define technology baselines, formulate weapon system concepts for the 1975-85 time-frame, perform performance and cost data analyses, evaluate proposed weapon systems, and recommend R&D programs. During the current reporting period, a survey was made of current direct fire SSM systems and Air-to-Ground Systems to ascertain primary HFE problems having a multisystem implication. These problems were analyzed from the standpoint of remedial action requiring change in system concept or advance in state-of-the-art. Analyses of these HFE problems yielded a limited "Technology Base" delineating characteristics and penalties of current HFE problems, means of correcting the problems, and anticipated levels of improvement. This effort was initiated during the last quarter of FY-67 and is continuing.

b.	CHAPARRAL	AERONUTRONIC MICOM

HFE evaluations were conducted during continuing Engineering Design Test firings and Service Tests at Ft. Bliss. Minimum observer deployment distances and times required to reload missiles were established. Results of preliminary sound surveys initiated further efforts to reduce noise levels in OMSS and SMSS. Optimum crew seat design and seating arrangements were evaluated. The CHAPARRAL HFE program is continuing.

c. DOD Standardization Program Project MISC-0421 — MICOM HEL

The objective of this program was to consolidate all Army, Navy, and Air Force military specifications for human engineering into a single, fully coordinated military specification. The scope of this specification extends across all materiel developments requiring application of a human engineering program. The Army Missile Command was designated preparing activity and the Naval Air Systems Command and the Air Force Systems Engineering Group were designated departmental custodians for this project. This effort was initiated in September 1966, and was completed in February 1968, with the publication of MIL-H-46855, "Human Engineering Requirements for Military Systems, Equipment and Facilities."

d. DOD Standardization Program Project MISC-0422 — MICOM HEL

The objective of this program was to consolidate all Army, Navy, and Air Force human engineering design requirements into a single, fully coordinated military standard. The scope of this standard extends across all materiel development items. The Army Missile Command was designated preparing activity and the Naval Air Systems Command and the Air Force Systems Engineering Group were designated departmental custodians for this project. This effort was initiated in September 1966, and was completed in February 1968, with the publication of MIL-STD-1472, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities."

e. Forward Area Alert Radar (FAAR) — SANDERS ASSOCIATES, INC. MICOM

Initial HFE efforts for this task consisted of evaluations of equipment mockups, crew assignments and operating procedures. Preliminary HFE assessments were conducted on the operator's console, interior environment, crew procedures and equipment stowage. A sound survey was conducted inside the hut to insure compliance of the acoustical levels with requirements which were established on the basis of communication and annoyance factors. Acoustical, illumination, and radiation surveys were formulated and incorporated into the acceptance test plan. Prototype number one was employed for emplacement and march order evaluations as well as investigations of man-machine interaction during a brief test against aerial targets. Plans include detailed time studies to determine the capability of the equipment-crew combination to meet operational requirements, and evaluation to determine compatibility of interior environment and work-space with anticipated personnel tasks, and to assess human factors aspects of the travel mode configuation. The FAAR HFE program is a continuing effort.

f. M-22 Improvement Program — N.K. WALKER ASSOCIATES APPLIED SYSTEMS CORP. MICOM

The objective of this program is to ascertain the degree of track-

(continued)

ing performance enhancement, if any, through substitution of a thumb-operated, force-type controller with aided tracking network for the standard displacement type controller. Results of preliminary laboratory experimentation disclosed that there were no compelling reasons to believe that tracking performance cannot be enhanced through this substitution. During the current reporting period, a study was performed to investigate the rapid training of operators for the M-22 system; force-controllers and aided tracking networks were developed for operation with the DX43 simulator and the M-22 subsystem; and flight test planning was completed. Accuracies obtained with the thumb-operated force-rate controller will be compared with those obtained with the standard displacement controller through a series of flight tests planned for the next reporting period.

g. NIGHT LIFE — RCA, MICOM

The principal experimentation performed on this program was contractor effort. Final human factors evaluation was a responsibility of the MICOM human factors engineering elements which also furnished inputs to the program in the areas of system evaluation, contract monitoring, and design assistance. Efforts on this program were completed and a final human factors summary report issued. Details of the program and the human factors efforts are classified.

h. SENTINEL — BTL(and subcontractors), MICOM, HEL

MICOM and HEL furnish consulting services to the SENTINEL System Command in the areas of system evaluation, contract monitoring, and design assistance from the HFE viewpoint.

i. Electro-Optical Missile Guidance Study — NORTH AMERICAN ROCKWELL, MICOM

The experimentation performed on this program is a contractor effort. The objective of the simulation program is to obtain operator performance data to investigate (1) the effect of possible missile and display/control configurations upon operator and system performance, and (2) the effect of various terrain and target location relationships upon operator and system performance. The MICOM human factors engineering element is furnishing inputs to the program in the areas of contract monitoring and design assistance.

j. PERSHING — MARTIN-ORLANDO, HEL

During the current reporting period, acoustical and intelligibility tests in the Improved Programmer Test Station (IPTS) Battery Control Center (BCC) were completed. A headset improvement program was initiated to insure that wearer comfort, headset/helmet compatibility, and ambient noise attenuation would be suitable for communication tasks. A noise survey of the XM656 truck was undertaken and resultant data

(continued)

evaluated. Remainder of HFE activity during the year concentrated on evluations of the IPTS and IPTS equipment, assessment of missile transfer equipment and procedures, and participation in simulated arctic tests. The PERSHING la HFE program is a continuing effort.

k. LANCE — LTV-M, HEL

HFE design evaluations were performed on the basic vehicle, loader-transporter and sligh, Self-Propelled Launcher, MX4 Skid, fin containers, and sighting and laying.

HFE support was provided during planning, implementing and reporting cold chamber tests of the new cab design, personnel heater and defroster, and the determination of tailgate loads at -40°F. An HFE evaluation was conducted during the Tropic tests. Lance HFE will continue as a minimum sustaining effort.

l. TOW — HUGHES AIRCRAFTS CO.

During the past year, the wide-angle sight was deleted to preclude the operator's loss of target during transfer from the low to high-power optics. A special tracking test program was conducted to determine how tracking capabilities might be affected when the weight of the night sight is added to the TOW system. Man-machine relationships considered most desirable for the XM-70 Training Set were determined and included utilization of the trainer in practice and qualification modes, development of quantitative performance scoring and recording methods, indoctrination and drill with and without the training set attached, and layout of the instructor console front panel. TOW HFE will continue as a minimum sustaining effort.

m. SAM-D — RAYTHEON, D&A, MARTIN-ORLANDO, HEL

A major effort was devoted to establishing the requirements for display symbology and optimum operator input to be used for the Advanced Development Model (ADM). Operational sequences were prepared and analyzed for Battery Control Group (BCG) surveillance and engagement activities under normal and ECCM conditions. ECM and ECCM display optimization studies were conducted, and manual ECCM procedures and control/display requirements for accomplishing these procedures were tentatively defined. Components to be used for the SAM-D display and control functions for both the ADM and Engineering Development Model (EDM) were analyzed to insure their adherence to sound human engineering principles. The BCG command and control information flow requirements were analyzed and operating modes studied with attention focused on command and control modes which delineate the major features of centralized/decentralized, autonomous/non-autonomous, automatic/manual, and contingency battery operations. An HFE analysis of Built-In Test Equipment (BITE) display requirements was conducted. Cursory control device evaluations were completed. Operator keyboard requirements for the Main Display Console were determined and supplemental control/dis-

(continued)

play needs, derived from the communication flow between the Fire Control Group and launcher, were identified. A color-coding system for the Main Display Panel and ambient lighting requirements for the Weapons Control Unit shelter were established. An HFE demonstration and acceptance test plan was prepared to insure, to the greatest degree possible, that the system can be operated effectively within human capabilities. The SAM-D HFE program is a continuing effort.

n. REDEYE GD-POMONA

During the current reporting period, HFE efforts were expended in two primary areas -- alternate sight configuration studies and assessments, and cyrogenic system manual recycling evaluations. Redeye HFE is continuing as a minimum sustaining effort.

o. DRAGON MICOM
McDONNELL-DOUGLAS

An extensive human engineering program is being conducted to optimize the interface between the weapon and the gunner and to establish guidelines for system configuration. The program consists of mockup tests, tracking tests, operational tests, environmental tests, and weapon system design and to define induced environmental factors which may be hazardous to the gunner and other operating personnel in proximity to the weapon.

Mockup tests are conducted using mockup rounds to establish configurations, evaluate current hardware, and tactical usage of the systems. Preliminary evaluation of gunner positions and hand-hold locations was done using mockups.

Tracking tests were completed and evaluation of the data was used to define launcher configurations and firing positions. As a result of these tests, improvements in the support stand design have been undertaken.

Preliminary sound pressure level measurements were made for the DRAGON preprototype launcher canister. A 4-day user handling study was conducted at Fort Benning consisting of observing and filming infantry personnel using the DRAGON system on various terrains, investigating various modes of carrying the tracker and rounds, defining the airborne operational capability of the system, and obtaining comments from experienced inf ntry/airborne personnel. The results of the study was used to define design changes to enhance mission accomplishment of the DRAGON system.

Gunner environmental tests were conducted to evaluate the effect of the induced environment resulting from operation of the weapon configuration with stainless steel breech on the gunner and associated personnel.

The DRAGON HFE Program is a continuing effort.

2B. U.S. ARMY MATERIEL COMMAND TANK-AUTOMOTIVE COMMAND

Warren, Michigan 48090

The Human Factors Engineering (HFE) element of the U.S. Army Tank-Automotive Command is responsible for coordinating and implementing Human Factors Engineering at USATACOM. It participates in planning for inclusion of Human Factors Engineering criteria considerations for new tracked, wheeled and other vehicle systems; serves as focal point for HFE at this Command and coordinates development of HFE standards, specifications and other criteria with Industry/Interservice Working Groups.

A. Current Human Factors Research and Human Factors Engineering Work at USATACOM

1. Task: Human Factors Engineering of Armored Reconnaissance Scout Vehicle XM800

   Experimenter: Max H. Alexander
   Date Started: March 1966
   Estimated Completion: Continuing

The development of this vehicle will be monitored continuously. The technical development plan (TDP) is being analyzed for Human Factors Engineering to be inclosed into the total acquisition program.

2. Task: Human Factors Engineering of the S.P. Howitzer, 155MM, XM179

   Experimenter: Max H. Alexander & Milton Dubay (Environmental Control Officer)
   Date Started: Jan 1968
   Estimated Completion: Continuing

A preliminary analysis of the biomechanical conditions of the cab is being made, and the level of CBR protection required for the crew investigated. Climatic control of the fighting crew compartment is being evaluated.

3. Task: Human Factor Engineering for the Cargo Truck (Ambulance)M705

   Experimenter: Max H. Alexander
   Date started: Oct 1967
   Estimated completion: Continuing

The Human Factors working program of the contractor has been reviewed for inclusion into the total procurement contract. The HFE guidance meeting with the contractor is planned for October 1968.

4. Task: Study to determine need of detector and alarm for toxic gases in combat vehicle^.

   Experimenter: Max H. Alexander
   Date started: September 1966
   Estimated completion: Oct 1968

The study will determine levels of carbon monoxide, ammonia, and oxides of nitrogen gases in an M60, Medium Tank during firing of weapons and simulated vehicle mobility. Test phases of weapons firing and simulated mobility are completed. Medical aspects of the results of these tests are evaluated by Surgeon General's Army Environmental Hygiene Agency (AEHA) for inclusion into final report.

2B. U.S. ARMY MATERIEL COMMAND MUNITIONS COMMAND

Dover, New Jersey 07801

EDGEWOOD ARSENAL

Current Work Program

All of the projects listed below are small projects requiring standard human factors analyses and evaluations and therefore separate paragraphs describing each of them cannot be justified. The projects require applied research to insure that proper human engineering attention is given to the end items so that they may be most efficiently operated and maintained. In many cases experiments and field tests are conducted to establish design criteria. In other cases design data are extracted directly from handbooks.

Title	Date Started	Estimated Completion
Evaluation of Atropen Training Injector	Jan 68	Jun 68
Aircrewman's Respiratory Protection	Sep 67	Cont'd
Speech Intelligibility through Protective Masks	Jun 65	Jun 68
M9-7 Flamethrower - ENSURE modification	Apr 67	Cont'd
Canister, Cluster, Tactical, CS, XM15 and XM165	Jul 66	Cont'd
Grenade, Hand, Riot, CS, XM47	Aug 66	Cont'd
Cartridge, 40mm Riot Control CS, E24 Cartridge, 40mm, Red Smoke, E25	Aug 64	Jul 68
Projector Adapter XM 42	Dec 65	Compl
Mine Antipersonnel, PWP, Pop-Up, XM54	Dec 67	Cont'd

Title	Date Started	Estimated Completion
CS Pocket Grenade	Mar 68	Cont'd
Brown Bagger XM28	May 67	Suspended Pending Funds
Multishot Portable Flame Weapon (MPFW)	Jan 68	Cont'd
Launcher and 35mm Cartridge Tactical CS, 16 Tube E8	Dec 64	Cont'd
M25 A2 Plastic Grenade	Jan 68	Compl
Smoke Grenade, Rifle, Floating XM63, 64, 65	Jan 68	Cont'd
BLU 52B, 52 A/B, CS	Feb 68	Compl
Projectile, 155mm, Binary	Feb 68	Cont'd
Dispenser, Riot Control Agent, M106	Feb 68	Cont'd
Drinking - Resuscitation Devices	Apr 64	Cont'd
XM8 Point Source Alarm	Dec 64	Cont'd
M17 Mask	Jul 68	Cont'd
CS Pressurized Pod (Shelter System XM51)	Apr 68	Cont'd
Light-Weight Mask XM28	Jan 67	Cont'd
Collective Protection for Command Post Vehicles	Feb 65	Cont'd
Decontamination Apparatus, Power Driven, Skid Mounted, M12A1	Jul 66	Compl
Projector and Smoke Grenade XM19	Jan 66	Compl
Canister Cluster, Tactical CS, E158	Jul 66	Cont'd
Canister Cluster, Tactical CS, E159	Jul 66	Cont'd
Cartridge, 40mm CS, XM651	Aug 64	Cont'd
CS Dispenser, XM920	Mar 67	Compl

FRANKFORD ARSENAL

A. CURRENT WORK PROGRAM

Task	Experimenter(s)	Date Started	Estimated Completion
1. Tracer Visibility Research Program	R. F. Kelly	Jan 65	Cont'd

This is a study of the characteristics of a tracer bullet for optimum visibility in daylight. Factors considered are: tracer candlepower intensity, amount of natural illumination, color and reflectance of background terrain, color of trace, velocity of bullet, and position of the observer. Correlation will be established between observed visibility and tracer intensity. Effort on this program is dependent on the availability of funding for FY 1969.

2. Target Acquisition	R. F. Kelly	Jan 66	Cont'd

Effort on this project is dependent on the availability of funding for FY 1969 and succeeding years. The program involves target detection, recognition, and identification with the aid of optical devices. Areas of concern for FY 1969 and following include: practical upper limits of magnification, optimum combinations of magnification and field of view for stated visual tasks, relative merits of fixed and variable magnification, and the most effective search techniques for a given magnification and field of view.

3. Human Factors Study of Fuze Setting Problems	W. F. Clisham	1962	Cont'd

As part of a continuing program in which general concepts such as safety, ease and accuracy of setting, visual factors, and specific problems are under investigation, a study was undertaken to ascertain whether design engineering changes to the XM592 E1 & E2 fuzes were consistent with human capabilities and/or limitations and to provide additional design recommendations as needed. An interim report was submitted; a subsequent report is in the process of finalization.

This study underscored the need to validate existing information and generate new data to be made available to the fuze designer concerning the human factor variables involved in fuze setting.

4. MBT 70	R. F. Kelly	Jun 60	Cont'd

Purpose of this program is to provide human factors engineering support for the fire control aspects of the Main Battle Tank. The Branch is primarily concerned with coordinating the efforts of Frankford Arsenal with other agencies involved in the program. Currently under investigation is the compatibility of fire control equipment with the personal and protective gear of combat vehicle crew members such as helmets and gas masks.

Title	Experimenter(s)	Date Started	Estimated Completion
5. Special Products Devices	E. J. McGuigan	Jul 66	Cont'd

This is a continuing program for which funding is provided for human factors work for a variety of devices concerned with guerrilla and counter-guerrilla warfare and ancillary areas. Much of the work is of a classified nature and is conducted in the general areas of ammunition, improvised munitions, flares, and specialized devices concerned with unconventional warfare.

6. Advanced Flare and Dispensing System for Army Fixed and Rotary Winged Aircraft	W. F. Clisham	Jul 67	Cont'd

The Branch role in this program is to provide human factors support to the Frankford Arsenal Propellant Actuated Devices Group. An interim summary and evaluation of data compiled from: Tri-Service Flare Commission efforts; CEM pyrotechnical investigations; applicable journals, texts, reports; interview surveys relative to (a) current/future Army aircraft armament/system characteristics and (b) known/proposed illumination requirements, has been submitted. From the man-flare data obtained, several concepts were proposed for design consideration.

7. Forward Looking Infrared (FLIR) Target Acquisition and Fire Control Sub-system	L. Gallun	Dec 66	Cont'd

This program involves the monitoring of the Contractor's human factors effort. The major emphasis of this Branch is directed toward insuring the compatibility of the existing sighting and tracking equipment (XM21 sighting station) in the aircraft, with the design, location, and operational concepts of the FLIR sub-system and the intended user population. This program has reached the pre-deployment test phase and these tests will be conducted during the first quarter of FY 69. Concurrently, a human factors evaluation of the system will be made.

8. Human Factors Support of Artillery (Mortar) Fire Control Research	W. F Clisham	1967	Cont'd

Human factors support is provided for the continuing design and development of fire control items. Representative tasks in this category include the following:

(a) Hand-held Mortar Elevation Indicator

Conducted a preliminary analysis to estimate the man-device combination that might best satisfy the design goals for a manual direction/carrying handle for the 81mm mortar. Human factors recommendations have been incorporated in a casted one piece handle containing a vial type elevation indicator which is apparently acceptable pending further evaluation and testing.

(b) Wrist Mounted Graphical Firing Scale

Performed a comparative analysis to evaluate the human factors interface of two disk calculator design proposals. Recommendations relative to display design, compatibility, and control device were incorporated in a prototype now undergoing evaluation.

9.	Moving Target Radar (Fire Control)	L. Gallun	1967	Cont'd

Major emphasis in this system is directed toward the integration of an indicator, hand controls, and associated control panels into the UH-1 helicopter. Branch effort involves the monitoring of the contractor's human factors effort through periodic evaluation visits to the contractor's plant and by review of progress reports.

10.	Multi-Weapon Fire Control System	L. Gallun	Jan 67	Cont'd

Branch role in this program is primarily the monitoring of the contractor's effort in repackaging the Multi-Weapon Fire Control System for adaptation to the AH-1G helicopter. Overall project cognizance is maintained through review of progress reports and periodic visits are made to the contractor's plant to evaluate the current status of the cockpit mockup configuration.

11.	Cart 7.62mm (Tactical Packaging)	R. Kelly	Jun 68	Cont'd

Purpose of the program is to develop an optimal ammunition feeding system for the Mini-gun. A survey and analysis of systems currently in use is being conducted to obtain information which will assist in optimizing the parameters involved in the packaging, storing, handling, loading, and feeding of ammunition. Criteria will consist of reliability of operation, safety, ease of maintenance, and man/machine efficiency involved in handling, loading, and firing.

12.	Stabilized Sights, Binoculars, and Periscopes	W. J. Johnson	May 68	Sep 68

Purpose of this program is to evaluate the effectiveness of stabilized binoculars through a comparison test of several types of stabilizing devices in the functional helicopter environment. A test program is currently being drawn up and the program will be conducted shortly at the Aberdeen Proving Ground.

13.	5.56mm and 7.62mm Cartridge Ammunition Fixture	W. J. Johnson	May 68	Cont'd

Purpose of the program is to investigate the dynamics of the human system component as it affects the testing of small calibre ammunition. By reproducing the bodily reaction of an average gunner with programmed recoil buffers in a simulation test fixture, variation in the testing of ammunition resulting from individual differences in gunners

Task		Experimenter(s)	Date Started	Estimated Completion

could be controlled and reduced to minimal levels. A literature survey as well as a review of prior work in the general area has been accomplished. The award of a contract for the construction of the test fixture will be accomplished after appropriate negotiations which are currently in the initial stages.

14.	Day/Night Forward Infrared Periscope	R. F. Kelly	Mar 68	Dec 68

This is a classified program in which the overall purpose of the program is defined in the title. Branch effort consisted of an analysis of the proposed device from a photometric and visual standpoint and providing an estimate of its probable performance in terms of object resolution in minutes of arc as a function of luminance adaptation level and contrast. Simple simulation apparatus and procedures were proposed by which the estimated performance of the equipment could be verified experimentally.

15.	Human Factors Information Data Exchange Experimental Activities (IDEEA)	E. J. McGuigan	Dec 67	Cont'd

Branch effort is directed toward supplying human factors input for the software aspects of the system. Surveys of current operational information systems and participation in the development of a human factors experimental program designed specifically for IDEEA are a part of this effort.

16.	Consultation and Advisory Services	Staff		Cont'd

Human Factors engineering services are provided for research, development, and production engineering activities on an on-call basis. These services include such representative areas as participation in feasibility and concept evaluations, evaluation of components and/or equipment, provision of human factors engineering data to design engineers, participation on committees for consideration of human factors in product improvement contracts, and membership on ad hoc groups for investigation of specific problems.

17.	Monitoring Services	Staff		Cont'd

This function provides for the supervision, together with the technical supervisor of the contract, of the human factors engineering portions of Frankford Arsenal Research and Development contracts. Services include the evaluation of progress and final reports, visits to contractor installations as required, and participation in other pahses of procurement such as pre-award meetings or contract modification. General cognizance is maintained over research and development contracts by personal contact with project engineers and evaluation of quarterly progress reports.

PICATINNY ARSENAL

A. HUMAN ENGINEERING SUPPORT GROUP

1. Missile System Warhead Development	G.R. DeTogni	1961	Continuing

This series of projects provides human factors support for the design and development of the warhead sections for missile systems such as SPRINT and LANCE. Specific attention is paid to total system compatibility, multiple warhead capabilities, test and handling equipment and operational and procedural manual development.

2. Nuclear Demolition Development	J. Kostakis	1960	Continuing

This series of projects provides human factors support for the continual design and development of various types of nuclear projectiles and demolition devices. Emphasis is placed upon portability requirements, environmental effects on handling and tactical employment procedures.

3. Conventional Systems Development	J. Kostakis G. DeTogni	1960	Continuing

This series of projects provides human factors support for the continuing design and development of mortar systems, land mines and hand grenades. Laboratory and field studies are designed to evaluate specific engineering designs and particular operational procedures.

B. SPECIAL PROJECTS GROUP

1. Visual Detection Center Activities	J. Carlock B. Bucklin J. Rayner H. Weasner	1966	Continuing

These activities include human factors support for the establishment of design parameters for illuminating and targe marking systems including flares, smokes and chemiluminescent materials. An extensive literature search and a continuing series of field studies has been and will be conducted to isolate the effect of illumination, color, visual acuity, buring time, terrain features, movement and other variables upon the effectiveness of specific line items.

In addition, a major effort is underway to conduct Laboratory and field studies aimed at developing optimum camouflage techniques for small (less than 6" sq.) munitions. The principles of imitation, blending decision jamming and noise introduction are being studied in relation to tactical practice and human detection capability.

2. Portability Center Activities	P. Strauss J. Carlock	1962	Continuing

This project evaluates present and projected carrying devices and techniques for Picatinny Arsenal develped weapon systems. An attempt is being made to supplement existing load carrying literature with data on very heavy (over 100 pounds) loads and on the effects of load-carrying on psychomotor performance.

3. Industrial Psychology Center Activities	Staff	1966	Continuing

This project provides consultation services for Arsenal management in the areas of employee relations, motivation, staff development and engineering and scientific personnel problems.

2B. U.S. ARMY MATERIEL COMMAND NATICK LABORATORIES

Natick, Massachusetts 01760

A. CURRENT WORK PROGRAM

1. Man/Environment Compatibility Engineering Research

Within the Army Human Factors Engineering program, the purpose of this task is to conduct human factors engineering research in order to define and apply scientific principles of human physical and psychological characteristics to the design of clothing, equipment, and food. Anthropometric data are collected on U.S. and foreign military populations and analyzed in order to define the characteristics of body size for use in the design, sizing, and tariffing of military clothing and personal equipment. Psychological studies and performance measurements contribute to the development of military materiel that will increase the soldier's efficiency and effect compatibility among the soldier, his equipment and his environment.

Title	Investigator	Initiation	Completion
a. Human factors compatibility studies on the soldier, his clothing, equipment and performance in cold and tropic environments.	J. McGinnis	1961	Continuing

Human engineering studies are conducted to investigate the compatibility of the soldier and his clothing and equipment in cold and hot environments. Military systems, equipment, and tasks are studied to ascertain the requirements for protection, space, movement, dexterity, and alertness in severe environments, and to determine the interrelationships between protection and performance.

Title	Investigator	Initiation	Completion
b. Anthropometric studies of U.S. and foreign military populations.	R. M. White R. L. Burse J. M. B. Keyser	1946	Continuing

Anthropometric data on U.S. and foreign military populations are collected, analyzed and published in order to provide reliable information on the dimensions, proportions, ranges of variation and frequencies of body size in such populations. The anthropometric data are applicable to the design, sizing, fitting and tariffing of military clothing and individual equipment and in the human engineering of man-equipment systems. New anthropometric surveys of the U.S. Armed Forces were carried out in 1965-66 at the request of the Defense Supply Agency. The data collection phase of a new anthropometric survey of Army aviators is planned for FY 69. This survey will provide body-size information from various sub-groups of the Army aviation population applicable to both human factors engineering and the design of life-support equipment.

c. Consultation and design guidance on human factors problems associated with new items of clothing and other materiel under development.	J. McGinnis B. Crist F. Isgrig H. Kiess D. Randolph J. Hearns	1959	Continuing

Human engineering evaluations, assistance, guidance, and compatibility studies are furnished as needed in support of all types of equipment under development by NLABS. Clothing, armor, and personal equipment are included, along with airdrop equipment, tentage and air-supported shelters, containers for food and other items, food service equipment, field service equipment, and certain types of general equipment.

d. Conduct human engineering and applied research studies of the headgear, including helmet acoustics, weight, encumbrance, and other factors affecting performance.	B. Crist	1959	Continuing

Human engineering research is conducted to obtain guidance information for improvement of protective headgear, particularly for combat vehicle crewmen and aviators.

Title	Investigator	Initiation	Completion
e. Conduct applied research in experimental psychology in direct support of materiel research and development.	J. McGinnis B. Crist F. Isgrig J. Hearns	1966	Continuing

Research studies are conducted as needed in direct support of the development of specific items or families of items of clothing or equipment. These studies are planned in consultation with product development personnel to increase their applicability and timeliness. The effects of head supported weight on the speed and accuracy of head movements are currently being studied. Work planned in support of the development of new tentage field kitchens, and bakeries has been postponed.

Title	Investigator	Initiation	Completion
f. Studies to determine attitudes and preferences of soldiers toward QM food items.	J. L. Sidel H. L. Jacobs L. M. Bartoshuk	1964	Continuing

Studies are conducted to determine the soldier's attitude and preference toward QM material, particularly food items. Current emphasis is placed on both a program of taste panel evaluation of food items under development and/or procurement and food preference surveys of Army personnel.

Title	Investigator	Initiation	Completion
g. Conduct validation studies of acceptance data and development of new measuring devices.	L. M. Bartoshuk J. L. Sidel H. L. Jacobs	1966	Continuing

This task was initiated in 1966 as a long-term applied research program evaluating food acceptance techniques, sampling procedures, and subject population.

Title	Investigator	Initiation	Completion
h. Conduct studies of psychological and environmental stress effects on perceptual and cognitive performance.	J. Lockhart H. Kiess	1965	Continuing

Studies are conducted to determine the effects of environmental stress variables on perceptual and cognitive performance. Special attention is given to the interrelations between psychological and environmental stress effects of differential components of a task in order to provide a basis, ultimately, for evaluating the relative effectiveness of protective clothing, personnel selection, special training, and task modifications in reducing environmentally induced performance decrements.

Title	Investigator	Initiation	Completion
i. Conduct sensorimotor studies during performance of military tasks.	H. Kiess J. Lockhart	1965	Continuing

Studies are conducted to determine the sensory and psychological responses of a military population under environmental and situational variables and the effects of such responses under the performance of military tasks.

Title	Investigator	Initiation	Completion
j. Conduct sizing and tariffing studies of clothing and personal and protective equipment and provide human factors engineering guidance requiring the application of anthropometric data.	R. M. White R. L. Burse J. M. B. Keyser	1966	Continuing

Criteria for the proper fitting and sizing of clothing and equipment, both individual and protective, are developed and furnished to NLABS designers. Human factors engineering studies in fit, comfort, restriction and compatibility are conducted to determine the adequacy of the furnished criteria. Procurement and distribution tariffs are developed for sized items, based upon available anthropometric data and the correlations between body size in the user population and the item sizes in the size system. In the past year, continuing guidance was furnished the developers of twelve NLABS items, with priority to aircrew flight clothing, helmets and body armor, and infantry helments and body armor. Studies of the comfort and stability of several prototypes of the LINCLOE infantry helmet were completed and are being readied for publication along with an aircrew body armor fit, comfort and performance study conducted earlier. Beginning next year emphasis will be placed on applying the results of the 1966 anthropometric surveys to the revisions of standard milit[illegible] clothing size systems and tariffs.

2. Basic Research in Human Capabilities

The supporting research program is directly related to the long range problems of the Food Acceptance Laboratory, and also designed for inter-disciplinary collaboration with common problems of other NLABS laboratories, including Nutrition, Food Chemistry, the Experimental Kitchen and Food Irradiation in the Food Division, and Analytical Chemistry, Insecticides and Rodenticides, and Entomology in the Pioneering Research Laboratory.

Title	Investigator	Initiation	Completion
a. Basic Investigations of Human Psychophysics.	L. Bartoshuk	1967	Continuing

Basic research is conducted on the sensory and perceptual capacity of human subjects, with special emphasis on problems of scaling and measurement, sensory adaptation and analysis of flavor by integration of taste and olfaction.

b. Basic investigations of Sensory Psychophysiology.	L. Bartoshuk A. Adachi A. Niijima	1967	Continuing

Basic research is conducted on problems of information transfer in taste and olfaction, using direct electrophysiological techniques to supplement the psychophysical approach outlined above. Special emphasis will be on initial receptor-site stimulation, on the patterning of receptor-fiber systems and the problem of sensory coding.

c. Basic investigations of Appetite Regulation.	R. Gentile L. Hoff H. L. Jacobs	1967	Continuing

Basic research is conducted on the role of sensory and metabolic information supplied by the ingestion of food in the regulation of food and water intake. Special emphasis is on the role of energy balance, and environmental changes in the action of the Central Nervous System in these phenomena. New studies are underway on meal patterning and short-term intake in animals and man.

3. In-House Laboratory Independent Research

a. Changes in CFF as an indicant of physiological and psychological stress effects.	J. Lockhart	1966	Continuing

Basic research is conducted to determine the effect of thermal stress on the visual flicker-fusion threshold and to develop a differential indicant of thermal exposure induced physiological and psychological stress effects.

b. Development of a technique for establishing performance decrement to ultimately protect the individual against impulsive noise.	T. L. Nichols B. Crist	1968	Continuing

An experimental technique will be established to permit assessment of permanent hearing loss induced in animals by impulsive noise stimuli. Parameters of impulsive noise will be evaluated, and an attempt to isolate the most damaging will be made. Such data will prove useful in attenuator design and evaluation.

2B. U.S. ARMY MATERIEL COMMAND
U.S. NAVAL TRAINING DEVICE CENTER

Orlando, Florida 32813

CURRENT WORK PROGRAM

Study, Training Device Requirements for Main Battle Tank-70

NATOPS - The Study and Development of a Military Specification for Flight Manuals

Design Factors in Environmental Simulation - Phase 3

Degree of Simulation vs. Pilot Performance

Study, Decision Making

Study, Human Factors in Training Equipment Design

Study, Team and Tactical Decision Making Applications

Study, TV Parameters of Pilot's Visual World Simulation

Study, Advanced Amphibious Vehicle

Study, Land Combat Training

Study, BW/CW Simulants for Naval Training Applications

Adaptive Training Features, Devise 2B24

Study, Training Equipment and Individual Differences

Study, Feedback and Cuing in Training Tasks

Study, Learning, Retention and Transfer

General Vehicular Research Tool, Further Evaluation

Multi-Sensory Augmenting Feedback in Tracking Training

Sub-task Practive in Training Devices

Optimal Eye Movement Patterns

Visual and Auditory Autokinesis

Instinctive Firing

A System for Task Classification

Study, Training Effectiveness as a Function of Task Difficulty

Preparation of Annotated Human Engineering Bibliography

Training Effectiveness Evaluation, Aircraft Carrier Landing Trainer

Task Quantification

Experimental Training Facility

Study, Skill Retention

Generalized Sonar Maintenance Trainer

Training System Use & Effectiveness Evaluation

Study-Scoring of Team Communication

Study, Computer-Assisted Maintenance Training

Study, Computer Based Training

Automated WST

2B. U.S. ARMY MATERIEL COMMAND ARMY TEST AND EVALUATION COMMAND

Aberdeen Proving Ground, Maryland 21005

U. S. Army General Equipment Test Activity
Fort Lee, Virginia

A. CURRENT WORK PROGRAM

1. Test Boards, Management and Support (Project 1A665702D618)

	Task	Experimenters	Date Started	Estimated Completion
a.	Development of Methodology for Measuring Effects of Personal Clothing and Equipment on Combat Effectiveness of Individual Soldiers (USATECOM Project No. 8-3-7700-01)	Mr. James C. Perkins, Jr., STFGE-MI-H USAGETA Dr. J. William Dunlap, Dunlap & Associates, Inc., Darien, Conn.	Jul 1962	Dec 1969

Work has been completed on the initial three-phase research project to develop procedures and facilities for field measurement of the effect of experimental clothing and personal equipment on the combat effectiveness of individual infantrymen. A survey of experienced combat infrantrymen provided a ranked list of the physical tasks performed in combat. Performance measures were developed and evaluated for the ten most important tasks. Field facilities have been constructed to permit a realistic evaluation of the effect of clothing and equipment on the soldier's performance in these tasks using an automated data collection and analysis system. Validation of recently constructed performance courses has been completed and work for installing a fully automated data collection and analysis system is underway.

Task	Experimenters	Date Started	Estimated Completion
b. Development of a Checklist and Guidebook for Human Factors Evaluation of General Equipment (USATECOM Project No. 9-6-0072-01/02)	Mr. James C. Perkins, Jr., STEGE-MI-H USAGETA	Aug 1965	Jan 1968

Development of a checklist and procedural guidebook for use by test engineers in evaluating human factors aspects of the design of U. S. Army General Equipment has been completed. These materials are currently in use at USAGETA.

Task	Experimenters	Date Started	Estimated Completion
c. Evaluation of Psychological Techniques for Selection of Observer-Recorders for Field Tests	Mr. James C. Perkins, Jr., SP4 George Schweickert, STEGE-MI-H USAGETA	Jul 1964	Nov 1967

A study has been completed to establish the reliability and validity of the Lowry-Lucier Reasoning Test as a special selection device for enlisted Observer-Recorders. It was hypothesized that this test, which is reported to be less influenced by level of formal education than other tests of intelligence, may aid selecting enlisted personnel who would perform satisfactorily as O/R's during engineering and service tests of military equipment.

A follow-up study has been initiated in which O/R personnel selected on the basis of level of education, General Test Score and performance scores on the Lowry-Lucier test are rated by supervisory personnel on the basis of their performance as Observer/Recorders.

2B. U.S. ARMY MATERIEL COMMAND BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

Annett, John and Paterson, Laura. The Use of Cuing in Training Tasks: Phase III. Tech Rep 4717 -1, Aug 67. (U) NAVTRADEVCEN

Barnes, John A. Aircraft Instrument Panel Viewing Distance. Tech Note 2-68. HEL

Bauer, Robert W., Cassatt, Robert K., Corona, Bernard M., & Warhurst, Frank, Jr. Panel Layout for Rectilinear Instruments. Tech Memo 4-68, Jan 68. HEL

Bragg, Thomas S. Acoustical Study of the CH-47B Helicopter. Tech Note 4-68, Mar 68. HEL

Brown, James E., Bertone, Carmine M., & Obermayer, Richard W. Army Aircraft Voice Warning System Study. Tech Memo 6-68, Feb 68. HEL

Bucklin, B.L. Human Factors Evaluation of the 10 Cap Blasting Machine, ESL Information Report 386, Apr 68. PA

Burse, R.L. and Cahill, W.D. Comfort and Stability Ratings for LINCLOE Helmet and Suspension Systems Compared to those for Standard Items. Tech Rpt 69-3-PR, Jul 68 (U). (In Press) NATICK

Carlock, J. and Bucklin, B.L. Human Factors Camouflage Evaluation of Dart Concept, Letter Report, Aug 67. PA

Carlock, J. and Bucklin, B.L. Human Factors Evaluation XM180 Cratering Device, Letter Report, September 67. PA

Carlock, J. and Bucklin, B.L. Preliminary Report - Panama Color Proportion Test (VDC 100-2), Visual Detection Center Report, Mar 68. PA

Carlock, J. and Bucklin, B.L. Preliminary Report - Panama Size, Shape, Color Test (VDC 100-1), Visual Detection Center Report, Mar 68. PA

Carlock, J. and Bucklin, B.L. Preliminary Report - Simulative vs. Machine vs. Coated Concepts of Camouflage (VDC 100-3), Visual Detection Center Report, May 68. PA

Carlock, J. and Bucklin, B.L. Program 100 Task 100-3, Preliminary Field Evaluation of the Protective Characteristics of Adhesive Coated Munitions, Visual Detection Center Report, Nov 67. PA

Carlock, J. and Bucklin, B.L. Tunnel Destruct System - Liquid Explosive Concept, Letter Report, Aug 67. PA

Catalano, John F. and Whalen, Patricia M. Effects of Auditory Stimulation upon Decrement and Remininscence in Rotary Pursuit Tracking. Tech Rpt IH-139, 1967. (U) NAVTRADEVCEN

Chaikin, Gerald, Ed., "Human Engineering Design Data Digest," Jun 68. MICOM

Chipser, S. John. "A Human Factors Design Analysis of the NIGHT LIFE Operator's Workspace (U)," Tech Note RH-TN-68-1, Jan 68. Confidential Report. MICOM

Chipser, S. John and Chaikin, G. "Project NIGHT LIFE - Human Factors Summary (U)," Tech Rpt RH-TR-68-2, May 68. Secret Report. MICOM

Coles, R. Ross A., Garinther, Georges, Hodge, David C., & Rice, Christopher G. Criteria for Assessing Haring Damage Risk from Impulse-Noise Exposure. Tech Memo 13-67, Aug 67. HEL

Davis, C. Jane. Radar Symbology Studies Leading to Standardization. Tech Memo 5-68, Feb 68. HEL

DeLaney, Joseph P. "Human Factors Feasibility Testing of the E56 Multipurpose Chemical Agent Detector Kit." Tech Memo EATM 115-3, Jul 67. EA

DeTogni, G. Preliminary Study of Forces in Human Locomotion. ESL Information Report 362, Nov 67. PA

Dickinson, Nonnie F., Jr., Ganem, George P., & Torre, James P., Jr. A loading Study of the XM-138 Self-Propelled Howitzer. Tech Note 7-67, Dec 67. HEL

Doorley, Richard D., Walker, Norman K., Conroy, James, and Rabida, Geoffrey. "Optimization of the Control Parameters of a Thumb Controller for the M-22 Weapon System." Tech Rpt RH-TR-68-1, Mar 68, Final Report on Contract DAAH01-67-C-2421, Norman K. Walker Associates, Inc. MICOM

Eckles, Andrew J., III, Garry, Thomas A., & Mullen, William C. Human Limitations of Line of Sight Missiles During Limited Visibility. Tech Memo 3-68, Jan 68. HEL

Glucksberg, Sam, Fisher, Dennis F., & Monty, Richard A. Brief Visual Memory as a Function of Visual and Acoustic Confusability. Tech Memo 16-67, Aug 67. HEL

Gschwind, Robert T. & Hicks, Samuel A. Antiaircraft Tracking Accuracy as a Function of Optical Magnification and Control Gain (U). Tech Note 5-68, Confidential Report, Mar 68. HEL

Gschwind, Robert T., Nair, Ward M., & Johnson, William B. Troop Posture Sequences for Dismounted Armored Infantrymen. Tech Note 7-68, May 68. HEL

Hart, G. L., Faust, R.A., Jr., Rowland, G.E., Lucier, R.O.,

& Lee, R.J. (Ed.). Attitudes of Troops in the Tropics. Tech Rpt 67-57-PR, Feb 67 (U). AD 649-540. NATICK

Hart, G. L, Rowland, G.E., & Malina, R. Anthropometric Survey of the Armed Forces of The Republic of Korea. Tech Rpt 68-8-PR, Jul 67 (U). AD661-624. NATICK

Heal, S. F. and Prasilowski, J. C. Ride Characteristics of Light Weight Tracked Vehicles. Report No. RRC-38-(U), Feb 67. USATACOM

Hodge, David C. & McCommons, R. Bruce. A Behavioral Study of the Sound-Shadow Effect in Impulse Noise. Tech Memo 12-67, Jul 67. HEL

Holland, Howard H., Jr. Attenuation Provided by Fingers, Palms, Tragi, and V51R Ear Plugs. Tech Memo 2-68, Jan 68. HEL

Holland, Howard H., Jr. Noise Attenuating Materials in an S-141/G Shelter. Tech Note 1-68, Jan 68. HEL

Horley, Gary L. The Role of Human Engineering in Designing Combat Vehicles. Tech Note 3-68, Feb 68. HEL

Jordan, Stephen. Autokinesis and Felt Eye Position. Tech Rpt 1H-142, Mar 68. (U) NAVTRADEVCEN

Kamen, J.M., Peryam, D.R., Peryam, D.B., & Kroll, B.J. Studies on Acceptance Methodology: Preliminary Studies on Characteristics of Taste Panel, Sample Size, and Contrast and Convergence Effects. Tech Rpt 68-10-PR, Pioneering Research Laboratory, Jul 67, AD 666-228. NATICK

Kiess, H.O. Effects of Natural Language Mediators on Short-Term Memory. Journal of Experimental Psychology, 1968 77, 7-13.

Kostakis, J. A Human Factors Guide for the Design of Ammunition and Related Systems, Tech Rpt 3505, Sep 67. PA

Kostakis, J. Maximum Thumb Force Exertable on a Hand-Held Spring Gauge (Ref: M-26A1 Hand Grenade), Letter Report, Jan 68, PA

Kostakis, J. Portability of the Advanced Firing System, Interim Report, Aug 67. PA

Kramer, Richard R. Night Sights (U). Tech Memo 17-67, Confidential Report, Oct. 67. HEL

Lee, R.A. & Pradko, F. Analytical Analysis of Human Vibration. Presented at the Society of Automotive Eng., Automotive Engineering Congress, Detroit, Michigan, Jan 68. USATACOM

Lee, R.A. & Prasilowski, J. C. M521E1 Cargo Truck Goer Seat Study. Report No. SCD-3(U), Sep 67. USATACOM

Lockhart, J.M. Extreme body cooling and psychomotor performance. Ergonomics, 1968, Vol. 11, pp. 249-260.

Matanzo, Francisco. "Intelligibility of Speech Through the Protective Mask: Phases I and II." Tech Memo EATM 115-5, Sep 67. EA

McCommons, R. Bruce. & Hodge, David C. A Preliminary Study of Some Variables Affecting Pulsed-Tone Bekesy Thresholds. Tech Memo 14-67, Aug 67. HEL

Monty, Richard A. & Karsh, Robert.

Pacing of Rehearsal in Sequential Short-Term Memory. Tech Memo 15-67, Aug 67. HEL

Oatman, Lynn C. & Price, G. Richard. Role of Tonal Relevance in Auditory Fatigue. Tech Memo 7-68, Apr 68. HEL

Plutchik, Robert. Strategies of Research Design in Psychology. Tech Rep IH-129, Aug 67. (U) NAVTRADEVCEN

Rappoport, Emilie N. "Human Factors Engineering Problems in Land Combat Missile Systems: Preliminary Analysis and Prognosis." Tech Rpt RH-TR68-3. (In Press), Apr 68. MICOM

Shinaly, F.J., Grandy, A.J., Moore, J., Robertson, D., Hantho, R.E., & Kelly, R. Proposal for Development of Smoke Marking Munitions for Dry and Inundated Areas. Tech Proposal P68-41, Sep 67. FA

Strauss, P.S. Construct Validity of the Tennessee Self-Concept Scale. *Journal of Clinical Psychology*, in press (with R.B. Vacchiano). PA

Strauss, P.S. Factor Structure of the Dogmatism Scale. *Psychological Reports*, 20, 1967, 847-852 (with R.B. Vacchiano and D. Schiffman). PA

Strauss, P.S. How To Be More Creative. *NCE Bulletin*, Summer, 1968. PA

Strauss, P.S. Perceptual Distortion of Job Activities Among Engineers and Scientists. *Perceptual Motor Skills*, 1967, 25, 79-80. PA

Strauss, P.S. Personality Correlates of the Dogmatism Scale. *Journal of Consulting Psychology*, in press (with R.B. Vacchiano). PA

Strauss, P.S. Pupilary Response to Value-Linked Words. *Perceptual Motor Skills*, in press (with R.B. Vacchiano and L. Hochman). PA

Wokoun, William F. Effects of Music on Work Performance. Tech Memo 1-68, Jan 68. HEL

2B. U.S. ARMY MATERIEL COMMAND BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

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ALEXANDER, Max H., Mechanical Engineer (Human Factors); Dipl. Ing., 1936 Tech. University of Berlin, Germany; Reg. Prof. Eng. 1958, Detroit, State Board Michigan; Nat. Society of Prof. Eng., Industrial Mathematical Society Detroit. USATACOM

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NEWCOMB, Fred N., Engineer (Human Factors); University of Maryland. HEL

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OATMAN, Lynn C., Research Psychologist (Engr); BA 1958, MA 1961, University of Nebraska; Ph. D. 1968, University of Delaware; Vision. Member: APA; Psi Chi; AAAS. HEL

OLSON, Lawrence E., SP4, Biological Science Assistant, Food

Acceptance Group, Behavioral Sciences Division: BS 1964, Biology, Central Missouri State College; MS 1967, Zoology, Fort Hays Kansas State College. NATICK

PALMER, John E., Jr., Psychologist; BA 1967, Richmond Professional Institute. GETA

PERKINS, James C., Jr., Chief, Human Factors Division; MA 1965, Richmond Professional Institute; Psychology; Associate Member, American Psychological Association; Virginia Psychological Association; Member: Human Factors Society; American Association for the Advancement of Science. GETA

PETERSON, Rolf H., Jr., PFC, Bio. Sci. Asst; BS 1967, Colorado State University. HEL

PETTIT, George D., Engineer (Human Factors); BSEE 1949, North Carolina A&T. HEL

PHELPS, Russell M., MAJ, R&D Coordinator; BS 1961, US Military Academy. HEL

PRICE, George R., Research Psychologist (Phy & Exp); AB 1960, University of Delaware; Ph. D. 1963, Princeton University. Member: APA, Sigma Xi. HEL

RAAEN, John C., Jr., COL, CO, USAHEL: BS 1943, USMA; 1943 Engr School, Ft. Belvoir, Va; 1949, US Navy Post Grad School, Annapolis; MA 1951, Johns Hopkins University; C&CSG 1955, Ft. Leavenworth, Kansas; 1960, Ind. College of Armed Forces. HEL

RAKOWSKI, John R., Research Psychologist (Engr Psych); BA 1951, Western Reserve University; M. Ed. 1961, Rutgers University; Psychometrics, Education. Member: IEEE. ECOM

RANDALL, R. Bradley, Engineering Technician; BA 1959, Alma College. HEL

RANDOLPH, David I., CPT, MSC; Research Psychologist, Radiation Physics Group, Pioneering Research Laboratory: Ph. D. 1965, University of Massachusetts, Flash Blindness; Neurophysiology of vision. Member: Optical Society of America; AAAS. NATICK

RAPKING, Glenn D., PVT, Mechanical Engr. Asst; Industrial Technology, BA 1967, Tennessee Tech. University. HEL

RAPPOPORT, Emilie N., Research Psychologist (Engineering); BA 1962, Wittenberg University; MA 1964, Ohio State University; Integration of Human Factors Engineering into Weapon System Development Programs. Member: American Psychological Association; Human Factors Society (Huntsville Chapter). MICOM

RAYNER, Jay, Industrial Specialist; BA 1939, Norwich University, Field Test Procedures. MUCOM (PA)

REGAN, James J., Chief Psychologist. Ph. D. 1957, MA 1951, Fordham University; Ph. B. 1948, University of Detroit. Specialization: Training Research and Human Factors. Member: American Psychological Association; American Association for the Advancement of Science; New York State Psychological Association; EPA; Senior Member: IEEE; Ergonomics

Society; Human Factors Society; Sigma Xi. NAVTRADEVCEN

RUNYAN, Steven R., 1LT, R&D Coordinator; BS 1965; MS 1966, Stanford University. HEL

SANTANELLI, Anthony, Research Psychologist; AB 1950; MA 1954, The Catholic University; Image Interpretation; Displays; Programmed Learning. ECOM

SCHAEFER, James A., SP4, Mathematical & Statistical Assistant; BS (Math) 1965, Marietta College; University of Illinois. HEL

SIDEL, Joel L., Acting Head, Food Acceptance Group, Behavioral Sciences Division: BA 1963, Clark University; MA 1963, Northeastern University; Experimental design, statistics. Member: American Society for Testing and Materials. NATICK

SKOGLUND, Richard G., PVT, Mech Engr Asst; Mech Engr. BS 1965, Worcester Poly Inst., MS 1967, Chrysler Inst. of Engr. Member: ASME; SAE. HEL

SMITH, Dorothy G., Dietician, Food Acceptance Group, Behavioral Sciences Division: BS 1943, University of Washington. Nutrition, food technology, hospital dietetics, home economics. Member: Institute of Food Technologists; American Dietetics Association; Home Economics Association. NATICK

SOHM, Lawrence R., SP4, Electrical Engineer, Behavioral Sciences Division; BS 1964; MS 1967, Clarkson College of Technology; electrical engineering. NATICK

SPAROZIC, Nick, PFC, Electronic Engineer, BSEE 1967, Newark College of Engineering. HEL

SPELLMAN, Edsel A., Engineer (Human Factors); BSME 1953, Indiana Technical College. HEL

SPIER, Wayne L., Mechanical Engineering Assistant: BSME 1967, Auburn University; Integration of Human Factors Engineering into Weapon System Development Programs. Member: Human Factors Society (Huntsville Chapter). MICOM

STEPHENS, John A., Chief, Aviation Branch, Systems Research Laboratory; BFA 1951, Rhode Island School of Design. HEL

STOWELL, Harry R., MAJ, USAF (Res), Engineering Technician; San Diego Junior College; Xavier University; Electro/Hydraulics, air-to-ground and air-to-air recovery. HEL

STRAUSS, Paul S., Supervisory Psychologist; BS 1955, Hunter College; MA 1957, Ph. D. 1966, New York University; Industrial Psychology. Member: APA; Human Factors Society. MUCOM (PA)

SUMMERS, Earl P., SP4, Biologist (Human Factors); Behavioral Sciences Division; BS 1966, Claflin College, Biology. Member: Omega Psi Phi. NATICK

THOMAS, George T., Jr., 1LT, R&D Coordinator; BS 1965, University of Tennessee. HEL

TORRE, James P., Supervisory Research Psychologist (Physiological, Experimental & Engineering); Chief, Weapons Branch; BA 1954, Adelphia College. HEL

TUCKER, David J., IV, SP4, Mechanical Engineer; BA 1964, Erskine College; aircraft instrumentation, equipment improvement. HEL

VANDENBELT, David J., SP4, Biological Science Assistant, Behavioral Sciences Division: BA 1966, Kalamazoo College; Physiology, animal behavior. Member: Ecological Society of America. NATICK

VOSS, Harold A., Psychologist; BA 1935; MA 1937, Fordham; Specialization: Human Factors. Member: RESA. NAVTRADEVCEN

WAGNER, Richard V., PVT, Electrical Engineer, Instrumentation Group; Behavioral Sciences Division: BS 1967, University of Missouri; electrical engineering. Member: IEEE. NATICK

WAUGH, John D., Human Factors Engineer; BSME 1960, University of Buffalo; Rensselaer Polytechnic Institute. HEL

WEASNER, M. Harold, Psychologist (Human Factors); MA 1957, University of Virginia; Experimental Psychology. Member: APA; Human Factors Society. MUCOM (PA)

WEISZ, John D., Technical Director, USAHEL; Ph. D. 1953, University of Nebraska. Member: Army Human Factors Engineering Committee; National Academy of Sciences, Committee on Hearing & Bio-Acoustics (also Vision). HEL

WHITE, Robert M., Head, Anthropology Group, Behavioral Sciences Division: BS 1939, Haverford College, Biology; graduate work in anthropology, 1939-42; 1946-48, Harvard University; Physical anthropology, anthropometry, human engineering. Member: Human Factors Society (Past President, New England Chapter); American Association of Physical Anthropologists; Fellow: American Anthropological Assoc; Associate, Current Anthropology; Research Society of America. NATICK

WIBOM, Eric G., Supervisory General Engineer; ME 1918, Stevens Institute of Technology; Professional Engineer, New Jersey; Communication-Electronics; Human Factors Society. ECOM

WIGGINS, Harry F., PFC, Psychology Assistant; BA 1966, North Park College, Chicago, Illinois. HEL

WOKOUN, F. William, Jr., Research Psychologist; Ph. D. 1959, University of Nebraska. Committee Member: SAE. HEL

WOOD, Alan W., Physical Scientist; BS 1959, Monmouth College; Avionics; Human Factors Society. ECOM

YOUNG, Donald D., Psychologist. Ph. D. 1963, MS 1962, University of Miami; BS 1959, Purdue University. Specialization: Human Factors, Simulation, Experimental Design, Statistics. Member: APA; Society of Engineering Psychologists; Human Factors Society. NAVTRADEVCEN

ZUBAL, Orest, SP5, Mechanical Engineering Assistant; BAAE 1966, The Ohio State University. HEL

2C. U.S. MEDICAL RESEARCH AND DEVELOPMENT COMMAND OFFICE OF THE SURGEON GENERAL

Washington, D.C. 20315

SELECTED ASPECTS OF CURRENT WORK PROGRAM

1. Although the US Army Medical Research and Development Command does not have a primary "human factors" mission as such, virtually all of the Medical Research and Development Program bears directly on problems of human effectiveness and, hence, in the broadest sense, may be thought of as human-factors-related. Fiscal support for this research program is provided by the Life Sciences Division of the US Army Research Office.

2. AR 705-5 gives the Surgeon General sole responsibility for conducting research and development within the area of "psycholophysiological aspects of sensation, perception and motor coordination." Selected aspects of this research program are as follows:

	WORK UNIT	INVESTIGATORS	DATE STARTED	CURRENT STATUS
a.	Psychophysics of Visual Perception	I. Behar, Ph.D. J.R. Schjelderup USAMRL, Ft Knox	Mar 56	Continuing

The purpose of this work unit is to elucidate the visual capacity of humans, specifically studying visual acuity, form perception, and color vision.

b.	Psychophysiology of Vision	Adams, C.K, CPT, MSC Behar, I, Ph.D Schjelderup, J.R. USAMRL, Ft Knox	Sept 63	Continuing

The purpose of this work unit is to classify and quanify defective color vision in US Army personnel, and to investigate the anatomical and physiological basis of defective color vision through work with infrahuman primates.

c.	Biomechanical Aspects of Performance	Caldwell, L.S., Ph.D. Lloyd, A.J., CPT Schjelderup, J.R.	Jan 56	Continuing

The purpose of this work unit is to study the behavioral characteristics of the skeletal muscle system as it is involved in various types of physical activity, and to derive general principles which would help in understanding and predicting work efficiency.

d.	Vestibular Function and Disorientation	Rhodes, E.A., CPT Schjelderup, J.R. USAMRL, Ft Knox	Jun 54	Continuing

The purpose of this work unit is the thorough understanding of vestibular biophysics and physiology, such that appropriate personnel selection, training and equipment measures may be recommended prior to exposure to man to unusual acceleration environments.

e.	Traumatic Origins of Hearing Loss	Fletcher, J.L., LTC,MSC Behar, I., Ph.D. Schjelderup, J.R. USAMRL, Ft Knox	Jan 55	Continuing

The purpose of this work unit is to determine and study the relations between noise exposure, and hearing loss, and to predict susceptibility to noise induced hearing loss.

f.	Auditory Perception and Vigilance	Cronholm, J.N., Ph.D. Hatfield,J.L, LTC Kohfeld, D.L., CPT USAMRL, Ft Knox	Jan 55	Continuing

The purpose of this work unit is to assess the influence of sensory coupling on efficiency in detecting critical changes in auditory and visual signals, and to study the effects of prior stimulation on response potential.

g.	Measurement, Composition and Stability of Complex Skills	Herbert, M.J., Ph.D. Hatfield, J.L., LTC,MSC Baron, J.J., CPT USAMRL, Ft Knox	Jun 56	Continuing

The purpose of this work unit is to develop procedures for measuring the components of complex skills; to identify basic abilities, both general and specific, to a variety of skills; to observe revealed ability patterns under conditions of practice and stress, to test the regression hypothesis in performance decrement.

h.	Disorientation and Performance	Wolfe, J.W., Ph.D. Rhodes, F.A., CPT USAMRL, Ft Knox	Jul 65	Continuing

The purpose of this work unit is a long-range effort to provide fundamental information required to anticipate future problems and to solve contemporary problems stemming from spatial disorientation.

i. Specific Contract support in this program includes:

(1) J.R. Binford and J.B. Thurmond, University of Louisville: Vigilance--Factors Influencing Detection and Monitoring Performance (MD-2197). These investigators are attempting to describe the task variables underlying watchkeeping, vigilance, and signal detection performances; to delineate procedures and methods of improving control over level of watchkeeping performance and vigilance; and to modify and extend existing theory of sensory processes and detection theory to the vigilance situation.

(2) J.L. McGrath, Human Factors Research Inc.: Temporal Orientation and Task Performance (MD-2743). The purpose of this research program is to determine how temporal orientation influences human performance, and to determine how temporal orientation may be controlled to enhance performance.

(3) B.K. Lester, University of Oklahoma Medical School: Performance During Drowsy States and Sleep (MD-2758). This project studies sleep, sleep loss and behavior by analyzing performance before, during and after acute and partial sleep deprivation.

(4) E. Hartmann, Boston State Hospital: Sleep and Dream Research (G-9237). This series of studies is investigating what proportions of sleep, in what quantities,are necessary for optimal human performance, and is exploring methods to produce maximally beneficial sleep in the least possible time.

(5) R. Smith, University of Louisville: Effects of Drugs on Sensorimotor Processes and Mentation (MD-2688). Drugs are studied to assess their effects of intellectual functioning, auditory functions and muscular endurance/fatigue.

(6) L. Kaufman, Albert Einstein Medical School: Suppression and Fusion in Stereopsis (MD-2654). This research is elucidating the operations underlying stereoscopic combination on both physiological and psychological levels.

3. The mission of the US ARMY AEROMEDICAL RESEARCH UNIT, at Fort Rucker, Alabama, is to conduct timely aviation medical research which will be relevant to Army Aviation and airborne physical performance standards, medical aspects of retention and selection, training operations and equipment requirements. Liaison is maintained with Army, Navy, Air Force, Federal Aviation Agency and other federal and civilian institutions concerning aviation and airborne activities and collaborative

studies are conducted whenever possible to avoid duplication of effort. Current USAARU work program includes:

Aeromedical Psychology--CPT J.A. Bynum

Efforts of Distortion in Military Communications Systems--R.T. Camp, Jr.

Aromtical Enviornment of Army Aviation Personnel--R.T. Camp, Jr.

Army Aircraft Vibrations Survey--R.T. Camp, Jr.

Army Aviation Audiometry Program--R.T. Camp, Jr.

Vestibular Stimulation and Visual Effects in Army Aircraft--H.W. Huffman, Fred Guedry, and C.W. Hixson.

Urinary Hormone Level in Free-fall Parachuting--LTC W.P. Shane

Attitudes of Officers and Warrant Officer Candidates--CPT J.A. Bynum

Physiological Optics--MAJ J.K. Crosby and LTC R.W. Bailey

4. Other USAMRDC research programs of especial human factors interest:

	WORK UNIT	INVESTIGATORS	DATE STARTED	CURRENT STATUS
a.	Military Performance	Dusek. E.R., Ph.D. Kobrick, J.L., Ph.D. USARIEM, Natick, Mass.	Jan 64	Continuing

This research is producing information on the effects of extreme climatic stresses on important aspects of a soldier's performance and on methcds and techniques for preventing decrements under such stresses. This research involved investigations of how heat, cold, wind, moisture and anoxia, independently and in combination, affect a soldier's perceptual, intellectual, psychomotor, gross motor and emotional responses.

b.	Environmental Psycholophysiology	Dusek, E.R., Ph.D. Barofsky, I., Ph.D. Fine, B J., Ph.D USARIEM, Natick, Mass.	Jan 64	Continuing

This research provides information on the basic mechanisms involved in psycholophysiological responses in crganisms experiencing extreme climacteric stresses. Research is conducted primarily on animals to determine the peripheral and control processes involved in their behavior under extreme thermal stress. Drugs will be used in attempts to reverse the effects of climactic stresses. The acquisition of responses in stimuli under conditions of climactic stress will be studied in order to determine the effects of such stresses on perception and learning.

c.	High Altitude Bioenergetics	Consolazio, C.F. Hannon, J.P. Evans, W.D., MAJ USAMRNL, FHG, Denver	Jul 66	Continuing

This research is attempting to determine the detrimental effects of high terrestrial elevation (10 - 18,000ft.) in human performance in order to assess the limitations on military operations at these elevations, to evaluate acclimatization to altidues, and to minimize these effects through nutrition, selection, conditioning, drugs or other means.

d.	Physiological and Psychological Aspects of Performance at Altitudes	Evans, W.O., MAJ Carson, R., CPT USAMRNL, FGH, Denver	Jul 66	Continuing

Research on this work unit will be directed towards a description of the deterioration of different types of human capacities to perform physical, psychomotor, and mental tasks which are produced by a rapid transition from low terrestrial elevation to those ranging from 10 - 18,000 feet. In addition, correlations between behavioral and physiological changes will be determined in order to suggest ameliorative measures to reduce performance deterioration.

e.	Relation of Certian Psychological Factors and Adaptation to West Point	Dienel, R.M., LTC Lauterbach, C.G., LTC USAMRU, USAH, USMA	Mar 63	Continuing

This research is clarifying relationships and interactions among experimental, situational, and personality variables that underlie the general adaptation of cadets to USMA.

f.	Studies of Muscular Activities of Cadets at USMA	El Beheri, S., MAJ USAMRU, USAN, USMA	Jul 66	Continuing

This research is investigating the physiological aspects of some physical phenomena which are associated with training at USMA, such as brace palsy, decrement in physical performance, evidence and degree of muscle fatigue, and changes in body weight.

g.	Follow-up Study	Dienel, R.M., LTC Lauterbach, C.G., LTC USAMRU, USAH, USMA	Jul 66	Continuing

This is a follow-up study concerning the adjustment and performance of cadets who left the Academy during their Fourth Class year, 1952-53, 1957-38, and 1959-60.

h.	Effect of Fatigue on New Cadet Performance	Skrzypek, G., CPT El Beheri, M.S., MAJ USAMRU, USAH, USMA	May 65	Continuing

This research will determine the degree of physical fatigue in USMA Fourth Classmen and will relate this to broad aspects of USMA performance (academic grades and ASR) and to specific personality measure.

i.	Behavioral Effects of Infectious Diseases	Alluisi, E.A., Ph.D. Univ. of Louisville (MD-2567)	Jul 66	Continuing

This research is attempting to design, construct, and standardize test equipment to measure man's performance on a variety of tasks, and is utilizing this equipment in quantifying the nature and pattern of performance decrements associated with infectious diseases.

j.	Measurement of Performance and Decrement Under Stress	Frazier, T., Ph.D. Sorensen, J.C., CPT Bitetto, V.F., CPT Braine, M.D.S., Ph.D WRAIR	Jul 61	Continuing

This research focuses on the behavioral analysis of human performance and the decremental effects of stress. Considerable emphasis is given to learning and memory processes, language and communication, and decision-making processes.

2C. U.S. MEDICAL RESEARCH AND DEVELOPMENT COMMAND BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

Adams, C.K., Invited Address - Studies of primate color vision. Presented to the Psychology Club, Eastern Kentucky University, Richmond, Ky., 1 Apr 1968.

Adams, C.K., A.H. Bryan, and A.E. Jones. Electroretinographic determination of the spectral sensitivity of the baboon (Papio anubis). USAMRL Report No. 770, 1968.

Adams, C.K. and A.E. Jones. Effect of retinal area on photopic spectral sensitivity in the sooty mangabey. Presented (by Adams) at Psychonomic Society meeting, Chicago, Ill., 26-28 Oct 1967.

Adams, C.K. and A.E. Jones. Spectral sensitivity of the sooty managbey. Percept. and Psychophys. 2(10): 419-422, 1967.

Behar, I. Visual acuity as a function of luminance in three Catarrhine species. Presented at Southern Society for Philosophy and Psychology meeting, Louisville, Ky., 11-13 Apr 1968.

Behar, I. and J.S. Warm. Effects of electrocutaneous ready-signal variation on visual reaction-time. Percept. and Psychophys. 2(11):498-490, 1967.

Brown, J.H. Cross-modal estimation of angular velocity. Percept. and Psychophys. 3(2A):115-117, 1968; presented at Psychonomic Society meeting, Chicago, Ill., 26-28 Oct 1967.

Brown, J.H. and J.E. Marshall. Drug control of arousal and nystagmic habituation in cat. USAMRL Report No. 767, 1968 (DDC AD No. 666282); Acta Oto-larynogol. 64: 345-352, 1967.

Brown, J.H., J.E. Marshall, and V.H. Pribyl. Vestibular habituation: A specific or generalized response decrement. Presented (by Brown) at Southern Society for Philosophy and Psychology meeting, Louisville, Ky., 11-13 Apr 1968.

Brown, J.H. and J.W. Wolfe, Adaptation to prolonged constant angular acceleration. USAMRL Report No. 764, 1968 (DDC AD No. 666178).

Caldwell, L.S. The scaling of effort produced by strenuous

333-404 O-69—23

isometric muscle contraction. USAMRL Report No. 749, 1967 (DDC AD No. 658979).

Cronholm, J.N. A stochastic model of signal detection under conditions of temporal uncertainty. USAMRL Report No. 782, 1968.

Dodwell, P.C., G.S. Harker, and I. Behar. Pulfrich effect with minimal differential adaptation of the eyes. USAMRL Report No. 773, 1968.

Dawson, W.W., H.L. Stewart, and C.K. Adams. Potentials obscured by the electroretinogram. Presented (by Dawson) at Psychonomic Society meeting, Chicago, Ill, 26-28 Oct 1967.

Fletcher, J.L. Field evaluation of sound localization microphone system PHASE II RF linked (U). USAMRL Letter Report No. 14, Jul-Aug 1967.

Fletcher, J.L., A.B. Cairns, F.G. Collins, and J. Endicott. High frequency hearing following meningitis. J. Aud. Res. 7:223-227, 1967.

Fletcher, J.L. and M. Loeb. The effect of pulse duration on TTS produced by impulse noise. J. Aud. Res 7:163-167, 1967.

Fletcher, J.L. and M. Loeb. Real ear evaluation of the Willson sound silencer ear plug. USAMRL Report No. 784, 1968.

Fletcher, J.L., E.M. Weiler, and M. Loeb. Relationships between several indices of acoustic reflex function and susceptibility to temporary threshold shift produced by different spacings of impulsive noise and by continuous noise. Presented (by Fletcher) at Acoustical Society of America meeting, Ottawa, Ontario, Canada, 21-24 May 1968.

Gunn, W.J. Effects of attending to auditory signals on the magnitude of the acoustic reflex. USAMRL Report No. 751, 1967. (DDC AD No. 66413 No. 664133).

Guthrie, C.E., O.J. Dilly, and M. Loeb. Noise evaluation of M-155 reconnaissance vehicle and associated equipment. USAMRL Letter Report No. 16 Mar 1968.

Gettys, C.F. and G.S. Harker. Some observations and measurements of the Panum Phenomenon. Percept. and Psychophys. 2(9):387-395, 1967.

Greenberg, R, C. Pearlman, R. Brooks, R. Mayer and E. Hartmann Dreaming and Korsakoff's psychosis. Arch Gen Psychiat, Vol 18, Feb 1968.

Harker, G.S. A saccadic suppression explanation of the Pulfrich phenomenon. Percept. and Psychophys. 2(9):423-426, 1967.

Harker, G.S. Current trends in AMEDS psychology at USAMRL, Fort Knox, Ky. Presented at AMEDS Short Course, Fitzsimons General Hospital, Denver, Col., 15-19 Apr 1968.

Harker, G.S. and O.L. O'Neal, Jr. Some observations and measurement of the Pulfrich phenomenon. Percept. and Psychophys. 2(10): 438-440, 1967.

Hartmann, E. Dauerschlaf, A polygraphic study. Arch Gen Psychiat, Vol 18, Jan 1968.

Hartmann, E. The 90-minute sleep-dream cycle. Arch Gen Psychiat, Vol 18, Mar 1968.

Hartmann, E. The effect of l-tryptophan on the sleep-dream cycle in man. Psychon. Sci., 1967, Vol 8 (11).

Hartmann, E. The sleep-dream cycle and brain serotonin. Psychon. Sci., 1967, Vol 8 (7).

Hatfield, J.L. and M. Loeb. Sense mode and coupling in a vigilance task. USAMRL Report No. 753, 1967 (DDC AD No. 664760); presented (by Hatfield) at Psychonomic Society meeting, Chicago, Ill, 26-28 Oct 1967.

Herbert, M.J., G.S. Harker, M.L. Baron, and J.K. Miller. Comparison of two optical systems in performance on a driving skill battery (U). USAMRL Report No. 786, 1968 (Confidential report.)

Kohfeld, D.L. Intensity of the RT ready-signal as a determinant of adaptation level. USAMRL Report No. 763, 1968 (DDC AD No. 666180).

Kohfeld, D.L. and G.S. Harker. Subject-controlled treadmill performance as a function of group vs. individual surveillance. Presented (by Kohfeld) at Midwestern Psychological Association meeting, Chicago, Ill., 2-4 May 1968.

Kohfeld, D.L. and W. Weitzel. Relationship of personality factors to social facilitation. USAMRL Report No. 780, 1968.

Kohfeld, D.L., G.S. Harker, and E. Booker McClaskey. Some personality correlates of treadmill performance under public and private surveillan sureveillance. USAMRL Report No. 760, 1967 (DDC AD No. 666176).

Lloyd, A.J., J.H. Voor, and T. Thieman. Subjective and electromyographic assessment of duration during an isometric muscle contraction. USAMRL Report No. 772, 1968; presented (by Thieman) at Southern Society for Philosophy and Pyschology meeting, Louisville, Ky., 11-13 Apr 1968.

Loeb, M. and J.L. Fletcher. Impulse duration and temporary threshold shift. Presented (by Loeb) at Acoustical Society of America meeting, Ottawa, Ontario, Canada, 21-24 May 1968

Loeb, M., J.L. Fletcher, and K. Sigmund. Noise evaluation of prototype Hawk Missile Launcher and associated equipment. USAMRL Letter Report No. 13, Jul 1967.

Loeb, M., K. Sigmund, and J.L. Fletcher. Audiometric evaluation of hazard associated with firing of CHAPARRAL and REDEYE. USAMRL Letter Report No. 15, Jan 1968.

Loeb, M. and R.P. Smith. Relation of induced tinnitus to physical characteristics of the inducing stimuli. The Journal of the Acoustical Society of America, Vol 42, No.2 453-455, Aug 1967.

Marshall, J.E. Visual-vestibular interaction and threshold for angular acceleration. USAMRL Report No. 754, 1967 (DDC AD No. 660287).

Smith, R.P., J.S. Warm and E.A. Alluisi. Effects of temporal uncertainty on watchkeeping performance. Percept. and psychophy., 1966, Vol 1.

Smith, R.P. and L.S. Caldwell. Effects of instructional set upon subjective scaling of effort and pain. Presented (by Smith) at Southern Society for Philosophy and Psychology meeting, Louisville, Ky., 11-13 Apr 1968.

Smith, R.P., L.S. Caldwell, and D.M. Thomas. Effect of d-tubocurarine on the scaling of effort of isometric muscle contractions. USAMRL Report No. 765, 1968 (DDC AD No. 666749).

Smith, R.P. and M. Loeb. Recovery from temporary threshold shifts as a ounction of test and exposure frequencies. Presented (by Smith) at Acoustical Society of America meeting, Ottawa, Ontario, Canada, 21-24 May 1968.

Thurmond, J.B., M. Loeb, and J.R. Binford. Performance in monitoring single and multiple acoustic intensity increments. Presented (by Thurmond) at Psychonomic Society meeting, Chicago, Ill., 26-28 Oct, 1967.

Warm, J.S., R.P. Smith, and L.S. Caldwell. Effects of induced muscle tension on judgments of time. Percept Mot. Skills, 25: 153-160, 1967.

Warm, J.S., E.A. Alluisi, and M. Loeb. Variation in performance on a visual monitoring task as a function of signal rate and duration. Presented (by Warm) at Southern Society for Philosophy and Psychology meeting, Louisville, Ky., 11-13 Apr 1968.

Warm, J.S., M. Loeb, and E.A. Alluisi. Effects of color, relative position, and the onset or offset of signals in a watchkeeping task. Psychon. Sci. 9:95-96, 1967.

Wolfe, J.W. Technical Note: A restraint device for electrophysiological recording in the unanesthetized cat. USAMRL Report No. 771, 1968 (DDC AD No. 6686666).

Wolfe, J.W. and J.H. Brown. Effects of sleep deprivation on the vestibulo-ocular reflex. USAMRL Report No. 766, 1968 (DDC AD No. 666750).

Wolfe, J.S., J.R. Nall and C.D. Purpura. Description of optokinetic device. USAMRL Report No. 783, 1968.

2C. U.S. MEDICAL RESEARCH AND DEVELOPMENT COMMAND BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

ADAMS, Calvin K., Captain, MSC, Research Psychologist, Ph.D. Kansas State University, 1964. Sensory processes. AMRL

BAILEY, Robert, LTC. CO, USAARU, MS.S., Ohio State University, 1958. Physiological Optics. ARU, Ft. Rucker.

BAROFSKY, Ivan, Research Psychologist, Ph.D., Florida State University, 1964. Operant behavior under environmental stress. ARIEM.

BEHAR, Isaac, Research Psychologist, Ph.D., Emory University, 1959. Primate research. AMRL.

BOREN, John, Chief Department of Experimental Psychology, Ph.D., Columbia University, 1953. Conditioning and experimental analysis of stress. WRAIR.

BRADY, Joseph V., COL. Deputy Director, Division Neuropsychiatry, Ph.D., Chicago, 1951. Neurophysiology and experimental analysis of stress. WRAIR.

BROWN, James H., Research Psychologist, Ph.D., University of Virginia, 1962. Perception, vestibular mechanisms. AMRL.

BYNAM, J.A., CPT, Experimental Psychologist, Ph.D., Baylor University, 1966. Aviation psychology, ARU, Ft. Rucker.

CAHOON, Richard, Research Psychologist, Ph.D., Tufts University, 1966. Effects of hypoxia on physiological indices of behavior. ARIEM.

CALDWELL, Lee S., Research Psychologist, Ph.D., University of Kentucky, 1955. Biomechanics. AMRL.

CAMP, R.T., Jr., Director Basic Sciences Division, B.A., University of Florida, 1955. Psychoacoustics. ARU, Ft. Rucker.

CONSOLAZIO, C.F., Chief Bioenergetics Division, Ph.D., Respiratory physiology. AMRNL.

CRONHOLM, James N., Psychophysiologist, MS. University of Oregon, 1956. Primate research. AMRL.

CROSLEY, John K., CPT, MSC, Optometrist, M.Sc., Indiana University, 1966. Physiological optics. ARU, Ft. Rucker.

DIENEL, Richard, LTC, Research Social Worker, M.S.W., Washington University, 1950. Med Rsch Unit, USMA.

DUSEK, Ralph, Director Behavioral Sciences Laboratory, Ph.D., State University of Iowa, 1951. Environmental effects on human performance. ARIEM.

EL BEHERI, M.S., MAJ, MSC, Research Physiologist, Ph.D., Indiana. Electromyography. Med Rsch Unit, USMA.

EVANS, Wayne, LTC, MSC, Research Psychologist, Ph.D., Duke University, 1960. Psychopharmacology and human performance. ARIEM.

FINE, Bernard J., Research Psychologist, Ph.D., Boston University, 1951. Biochemical-endocrine correlates of behavior under stress. ARIEM.

FLETCHER, John L., LTC, MSC, Research Psychologist, Ph.D., University of Kentucky, 1955. Audition. AMRL.

FRAZIER, Thomas, Experimental Psychologist, Ph.D., Florida State University, 1966. Human performance under stress. WRAIR.

GERBEN, Martin, Research Psychologist, Ph.D., University of Pittsburgh, 1966. Effects of hypoxia on animal and human performance. ARIEM.

GOLDMAN, Ralph F., Director, Military Ergonomics Laboratory, Ph.D., Boston University, 1955. ARIEM.

GUNN, Walter, J., Electronics Engineer (Instrumentation), BS, Kings Point USMMA, 1959. Instrumentation and auditory measurement. AMRL.

HARKER, George S., Director, Experimental Psychology Division, Ph.D., University of Iowa, 1950. Vision. AMRL.

HARRIS, Mark R., CPT, MSC, Research Psychologist, M.A., University of Minnesota, 1953. Motor skills. AMRL.

HATFIELD, Jimmy L., LTC, MSC, Research Psychologist, Ph.D., Vanderbilt University, 1967. Aviation and human performance. AMRL.

HEDLUND, James L., LTC, Chief Biomedical Stress Research Branch, Ph.D., State University of Iowa, 1953. Clinical and experimental psychology. HQ USAMRDC.

HERBERT, Marvin J., Research Psychologist, Ph.D., University of Minnesota 1953. Motor skills. AMRL.

HODOS, William, Chief Neuropsychology Lab, Ph.D., University of Penn., 1960. Physiological and experimental psychology. WRAIR.

KOBRICK, John L., Research Psychologist, Ph.D., Pennsylvania State University, 1953. Perception and cognitive functions under stress. ARIEM.

KOHFELD, David L., CPT, MSC, Research Psychologist, Ph.D., University of Illinois, 1966. Experimental psychology. AMRL.

KOLMER, Harold, COL, Chief, Medical

Research Project, M.D., Temple University, 1947. Military psychiatry. Med Rsch Unit, USMA.

KINSMAN, Robert A., Research Psycho logist, CPT, MSC, Ph.D., University of Colorado, 1967. Human cognition. AMRNL.

LLOYD, Andree, CPT, MSC, Research Psychologist, M.A., University of Kentucky, 1963. Kinesthesis. AMRL.

MAILLET, Edward L., MAJ, MSC, D.S.W., Catholic University 1966. Social systems and performance effectiveness. WRAIR.

MASON, John, Chief, Department of Neuroendocrinology, M.D., Indiana University, 1947. Neuroendocrinology. WRAIR.

PATTON, Gary, Research Psychologist, Ph.D., Tufts University, 1967. Effects of hypoxia on physiological indices of behavior. ARIEM.

RIOCH, David McK., Director, Division of Neuropsychiatry, M.D., Johns Hopkins Medical School, 1924. WRAIR.

ROSENBERG, Edwin M., CPT, MC, Assistant Chief, Biomedical Stress Research Branch, Dalhousie University, 1965. Military psychiatry. HQ USAMRDC.

SCHANE, William, LTC, Director, Aviation Medicine Research Division, M.D., University of Pennsylvania, 1955. Cardiovascular stress responses. ARU, Ft. Rucker.

SCHUBERT, Daniel, CPT, MC, M.D., University of Buffalo, 1965. Measurement of environmental stress on social and physiological responses. ARIEM.

SORENSEN, James C., CPT, MSC, Psychologist, Ph.D., Purdue, 1967. Clinical experimental and human performance. WRAIR.

STEINBERG, Roy H., CPT, MC, Neurologist, M.D., N.Y.U., 1961, Ph.D. McGill University, 1965. Neurophysiology of vision. ARU, Ft. Rucker.

WINTER, David L., Chief, Department of Neurophysiology, M.D., Washington University School of Medicine, 1959. Neurophysiological correlation of stress. WRAIR.

WOLFE, James W., Research Psychologist, Ph.D., Rochester University, 1966. Vestibular functions. AMRL.

2D. U.S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY

Washington, D.C. 20315

MISSION AND SCOPE

The U.S. Army Behavioral Science Research Laboratory, a Class II activity under the jurisdiction of the Chief of Research and Development, in accordance with AR70-8 and CSR 10-56, undertakes research in behavioral science and operations research in support of the broad areas of personnel management, human performance experimentation, and manned systems research. The research is conducted in and for the Department of the Army to meet objectives of Army-wide scope and significance and is directed toward optimal employment of Army personnel in a variety of military settings.

The research effort is RDT&E-funded and is carried out principally under five Project-level DD 1498's, with additional RDT&E funding provided for In-House Laboratory Independent Research, for Basic Research, and for special DOD assignments. The program is organized around four Research Areas:

Personnel Management Research--Selection includes research on selection and classification and evaluation of behavior involving unusual demands upon individuals, groups or systems, on the development of military selection and classification systems for other cultures. The research has implications for manpower planning (e.g., impact of EM with low general aptitude on training and operations), early identification of individual assets (including officer and combat potential) for maximum job performance; also, adjustment, motivation and operating relationships with fellow team members.

Personnel Management Research--Manpower Management seeks direct solutions to problems involving development and implementation of mathematical manpower models to assist in manpower processing, planning and policy formulation, and quantitative models and computer aided simulation studies relating to human behavior and/or personnel utilization. Use is made of operations research to evaluate systems performance where the human element is critical.

Human Performance Experimentation involves study of behavioral functions common to many systems in order to discover general principles which, when applied operationally, will enhance the performance of individuals within these systems. Typical outputs are work methods, work-rest cycles, supervisory techniques, information input and response output procedures. Those means of improving performance determined to be successful in the laboratory setting are evaluated with field research in an operational setting.

Manned Systems Research has as its principal objective the enhancement of human performance in relation to total systems effectiveness. It involves experimentation with various configurations of systems components considering interactions with trade-offs with the goal not only of improving human performance but of providing the means of evaluating systems effectiveness as a function of systems factors.

ORGANIZATION

The Director has responsibility for the planning and conduct of the scientific program, which is carried out by an in-house staff of 135 augmented by contract resources. More than half are professionally trained psychologists, statisticians and mathematicians; the others are support personnel. A Deputy Director assists the Director in a staff capacity in each of the BESRL broad areas--military selection research, manned systems research, and human performance experimentation. Line authority for execution of the program extends from the Director to five Divisions, one of which lends statistical and computer support to the other four in addition to carrying out its research responsibilities.

A. CURRENT WORK PROGRAM

1. Selection and Behavioral Evaluation (Project 2J062106A722)

Work Unit	Experimenter	Date Started	Estimated Completion
a. Enlisted Manpower	E.F. Fuchs A.G. Bayroff BESRL, Wash., D.C.	Jul 68	Continuing

Objectives are to develop new forms of screening measures for use by Army and the other services so as to measure more effectively the level of trainability and usability of potential enlisted men, to develop new reference measures for use as standards in development of screening and classification tests of all the services, and to improve methods for extracting predictive information from screening tests. The potential military research and results are differential screening batteries and related instruments for use by all the services, more effective identification of usable marginal personnel, more appropriate basic tools for development of military aptitude tests, and new understanding of unconventional testing techniques for use in developing future operational instruments. BESRL, continuing in its role as lead service, will monitor a contract effort to develop two new forms of ASVAB, including an item analysis study as well as a standardization study, to overcome the limitations of the present ASVAB. BESRL has been engaged in methodological research on the potential value of unconventional testing techniques for extracting predictive information. Work with very short, limited range tests for go-no go screening has progressed sufficiently to demonstrate their feasibility. Disguised aptitude tests constitute a new approach to detecting deliberate test failures. Facilities of the BESRL computer system and the SSRD Information Systems Laboratory will be studied to determine what modifications are necessary to make them serve as a programmed testing machine. Present indications are encouraging although some problems remain.

b. Differential Classification	E.F. Fuchs M.H. Maier BESRL, Wash., D.C.	Jul 68	Continuing

Objective of research is to achieve optimal utilization of the enlisted input by identifying the conditions, such as type of training program and job content, that may interact with the effectiveness of the classification tests, and by maintaining and improving the effectiveness of the Army Classification Battery (ACB) and related techniques. Potential military research end reults are determination of conditions that affect validity of the classification tests, to provide a basis for judging how changes in condition are related to the kinds of aptitudes utilized in training and job performance, and increased coverage of the classification battery to include measures that have greater differential validity, which will result in improved utilization of the enlisted manpower. A long-term research effort resulted in the Army Differential MOS Battery, which was tried on about 25,000 EM in over 100 training courses; the experimental measures that prove effective will become replacements for or supplements to the operational ACB. The effectiveness of the measures, both experimental and operational, must be determined for the conditions under which they are used; these include effectiveness for predicting success in intial training assignments and in subsequent training and job assignments.

c. Optimum Mental Distribution	E.F. Fuchs S.F. Bolin BESRL, Wash., D.C.	Oct 65	Continuing

Objective of research is to develop measures of small unit and individual effectiveness to estimate mixtures of individual mental ability levels which will permit application of relatively low individual screening standards while achieving relatively high levels of unit performance. Potential military research end results are determination of impact of various levels of mental ability input on Army performance, standards for qualitative input to meet Army needs under various conditions of peace and mobilization, estimation of the critical levels and maximum safe percentages of below-average input for meeting Army performance requirements. Planning has taken place for the development of objective measures of the performance of individuals and their units to compare units composed of differing distributions of individual ability. Performance measures for individuals must take account of typical productivity and disciplinary problems as well as technical ability. Preliminary studies will explore the problem of developing measures of unit and individual effectiveness. The range of MOS and unit types getting large numbers of low mental ability men will be determined. In rifle squads and one type of non-combat unit, various approaches capitalizing on experience with performance tests, peer and supervisory ratings, administrative records, and the like will be explored. A search for insights to pass-fail points on relative performance measures will be emphasized.

d. Officer Prediction	W.H. Helme L.P. Willemin BESRL, Wash.,D.C.	Oct 63	Continuing

Objective of research is to develop improved techniques and prerequisites for selecting officers who have aptitude and other characteristics that lead to enhanced leadership performance in combat, administrative, or technical assignments, and who are favorably oriented toward an Army officer career. Potential military research end result includes maximum utilization of available officer talent in the Army of the future, through: (1) early measurement of aptitudes and characteristics related to competent performance in specific job areas, (2) improved prerequisites for the selection or early identification of potential officers, and (3) improved stability of the officer corps through use effective junior officers. With the advent of U.S. participation in Vietnam, the effort of the Officer Prediction Work Unit was redirected to permit the collection of available human performance data in up-to-date combat or combat-ready settings. The basic design remained the same: Development and administration of experimental psychological predictors, developmen. of criterion measures of human performance, collection of measures human performance, analysis of predictors against criteria, and follow-up to identify qualified officers who remain on active duty beyond their obligated service. Officers originally given the experimental screening measures and still on active duty are being followed up in order to validate the predictors against actual performance demonstrated beyond the OEC. Evaluations of such actual performance have been obtained in Vietnam, Europe and elsewhere. In all, the accumulated research data are of unprecedented magnitude. From the complete analysis, a final test will be made of the major hypothesis of this work unit: that ability to meet the requirements of combat, administrative, and technical jobs is predictable. The analysis is expected to indicate as well the extent to which the career orientation of the more effective officer is predictable.

e. Officer Evaluation	W.H. Helme F.F. Medland BESRL, Wash., D.C.	Oct 68	Continuing

Objectives of research are to investiage methods of evaluating performance of officers and develop techniques for evaluation for such purposes as promotion, assignment, and career development of officers. Initially the findings from the Officer Prediction Work Unit will provide hypotheses and techniques for evaluation of first-tour officers. New research will be initiated at other levels such as transition from CPT to MAJ and LTC to COL to BG, utilizing diverse techniques such as situational evaluations, peer ratings, and structured interviews and board procedures.

Particular career fields will be investigated which offer unusual demands as to technical requirements and staff or field leadership and interpersonal expertise. Potential military research end results will be techniques and procedures for incorporation into an officer evaluation system designed to provide better information for use in career personnel actions by the Army and in better self-appraisal and career decisions for the individual officers. An additional objective is to complete development and standardization of new instruments for selection of combat enlisted men conducted under the Combat Performance Work Unit of FY 68, and to apply findings to the differential classification and assignment of such men. Potential military research end results will be improved measures for initial assignment of personnel to the combat MOS.

f.	Culture Fair Testing	W.H. Helme L.J. Kotula BESRL, Wash., D.C.	Mar 67	4th Q FY 70

Objective of research is to develop general methods and techniques for instituting military selection and classification systems which take into account dynamic cultural factors in selected countries. Potential military research end result is a selection and classification system for the Imperial Iranian Army with guidelines as to methods and techniques applicable to other countries desiring to adopt comparable systems. The basic approach is to assist in determining the country's qualitative manpower resources in terms of the incidence of general and specific skills, and to assist in determining its Army's qualitative requirements in terms of incidence of skills needed to enter the military specialist training programs and also to assist with the identification of methods and techniques for generalization to other countries.

g.	Cadet Leaders	W.H. Helme L.P. Willemin BESRL, Wash., D.C.	Feb 63	Continuing

Objectives of research are to provide procedures that will improve the academic quality and leadership potential of college and university students selected for Army ROTC programs. These procedures will apply to applicants for scholarships under PL 88-647, to applicants for initial and advanced ROTC training and to those cadets eligible for direct commissions upon graduation; to improve selection procedures for USMA and other primary officer training programs, particularly with respect to the problems of identifying leadership potential and career motivation among applicants. Potential military research end result is increased quality and career motivation of USMA, OCS and ROTC graduates through the use of improved selection measures. For FY 69, research to verify operational effectiveness of the new OCS selection battery will be conducted. Research on cadet leadership and attrition conducted by the Office of Research, USMA, will be coordinated with product appraisal of USMA graduates by BESRL. Follow-up data on junior officer performance in Vietnam, Korea, and elsewhere will be analyzed.

2. Army Operations Analysis (Project 2J065101M711)

Work Unit	Experimenter	Date Started	Estimated Completion
SIMPO I	C.D. Johnson Pauline T. Olson BESRL, Wash., D.C.	Jun 67	4th Q FY 70

Objectives of research are to analyze the personnel subsystem, from a problem oriented point of view, to determine points at which decisions are made, operations which affect total system effectiveness, and criteria by which policies may be evaluated; to simulate personnel functions in the context of a personnel system in order to predict and assess the total result of policy changes; to provide a basis for an increasingly integrated approach to policy evaluation within the full scope of the total personnel subsystem. Potential military research end result will include interim models used to evaluate policies relating to the assignment, training, and utilization of aviators, contingency readiness models, procedures for improving the management of Army resources (PRIMAR), and for capability analyses requirements of ODCSPER. In broader terms, the SIMPO I product will provide computer aided operations research methods and tools that will increase the Army's in-house capability for responding to personnel management requirements.

3. Human Performance in Military Systems (Project 2J062106A723)

	Work Unit	Experimenter	Date Started	Estimated Completion
a.	Optimization Models	C.D. Johnson BESRL, Wash., D.C.	Jul 67	Continuing

Objectives of research are to solve personnel management problems relating to the distribution, training, career progression, reassignment, and utilization of personnel in both current and future systems; to analyze personnel systems and identify areas where objective optimization techniques can be applied; to develop further quantitative techniques for management and provide consultative assistance regarding their application. Potential military research end results are the design and evaluation of alternative information systems for effecting initial assignment and distribution of personnel; increased knowledge of the effect of automated procurement, distribution, training and reassignment policies on manpower quality; expanded manpower management control through use of computer aided management decision models; and application of optimization models to a greater variety of manpower problems.

b.	Monitor Performance	A. Hyman J.H. Banks BESRL, Wash., D.C.	Jul 62	Continuing

Objectives of research are to develop and test principles, techniques, and operating procedures to improve the performance of personnel working in a variety of Army monitoring jobs, and to improve the performance of information monitoring personnel within the Army Security Agency. Potential military research end results are improvement of work methods and selection techniques for a broad spectrum of critical U.S. Army monitoring jobs, the development and/or reorganization of monitoring tasks to exploit human monitoring capabilities, and improved utilization and selection of personnel for the Army Security Agency.

c.	Night Operations	A. Hyman J.J. Sternberg BESRL, Wash., D. C.	Jul 67	Continuing

Objectives of research are identification of variables and parameters influencing perceptual performance during night operations, development of principles and techniques which will enhance perceptual performance during night operations, evaluation and validation of resulting work methods and procedures leading to most effective utilization of appropriate personnel. Potential military research end results include specifications of capabilities, limitations and reliability of human perceptual performance for night operations; development of principles and techniques leading to more effective work methods; information useful to specifying allocation of job functions among men and equipment, including the type and number of visual devices; evaluation of night operations performance with and without aids in order to assess the contribution of such aids; identification of effective team procedures to employ under various system conditions and requirements. In general, the salient questions deal with who should use which devices, how, under what conditions, and what should be the basis of issue and mix. Presently, there is a serious lack of research data dealing with these questions. There have been virtually no controlled laboratory or field studies evaluating the actual performance of the newer devices nor any comparisons of their relative effectiveness.

d.	Control Performance	A. Hyman BESRL, Wash., D.C.	Jul 68	Jun 69

Objectives of research are to develop and test operating procedures, techniques and principles to improve the performance of personnel working in a variety of Army controller jobs: to develop measures of the individual soldier's potential to reach effective performance levels in operator MOS which require precise control response sequences. Of particular importance are the control responses to man-machine interfaces that present complex displays having a high density and rapid change of information. This work unit will conduct a survey of Army jobs to determine those which have a critical controller component. On the basis of this survey, controller performance relating to a number of Army jobs and controller performance critical to combat operations (i.e., where controller error would endanger large numbers of men and/or destory costly military equipment) will be identified. The survey findings will determine the focus of the ensuing research. It is anticipated that part-task simulators will be developed and employed in the further conduct of the research effort.

e.	Tactical Information Processing	J. Zeidner S. Ringel BESRL, Wash., D.C.	Jul 68	Continuing

Objective of research is to develop techniques for efficient processing and use of information by operational personnel in tactical situations. Potential military research and results include assistance to users and developers of current and future Command Systems by providing empirical information about: (1) the capabilities, limitations, and reliability of human performance and implications for system development; (2) various modes and sensory modalities for presenting information for assimilation and decision making; (3) specification of effective individual and group work methods and techniques. Objective performance measures will be developed. Operations will be studied to ascertain human limits and reliability and the factors which underlie the performance of critical functions. Various work methods and techniques will be evaluated. One series of studies concerns information assimilation and decision making. These studies will investigate the effects on performance of various information factors such as: amount, coding, specificity, alpha-numeric and graphic formats, rate and degree of updating, and hard copy. Further research will be conducted on individual and group procedures and on probability data, decision alternatives, and consequences generated by man and computer. Other studies will concern the problems inherent in preparing information (screen, transform, input) for subsequent use.

f.	Tactical Operations Systems	J. Zeidner S. Ringel BESRL, Wash., D.C.	Jul 68	Continuing

Objective of research is to maximize effectiveness of Command Information Processing Systems through most efficient use of human abilities. Potential military research end results include assistance to users and developers of current and future Command Systems by providing empirical information about: (1) allocation of functions among men and equipment: (2) procedures for identification and assignment of appropriate personnel to critical positions; (3) objective performance measures for the evaluation of man-machine interaction; (4) emergency backup systems and procedures; (5) various system configurations. Relevant and objective performance measures are a basic requirement for all further research. The measures to be developed are expected to reflect the effects of variations in conditions or variables. Examination of such effects will make it possible to identify those factors which make a significant contribution to the overall success or failure of the system. Additionally, such measures will be of use to commanders in assessing the capabilities of their system, sub-systems, and individuals. Additional attention will be given to the development of a Manual Backup System, to allocation of functions to man and equipment, to simulation possibilities, and to the TOS-ADSAF interface.

4. Image Characteristics & Interpreter Performance (Project 2J662704A732)

Work Unit	Experimenter	Date Started	Estimated Completion
Interpreter Techniques	J. Zeidner A. H. Birnbaum BESRL, Wash., D.C.	Jul 63	Continuing

Objective of research is through the most efficient use of human abilities to develop methods and procedures which maximize the accuracy, completeness and speed of intelligence information derived from the interpretation of imagery. The imagery includes static as well as dynamic (real time) presentations from photo, infra-red and radar (SLAR) sensors. Potential military research end results include quick-time interpretation and screening methods which will permit an interpretation facility to quickly process a greater amount of the acquired imagery; empirical data on the interpretability of infra-red and SLAR displays and techniques for better interpretation of such imagery; performance data on the utility of multi-sensor cover together with concepts of use for multi-sensor cover and its interpretation; data on equipment needs and procedures necessary for maintaining and improving system personnel proficiency and operations, information flow, and duty station assignment in quick-time and IR interpretation.

5. Surveillance Systems (Project 2J662704A721)

	Work Unit	Experimenter	Date Started	Estimated Completion
a.	Image Interpretation Displays	J. Zeidner A. H. Birnbaum BESRL, Wash., D.C.	Jul 63	Continuing

Objective of research is to determine how interpreter performance is affected by variations in the characteristics of the image (e.g., magnification, image quality, etc.) for photos, infra-red and radar (SLAR) imagery, and by variations in the nature and content of references and reporting devices to be used by the interpreter. Potential military research end-results include (1) Characteristics that define photos, infra-red and radar keys and references that will assist the interpreter to accomplish his work more accurately; (2) performance data on the interpretation of transmitted imagery which may be differentially degraded due to signal reflections from different terrain features; (3) data on the effects of image quality on rapid interpreter screening performance; (4) the specification of information entry and transfer techniques for accurate and speedy reporting while viewing displays.

b.	Intelligence Systems	J. Zeidner R. Sadacca BESRL, Wash., D.C.	Jul 68	4th Q FY 70

Objective of research is to improve the speed, accuracy and completeness of Field Army intelligence processing in advanced computerized systems through research on man/machine functions, procedures, and information management. Potential military research end results are (1) improved human factors, computer procedures and man/machine dialogues for processing intelligence information; (2) development of an intelligence data bank and objective measures for the evaluation of individual and system performance; (3) efficient management of intelligence systems input, internal information flow, and output. The emphasis in this work unit is on the development of automated data handling techniques to assist the intelligence decision process. The research will be conducted within the computerized Information Systems Laboratory. A computer data base will be established so that modeling or simulated intelligence processes can be employed.

c.	Image Systems	J. Zeidner R. Sadacca BESRL, Wash., D.C.	Jul 68	Continuing

Objective of research is to integrate, evaluate, and improve advanced surveillance information processing systems through laboratory simulation and the development of effective techniques for improving team operations, data bank utilization, and the control of the imagery and information flow through the system. Potential military research end results are (1) acquisition of reliable empirical and simulation data concerning system operations, components, and performance characteristics from which designers of advanced systems can confidently construct future systems; (2) determination of the men, equipment and procedures necessary for improving team operations and system information flow and interpreter decisions; (3) development of computerized techniques for utilizing references involving efficient indexes, physical forms, storage media, and retrieval and display procedures.

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2D. U.S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

Technical Research Reports

Katzell, Raymond A. and Barrett, Richard S. (Research Center for Industrial Behavior, NYU). Impact of the executive on his position. BESRL Technical Research Report 1154. January 1968

Uhlaner, J.E. (Ed.) The research psychologist in the Army--1917 to 1967. BESRL Technical Research Report 1155. April 1968.

Technical Research Notes

Brown, Emma E. Abstracts of BESRL Research publications--FY 1967. BESRL Technical Research Note 191. August 1967.

Stichman, Eugene P. Relationship of expressed confidence to accuracy of transcription by operational communications personnel. BESRL Technical Research Note 192. October 1967.

Niehl, Elizabeth and Sorenson, Richard C. SIMPO-I entity model for determining the qualitative impact of personnel policies. BESRL Technical Research Note 193. January 1968.

Andrews, Robert S., Vicino, Frank L., and Ringel, Seymour. Relation of certitude judgments to characteristics of updated symbolic information. BESRL Technical Research Note 194. April 1968.

Cockrell, John T. (System Development Corporation). Maintaining image interpreter proficiency through team consensus feedback. BESRL Technical Research Note 195. April 1968.

Fiedemann, John J. and Dean, Robert F. Field evaluation of the BESRL RIB method in special devices search and analysis. (Unclassified title). BESRL Technical Research Note 196 (SECRET). April 1968.

Maier, Milton. Procedures for assigning criterion grades to failures and turnbacks in Army school courses. BESRL Technical Research Note 197. April 1968.

Tiedemann, John J. and Feil, Richard N. Monitoring performance as a function of muscular response effort. BESRL Technical Research Note 198. May 1968.

Olson, Pauline T. Use of Army school samples in estimating ACB test validity. BESRL Technical Research Note 199. August 1968.

McKendry, James M. and Mace, Doughlas J. (HRB-Singer, Inc.) and Baker, James D. (BESRL). Certitude judgments in an operational environment. BESRL Technical Research Note 200. August 1968.

Research Studies

Helme, William H. and Orleans, Isaak. Personnel systems of the Imperial Iranian Army--Research requirements. (Unclassified title). BESRL Research Study 68-1 (CONFIDENTIAL). March 1968.

Fuchs, Edmund F. New forms of the Examen Calificacion de Fuerzas Armadas--Preparatory studies. BESRL Research Study 67-2. July 1967.

Kotula, Leo J. Review of OCS board interview procedures. BESRL Research Study 67-3. November 1967.

Olson, Pauline T. ACCMOD: A SIMPO-I dynamic flow model to project enlisted accession needs. BESRL Research Study 68-2. April 1968.

Bigelow, George F. and Martinek, Harold. Contents of BESRL aerial surveillance film library--1 January 1968. BESRL Research Study 68-3. May 1968.

Baker, James. Human factors experimentation within a tactical operations system (TOS) environment. BESRL Research Study 68-4. July 1968.

Papers Presented at Meetings of Professional Organizations

Birnbaum, Abraham H. Preliminary PROJECT PELICAN results on thermal sensitivity versus spatial resolution. ACSI and Army R&D Conference. Washington, D.C. 1 September 1967.

Jeffrey, Thomas E. Extraction of tactical information from SLAR imagery. 13th Annual Army Human Factors R&D Conference. Fort Monouth, New Jersey. October 1967.

Kotula, Leo J. Psychological measures for use in ROTC selection and related problems. 5th Annual USCONARC ROTC/NDCC Conference. Fort Monroe, Virginia. 6-8 September 1967.

Ringel, Seymour. Human Factors in tactical command systems. 13th Annual Army Human Factors R&D Conference. Fort Monmouth, New Jersey. October 1967.

Sorenson, Richard C. Dynamic flow models for the study of manpower systems. Manpower Allocation and selection Modeling Working Group, 19th Military Operations Research Symposium. Fort Bliss, Texas. 1 April 1967.

Zeidner, Joseph. Human Factors in information processing and target acquisition. 13th Annual Army Human Factors R&D Conference. Fort Monmouth, New Jersey. October 1967.

Castelnovo, Anthony E. Effects of spectrum sampling on speech intelligibility. 1968 U.S. Army Science Conference Program, sponsored by OCRD. Washington, D.C. 25 March 1968.

Haynam, Kenneth W. Minimization of training cost and quantity of multi-skilled personnel under contingency skill-requirement conditions. 7th Annual U.S. Army Operations Research Symposium. Durham, North Carolina. 22-24 May 1968.

Niehl, Elizabeth. An experimental comparison of Monte Carlo sampling techniques to evaluate the multivariate normal integral. 7th Annual

U.S. Army Operations Research Symposium. Durham, North Carolina. 22-24 May 1968.

Andrews, Robert S. and Sadacca, Robert. Improving photo interpretation output through computer utilization. Prepared for Commission VII of the International Society for Photogrammetry for presentation to the Eleventh International Congress. Lausanne, Switzerland. 8-20 July 1968.

2D. U.S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

UHLANER, Julius E., Director, BESRL; PhD, New York University, 1947, Psychology; Phi Delta Kappa, Psi Chi; Fellow, American Psychological Association, Washington Academy of Sciences; Operations Research Society of America, Human Factors Society, Psychometric Society, Psychonomic Society, EPA, DCPA, SEPA, WPA; NRC--Highway Research Board, NRC--Armed Forces Committee on Vision, Army Behavioral and Social Sciences R&D Committee.

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BAYROFF, Abram G., Sr. Task Leader; PhD, University of North Carolina, 1931, Psychology; Fellow, American Psychological Association, AAAS; Member, APA Committee on Assessment, EPA, DCPA (President 1968), SEPA, Psychonomic Society; Sigma Xi; Diplomate (Industrial) ABEPP.

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WILLIAMSON, Roger L., Research Psychologist (PM&E); BA, Valparaiso University, 1962, Psychology.

HYMAN, Aaron, Deputy Director for Human Performance Experimentation and Chief, Combat Systems Research Division; PhD, Columbia University, 1959, Experimental Psychology; Member, American Psychological Association, Human Factors Society, Am. Institute of Physics (OSA), AAAS, Society of Sigma Xi, Armed Forces--NRC Committee on Vision.

BANKS, James H., Jr., Sr. Task Leader; PhD, University of Minnesota, 1959, Psychology; Member, American Psychological Association, EPA.

CASTELNOVO, Anthony E., Research Psychologist (PM&E); MS, Kent State University, 1950, Psychology.

COHEN, Stanley L., Research Psychologist (P&E); MA, George Washington University, 1966, Psychology (course work and research completed toward PhD); Assoc Member, APA; Sigma Xi, Psi Chi.

DEAN, Richard, Research Psychologist (E&P); MS, University of Maryland, 1962, Gen. Experimental Psychology; Associate Member, American Psychological Association, American Statistical Association, Human Factors Society, DCPA, Potomac Area Human Factors Society.

FARRELL, John P., Jr., Research Psychologist (E&P); MA, The Catholic University of America, 1965, Psychology (course work and research completed for Ph.D., Experimental Psychology)

KAPLAN, Michael, Principal Scientist; Ph.D., Columbia University, 1952, Experimental Psychology; Member, Psychonomic Society, American Psychological Association, EPA, AAAS, New York Academy of Sciences, Society for Psychophysiological Research; Sigma Xi, Phi Beta Kappa

STERNBERG, Jack J., Sr. Task Leader; MA, Syracuse University, 1950, Psychology and Statistics; Member, Psychometric Society; Psi Chi

ZEIDNER, Joseph, Deputy Director for Manned Systems Research and Chief, Support Systems Research Division; Ph.D., the Catholic University of America, 1954, Psychology; Member, American Psychological Association, Division of Military Psychology (APA), DCPA, NRC--Armed Forces Committee on Vision.

ANDREWS, Robert S., Chief, Applications Evaluation Br.; MS, William & Mary College, 1958, Psychology; Associate, American Psychological Association, Human Factors Society

BIGELOW, George F., Intelligence Operations Specialist; AB, Harvard University, 1938, English; American Society of Photogrammetry

BIRNBAUM, Abraham H., Program Director, Ph.D., New York University, 1957, Psychology; Member, American Psychological Association, EPA, DCPA, American Society of Photogrammetry

HILLIGOSS, Richard E., Research Psychologist (PM&E); MA, George Washington University, 1960, Psychometrics; Member, American Psychological Association, SEPA; Psi Chi; Certification - Va.

JEFFREY, Thomas E., Principal Scientist; Ph.D., University of Chicago, 1957, Psychometrics; Member, Psychometric Society, AAAS, Sigma Xi.

KENSINGER, Loren L., Research Psychologist (E&P); MA, University of Hawaii, 1967, Psychology.

MARTINEK, Harold, Chief, Technical Support Branch; BA, Kalamazoo College, 1951, Physics; MS, Iowa State University, 1954, Psychology; Member, American Psychological Association, Human Factors Society.

NARVA, Marshall A., Research Psychologist (E&P); Ph.D., University of Maryland, 1960, Psychology; Member, American Psychological Association, EPA, DCPA, Human Factors Society; Sigma Xi, Phi Beta Kappa

RINGEL, Seymour, Sr., Task Leader; MA, Brooklyn College, 1952, Psychology (Ph.D. candidate, American University, Psychology); Member, American Psychological Association, EPA, SEPA, DCPA.

SADACCA, Robert, Program Director; Ph.D., Princeton University, 1962, Psychometrics; Member, American Psychological Association, Psychometric Society, Human Factors Society, American Photogrammetry Society; Sigma Xi.

SIMONTACCHI, Alexander, Intelligence Operations Specialist; BS, University of California, 1938, Forestry

STRUB, Michael H., Research Psychologist (E&P); Ph.D., Ohio State University, 1968, Psychology.

HELME, William H., Chief, Behavioral Evaluation Research Division; Ph.D., New School for Social Research, 1959, Psychology; Member, American Psychological Association, EPA

FRANKFELDT, Eli, Research Psychologist (PM&E); MS, CCNY, 1938, Psychology; Member, American Psychological Association, EPA, WORC, SPSSI.

KOTULA, Leo J., Task Leader; Ph.D., University of Pittsburgh, 1951, Psychology; Member, American Psychological Association; Sigma Xi

MEDLAND, Francis F., Sr. Task Leader; MA, University of Chicago, 1948, Psychometrics; Member, American Psychological Association; Sigma Xi.

ORLEANS, Isaak D., Research Psychologist (PM&E); MS, CCNY, 1940, Psychology; Member, American Psychological Association.

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SAIT, Edward M., Research Psychologist (PM&E); AB, University of California, 1935; Member, American Psychological Association, AAAS, Psychometric Society; Sigma Xi.

SMITH, Kay H., Research Psychologist (PM&E); Ph.D., Wayne State University, 1961, Psychology; Licensed in Psychology, Utah, Member, American Psychological Association, Utah PA, RMPA; Sigma Xi.

WILLEMIN, Louis P., Jr., Sr. Task Leader; MBA, University of Pennsylvania, 1955, Statistics; Member, Psychometric Society, DCPA, AAAS

YATES, Louise G., Research Psychologist (PM&E); Ph.D., University of North Carolina at Chapel Hill, 1967, Psychology; Member, American Psychological Association, SPSSI.

JOHNSON, Cecil D., Chief, Statistical Research and Analysis Division; MA, George Washington University, 1951, Psychology; Member, American Psychological Association, Psychometric Society, Association for Computing Machinery, Army Mathematics Steering Committee; Psi Chi, Sigma Xi.

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ABBE, Elizabeth N., Research Psychologist (PM&E); Ph.D., University of North Carolina, 1966, Psychometrics; MS, Brown University, 1960, Experimental Psychology; Sigma Xi.

BARNES, Paul J., Chief, Statistical Systems and Numerical Analysis Section; Ph.D., Columbia University, 1962, Psychology; Member American Psychological Association, Psychometric Society, AAAS, American Statistical Association, DCPA, NYSPA

BURKE, Laverne K., Chief, Computer Programming and Operations Section; MA, Ohio State University, 1935, Psychology; Member, American Psychological Association, EPA, DCPA, Psychometric Society, American Statistical Association, Association for Computing Machinery, Society for Industrial and Applied Mathematics; Pi Mu Epsilon.

CORY, Bertha H., Chief, Statistical Systems and Computer Branch; MA, University of Rochester, 1941, Psychology; Member, American Psychological Association, EPA, Md, PA, DCPA, Psychometric Society Association for Computing Machinery; Sigma Xi, Phi Beta Kappa

GRANDA, Thomas M., Research Psychologist (PM&E); MA, California State College Long Beach, 1967, Psychology

HAYNAM, Kenneth W., Mathematical Statistician; BA, The College of Wooster, 1960, Mathematics; Member, American Statistical Association, The Institute of Management Sciences, ORSA

MELLINGER, John J., Chief, Statistical Research and Consultation Branch; Ph.D., University of Chicago, 1965, Psychometrics; Member, American Psychological Association, AAAS, Psychometric Society, American Statistical Association; Sigma Xi

OLSON, Pauline T., Task Leader; BS, University of Kentucky, 1937, Mathematics; Associate Member, ORSA; Phi Beta Kappa

SACHS, Sidney A., Supervisory Mathematical Statistician; MA, University of Illinois, 1960, Statistics; BS, University of Illinois, 1959, Industrial Engineering; Member, American Inst. Industrial Engineers, Associate Member, ORSA

SORENSON, Richard C., Chief, Operations Research Branch; Ph.D., University of Washington, 1965, Psychology; Member, American Psychological Association, Psychometric Society, ORSA, American Statistical Association; Sigma Xi

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2E. HUMAN RESOURCES RESEARCH OFFICE

Alexandria, Virginia 22314

A. CURRENT WORK PROGRAM*

The HumRRO Work Program is concerned with human factors research in training, motivation and leadership. Research aimed at solving practical military problems is carried on by seven research groups: Division No. 1 (System Operations) and Division No. 7 (Language and Area Training) in Alexandria, Virginia; Division No. 2 (Armor) at Fort Knox, Kentucky; Division No. 3 (Recruit Training) at Presidio of Monterey, California; Division No. 4 (Infantry) at Fort Benning, Georgia; Division No. 5 (Air Defense) at Fort Bliss, Texas; and Division No. 6 (Aviation) at Fort Rucker, Alabama. Division 2, 3, 4, 5, and 6 are co-located with Headquarters, USCONARC, Human Research Units. In addition, a basic research program is being conducted by several research groups. Each research division provides Technical Advisory Service to assist the Army in planning implementation of research results and to meet other Army requests. Exploratory studies aimed at identifying human factors problems likely to arise in future military operations are also conducted by the research divisions.

The numbers which appear with each Work Unit are HumRRO assigned and are those which appear in the Work Program.

The Work Units and Work Unit objectives for Fiscal Year 1968, grouped by Research Areas, are given in the following list. This list also includes by number and title, Basic Research Studies and Exploratory Studies for Fiscal Year 1969.

*A copy of the approved Work Program for FY 1969 will be available when published, on request to the Director, Human Resources Research Office, 300 No. Washington Street, Alexandria, Virginia 22314

Research Area 1:
Individual Training and Performance

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion
a. 12-37	Dr. Hilton M. Bialek Dr. Ernest K. Montague Dr. Morris Showel	03 68	Continuing

APSTRAT - Training Strategies Appropriate to Aptitude Level for Selected Training Courses

Objective: To develop and test training strategies appropriate for varying levels of aptitude in the operation field-training of a variety of U.S. Army military occupational specialties (MOSs).

b. 15-32	Dr. Francis H. Thomas	07 68	Continuing

MANPROBE - Human Information-Processing Requirements in Manned Aerial Reconnaissance and Surveillance Tasks (New)

Objective: To identify and assess perceptual-cognitive functions associated with manned aerial reconnaissance and surveillance (R&S) tasks important to the success of operational R&S missions.

c. 11-39	Mr. G. Gary Boycan Mr. Ralph Graham Mr. Ronald Kraemer Mr. William C. Osborn	07 66	Continuing

MBT - Training Guidelines for the US/FRG Main Battle Tank

Objective: To outline the training methods and prescribe training materials that will be required by the personnel responsible for the development of programs for operator training and user maintenance training on the US/FRG Main Battle Tank.

d. 11-36	Dr. Laban L. Ainsworth Mr. Donald L. Wright Mr. William N. Gipe Mr. William L. Warnick	01 07	Continuing

NIGHTSIGHTS - Training Techniques for Passive Night Vision Devices

Objective: To identify critical human factors problems in the use of new passive night vision devices, and to develop effective techniques of training in the use of the devices.

e. 12-38	Dr. Thomas G. Sticht Dr. Richard E. McCrady	03 68	Continuing

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

Objective: To determine the levels of reading, listening, and arithmetic skills required for the satisfactory performance of essential job duties in major military occupational specialties(MOSs), and to develop guidelines and methodologies for reducing discrepancies between personnel skill levels in reading, listening, and arithmetic, and levels of these skills required by the job.

f. 12-36	Dr. Richard P. Kern Mr. Lynn Fox	09 67	Continuing

SKILLCON - Curriculum Engineering to Enhance the Soldier's Resistance to Stress in Combat and Hazardous Job Situations

Objective: To apply the training concepts presented in HumRRO Technical Report 66-12 ("A Conceptual Model of Behavior Under Stress, With Implications for Combat Training," June 1966; Work Unit FIGHTER) to selected areas of hazardous duty training in order to improve training capacity to strengthen the individual's procedures to enable Army trainers to improve training in other areas of hazardous duty performance.

g. 14-19	Dr. Albert L. Kubala Mr. Walter E. Burrell Mr. Robert J. Foskett Mr. Michael R. McCluskey Mr. Harold E. Christensen Mr. A. Dean Wright	06 66	Continuing

SKYFIRE - Training Methods for Forward Area Air Defense Weapons

Objective: To determine man's capabilities to performan the operator skills required by forward area air defense weapons, and to identify effective training concepts for developing the required skills.

h. 12-34	Dr. Ernest K. Montague Dr. Morris Showel Dr. John S. Caylor Dr. Wayne L. Fox Dr. John E. Taylor	10 66	Continuing

SPECTRUM - Development of Efficient Training Across All Aptitude Levels

Objective: To develop procedures for selecting and organizing training content and training methods for high-density combat and combat support MOSs in order to achieve more efficient training at all aptitude levels.

i. 14-17	Dr. Paul G. Whitmore Mr. Arthur C. Vicory Mr. Charles Hayes	07 65	Continuing

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

STAR - Aircraft Recognition Training

Objective: To develop concepts of aircraft recognition training suitable for personnel manning all forward area air defense weapons.

j. 12-31	Dr. Howard H. McFann Dr. Joseph S. Ward Mr. Donald F. Polden COL Nelson I. Fooks (USA, Ret.)	05 66	Continuing

SUPPORT - Development of Improved Training for Combat Support Training

Objective: To develop improved individual training programs for Combat Support MOSs through human factors research on training objectives, content, methods, and procedures.

k. 15-11	Dr. Paul W. Caro, Jr. Dr. Robert H. Wright Mr. Oran B. Jolley Mr. Robert N. Isley	04 68	Continuing

SYNTRAIN - Modernization of Synthetic Training in Army Aviation

Objective: To expedite the application of advances in training technology to the design of Army aviation synthetic training equipment, through surveys of training device design requirements and technology and the conduct of human factors and training research.

l. 15-10	Mr. Russel E. Schulz Mr. John O. Duffy Miss Barbara K. Sutey Mr. Warren P. Pauley	07 66	Continuing

UPGRADE - Improving Aviation Maintenance Training Through Task and Instructional Analysis

Objective: To construct a model instructional development system for aviation maintenance training. Specifically, to develop techniques for gathering task data and procedures for translating the data into effective training programs, and to develop techniques to assist in the definition of school and unit training responsibilities.

m. 12-35	Dr. Robert Vineberg Dr. Elaine Taylor	11-66	Continuing

UTILITY - Study of Men in Lower Mental Categories: Job Performance and the Identification of Potentially Successful and Potentially Unsuccessful Men

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

Objective: To compare the job proficiency and overall military suitability of personnel in Mental Category IV and in other mental categories of selected MOS; to identify characteristics of these men associated with successful and unsuccessful performance; and to demonstrate the utility of background and non-cognitive information in the screening and the differential classification and assignment of men of lower mental ability.

Research Area 2:
Unit Training and Performance

11-37	Dr. Laban L. Ainsworth Mr. Eugene H. Drucker Mr. John D. Engel Mr. Walter J. Gunn Mr. William L. Warnick	07 65	Continuing

ENDURE - Tank Crew Performance During Periods of Extended Combat

Objective: To determine the endurance of troops using combat equipment with a 48-hour capability and, as necessary, to establish ways of extending troops' endurance so that the effectiveness of the equipment will not be limited by the user.

Research Area 3:
Training for Leadership, Command, and Control

a. 13-19	Dr. T. Owen Jacobs LTC George J. Magner (USA, Ret.)	02 66	Continuing

ACTION - Research for Improvement of Infantry Stability Operations Training

Objective: To develop the informational basis for improved infantry stability operations training.

b. 13-54	Mr. Theodore R. Powers Mr. Arthur J. De Luca	07 68	Continuing

CAMBCOM - Knowledges, Skills, and Thought Processes of the Battalion Commander and Primary Staff (New)

Objective: To identify the knowledges, skills, and thought process of the battalion commander and primary staff officers of a combat arms maneuver battalion.

c. 13-22	Dr. Joseph A. Olmstead LTC Langhoren P. Withers (USA, Ret.)	07 67	Continuing

FORGE - Factors in Organizational Effectiveness

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

Objective: To identify and discover ways of controlling human factors that influence the effectiveness of military organizations.

d. 13-14	Dr. T. Owen Jacobs LTC Frank L. Brown, (USA, Ret.) LTC Fred Cleary (USA, Ret.)	07 62	Continuing

LEAD - Development of Training for Improving the Combat Skills of Leaders in Small Infantry Units.

Objective: To improve officer training in the critical skills required for effective combat leadership in small infantry units.

e. 14-20	Dr. Harry L. Ammerman Dr. William H. Melching Mr. Richard L. Dueker Mr. Stephen Fishman	07 66	Continuing

MANICON - Determination of Performance Capabilities and Training Requirements for Manual Command and Control Functions of the Sentinel Weapon System

Objective: To identify and evaluate manual performance capabilities and training requirements for command and control functions within the Sentinel weapons system, in support of the activities of the Sentinel System Evaluation Agency (SENSEA).

Research Area 4: Language and Area Training

a. 16-02	Dr. Arthur J. Hoehn	03 63	Continuing

AREA - Development of Concepts and Techniques for Area Training

Objective: To increase the effectiveness of area training.

b. 16-03	Dr. George H. Brown Miss Thelma R. Smackey	07 63	Continuing

AUTOSPAN - Development of a Generalized Method for Preparing Self-Instructional Foreign Language Courses

Objective: To develop a generalized method for preparing self-instructional, introductory level, foreign language courses. The effort is organized in large part around the development and evaluation of aprototype course in Spanish.

c. 16-13	Dr. Arthur J. Hoehn (Monitor of Subcontracted effort to University of Maryland)	10-67	Continuing

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

COMSERVE - Development of a Manual for Community Service Volunteers

Objective: To develop a manual to assist in the recruitment, training, and utilization of volunteers in the Army Community Service Program.

d. 16-09	Dr. Alfred J. Kraemer Dr. Dharam P. Yadav	07 67	Continuing

COPE - A Program of Instruction for the Development of Cultural Self-Awareness.

Objective: To design, produce, and evaluate a program of audio-visual instruction for the development of cultural self-awareness.

e. 16-10	BG Samuel G. Taxis (USMC, Ret.) Dr. Jose Armilla Miss Carolyn McClelland	07 67	Continuing

DEBRIEF - Feasibility Study of a System for Debriefing MAAG Advisors

Objective: To develop and evaluate techniques, instruments, and systematic procedures for debriefing U.S. military personnel who have served overseas with the Military Assistance Program, in order to (1) obtain information relevant to improving standards and methods of advisor training, and (2) develop and evaluate procedures for processing, packaging, and disseminating the information obtained.

f. 16-11	BG Samuel G. Taxis (USMC, ret.) Dr. Jose Armilla	07 67	Continuing

REFOCUS - Implementation and Modification of the USMACTHAI Advisor Debriefing Program

Objective: To develop and evaluate techniques and instruments for the systematic continuation and modification of the Advisor Debriefing Program within U.S. Military Assistance Command, Thailand (USMACTHAI). Specific purposes are to (1) focus the debriefing research effort upon the local situation, (2) provide for timely revision of data collection instruments in order to reflect changes in the local situation, (3) insure continuity in data collection, and (4) assist USMACTHAI in interpreting, evaluating, and utilizing the information provided by this and related research efforts.

g. 16-24	Dr. Dean K. Froehlick	07 68	Continuing

REFRACT - Factors Influencing Effectiveness of Advisor-Counterpart Interactions

HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

Objective: To define and develop operational techniques for assessing the effectiveness of advisor-counterpart interactions, and to identify factors that influence them.

h. 16-12	Dr. Harley M. Upchurch	07 67	Continuing

SOJOURN - Overseas Military Posts and Communities

Objective: To develop and illustrate the application of methods for obtaining information relevant to the management, organization, and planning of overseas American military communities.

Research Area 5: Training Technology

a. 10-53	Dr. Robert J. Seidel Dr. Felix F. Kopstein Mr. George R. Sedberry Mr. Roy Proctor Mr. Richard Rosenblatt Mrs. Judith Compton Mrs. Marcia Harrington Mr. Edward Kinglsey Dr. John Stelzer Mr. Ronald Walker Mrs. Doris Shuford Mr. Hilton Nicholson Mrs. Sarah See Mr. Joseph Bangiolo Mr. Jon Nachison Dr. Herbert Gerjuoy Miss Lala Curry	05 67	Continuing

IMPACT - Instructional Model/Prototypes Attainable in Computerized Training

Objective: To develop (1) a prototype computer-administered instructional system with (2) accompanying prototype multiple-track (branching), individualized programs of instruction. To be selected for prototype development, each course must be (1) critical for the Army, and (2) representative of a particular kind of behavior.

b. 13-55	Dr. J. A. Olmstead, Jr.	07 68	Continuing

INGROUP - Small-Group Instructional Methods (New)

Objective: To evaluate the effectiveness of small-group instructional techniques, and to identify ways to best exploit these techniques for military instruction.

c. 11-45	Mr. John D. Engel	07 68	Continuing

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HumRRO Work Unit No.	Experimenter(s)	Date Started	Estimated Completion

JOBTEST - Proficiency Measurement Techniques (New)

Objective: To investigate and evaluate a variety of concepts and procedures for measuring job performance, in order to identify techniques that are valid and useful in practical testing environments and that have generality across groups of tasks.

Research Area 6:
Training Management

a. 12-48	Dr. Joseph S. Ward COL Nelson I. Fooks (USA,Ret) COL Mark K. Brennan (USA,Ret)	07 68	Continuing

ATCSYSTEM - Analysis of the Army Training Center System (New)

Objective: To improve the efficiency with which the Army Training (ATC) system attains its objectives.

b. 15-33	Dr. Wiley R. Boyles Mr. Alton H. Boyd Mr. Peter R. Prunkl	07 68	Continuing

PREDICT - Longitudinal Analysis of Aviator Performance (New)

Objective: To develop systems for predicting performance of Army aviators during training and operational assignments by means of computerized multiple regression equations and probability tables.

c. 10-54	Dr. A. James McKnight Dr. Harold Wagner Dr. Richard D. Behringer Mr. James R. Lodge	09 67	Continuing

STOCK - Development of Training Management Procedures for Heterogeneous Ability Groups.

Objective: To develop practical techniques for the management of entry-MOS training programs in order that they may more effectively use individualized instruction for students at all aptitude levels.

Following is the list of Basic Research Studies grouped by Research Area for Fiscal Year 1969:

Research Area 1:
Individual Training and Performance

BR-16 - Visual Pattern Discrimination

Research Area 5:
Training Technology

BR- 8 - Common Job Elements
BR-14 - Prompting and Guidance
BR-18 - Behavior Management
BR-19 - Definition of Learning Variables

Following is the list of Exploratory Studies grouped by Research Area for Fiscal Year 1969:

Research Area 1:
Individual Training and Performance

ES-58 - Manual Format

Research Area 2:
Unit Training and Performance

ES-63 - Logistics Systems
ES-54 - Human Performance Degradation

Research Area 3:
Training for Leadership, Command, and Control

ES-60 - Troop Information

Research Area 4:
Language and Area Training

ES-73 - U.S.-Thai Security Guard

2E. HUMAN RESOURCES RESEARCH OFFICE BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

Bialek, Hilton, and Michael McNeil. Preliminary Study of Motivation and Incentives in Basic Combat Training, HumRRO Technical Report 68-6, May 1968.

Brown, LTC F.L., USA (Ret.). "Combat Patrols," Infantry, vol. 58 no. 1, January-February 1968.

Brown, George H., and Alfred I. Fiks. Modern Approaches to Foreign Language Training: A Survey of Current Practices, HumRRO Technical Report 67-15, December 1967.

Boyd, H. Alton, Jr., and Wiley R. Boyles. "Statements of Career Intentions: Their Relationship to Military Retention, Problems," paper for annual meeting of Alabama Psychological Association, Birmingham, Ala., May 1968.

Boyles, Wiley R. "Background and Situational Confidence: Their Relation to Performance Effectiveness," paper for annual meeting of Alabama Psychological Association, Birmingham, Ala., May 1968; issued as Professional Paper 22-68, June 1968.

Caro, Paul W., Jr., and Robert N. Isley, and Oran B. Jolley. The Captive Helicopter as a Training Device: Experimental Evaluation of a Concept, HumRRO Technical Report 68-9, June 1968.

Caro, Paul W., Jr. Flight Evaluation Procedures and Quality Control of Training, HumRRO Technical Report 68-3, March 1968.

Cassileth, Barrie. Review of Concepts and Literature on Contingency Management, HumRRO Professional Paper 15-68, June 1968.

Caylor, John S., and Howard H. McFann. "A Follow-Up Study of the Performance of Army Recruits in Their First Tour," briefing to Deputy Chief of Staff for Personnel, Department of the Army, and to Deputy Chief of Staff for Personnel, U.S. Continental Army Command, October 1967; issued as Professional Paper 10-68, April 1968.

Crawford, Meredith P. "Simulation in Training and Education," paper for NATO Symposium on the Simulation of Human Behavior, Paris, France, July 1967; issued as Professional Paper 40-67, September 1967.

Danielian, Jack. "Live Simulation of Affect-Laden Cultural Cognitions," J. Conflict Resolution, vol. XI, no. 3, September 1967; issued as Professional Paper 49-67, November 1967.

DeLuca, COL Arthur J., USA (Ret.). "Infantry Platoon Leaders: A Changing Picture of Leadership," Infantry, vol. 57, no. 5, September-October 1967.

Fiks, A.I., and J.P. Corbino. "Course Density and Student Perception," Language Learning, vol. XVII, nos. 1-2, 1967; issued as Professional Paper 44-67, October 1967.

Fiks, A.I. Development of a Short, Practical, Programmed Vietnamese Course, HumRRO Professional Paper 41-67, September 1967; previously listed as paper for 11th Annual Army Human Factors Research and Development Conference, Fort Bragg, N.C., October 1965.

Fiks, A.I. "A Short Vietnamese Language Program: Training Course and Research Vehicle," International Rev. of Applied Linguistics, Vol. VI, no. 4, December 1966; issued as Professional Paper 4-68, February 1968.

Fink, C.D. Technical Manuals for Maintenance Support: A Maintenance Rationale, Some Research Findings, and Some Projections, HumRRO Professional Paper 37-67, August 1967; based on a paper for AMC Maintenance Manual Council, Fort Knox, Kentucky, June 1967.

Foster, Robert J., and David T. O'Nan. Some Resources for Area Training, HumRRO Technical Report 67-11, September 1967.

Fox, William F. Human Performance in the Cold, HumRRO Professional Paper 2-68, January 1968; previously listed as published in Human Factors, vol. 9, no. 3, June 1967.

Hoehn, Arthur J. "The Need for Innovative Approaches for Training in Cross-Cultural Interaction," paper for American Psychological Association convention, Washington, September 1967; revised version under the title, The Need for Innovative Approaches for Training in Inter-Cultural Interaction, issued as Professional Paper 9-68, March 1968.

Hood, Paul D., and Morris Showel, and Edward S. Stewart. Evaluation of Three Experimental Systems for Noncommissioned Officer Training, HumRRO Technical Report 67-12, September 1967.

Isley, Robert N. "Inflight Performance After Zero, Ten, or Twenty Hours of Synthetic Instrument Flight Training, paper for annual meeting of Alabama Psychological Association, Birmingham, Ala., May 1968; issued as Professional Paper 23-68, June 1968.

Jacobs, T.O. "Leadership in Small Military Units," paper for Fourth International Congress on Applied Military Psychology, The Hague, The Netherlands, Sept. 1967.

Kelly, COL Henry E., USA (Ret.). "Control of Combat Rifle Fire," Infantry, vol. 57, no. 4, July-August 1967.

Kelly, COL Henry E., USA (Ret.). "Military Discipline and the Soldier," Infantry, vol. 58, no. 3, May-June 1968.

Kopstein, Felix F., and Robert J. Seidel. "Comment on Schurdak's 'An Approach to the Use of Computers in the Instructional Process and an Evaluation'," Amer. Educ. Res. J., vol. IV, no. 4, November 1967.

Kraemer, R.E. Crew Duties and Tasks for Operation of the M551, HumRRO Research By-Products, March 1968.

Kubala, Albert L., and Harold E. Christensen. The Effects of Group Competition Upon Student Performance, HumRRO Technical Report 68-7, June 1968,

Kulp, Richard A. "A Comparison of Constrained and Random Metric Figures in Paired-Associates Learning," Psychonomic Sci., vol. 8, no. 12, 1967; issued as Professional Paper 42-67, September 1967.

Kulp, Richard A. "Effects of Amount of Interpolated Activity in Short-Term Memory," Psychol. Rep., vol. 21, no. 2, October 1967; issued as Professional Paper 46-67, October 1967; previously listed as paper for annual meeting of Midwestern Psychological Association, Chicago, May 1967.

Lyman, Bernard. Visual Detection, Identification, and Localization: An Annotated Bibliography, HumRRO Technical Report 68-2, February 1968.

MacCaslin, Eugene G., and Eugene A. Cogan. Learning Theory and Research Paradigms Applied to Training Research: Some Dissonances, HumRRO Professional Paper 13-68, May 1968; previously listed as paper for American Psychological Association convention, Los Angeles, September 1964.

McClelland, W.A. From Research to Practice in Electronics Maintenance Training, HumRRO Professional Paper 21-68, June 1968; based on a paper for USCONARC School Curriculum Conference, Fort Knox, Ky., February 1967.

McClelland, William A., and J. Daniel Lyons. "Guidelines for Manpower Training as Developed by the Human Resources Research Office," paper for annual meeting of Highway Research Board, Washington, January 1968.

McClelland, William A., with the technical assistance of Angela D. Bentz. Utilization of Behavioral Science Research in a Large, Operational System, HumRRO Professional Paper 7-68, March 1968; based on a paper for Conference on Social Research and Military Management of the Inter-University Seminar on Armed Forces and Society, University of Chicago, June 1967.

McCluskey, Michael R., and A.D. Wright, and E.W. Frederickson. Studies on Training Ground Observers to Estimate Range to Aerial Targets, HumRRO Technical Report 68-5, May 1968.

McCrary, John W. "Human Factors in the Operation of U.S. Military Units Augumented with Indigenous Troops," paper for 13th Annual Army Human Factors Research and Development Conference, Fort Monmouth, N.J., October 1967; issued as Professional Paper 48-67, November 1967.

McDonald, Robert D. Retention of Military Skills Acquired in

Basic Combat Training, HumRRO Technical Report 67-13, December 1967.

Melching, William H. "A Concept of the Role of Man in Automated Systems," paper for annual meeting of Southwestern Psychological Association, New Orleans, La., April 1968; issued as Professional Paper 14-68, May 1968.

Neal, G.L. Some Effects of Differential Pretask Instructions on Auditory Vigilance Performance, HumRRO Professional Paper 34-67, July 1967; previously listed as paper for annual meeting of Southwestern Psychological Association, Houston, Texas, April 1967.

Niehoff, Arthur H., and J. Charnel Anderson. The Process of Cross-Cultural Innovation, HumRRO Professional Paper 36-67, August 1967; previously listed as published in International Develpm. Rev., vol. VI, no. 2, June 1964.

Olmstead, Joseph A. Instructor's Guide to Performance Counseling, HumRRO Research By-Product, March 1968.

Olmstead, Joseph A. Leadership at Senior Levels of Command, HumRRO Professional Paper 5-68, February 1968; previously listed as paper for meeting of Georgia Psychological Association, Jekyll Island, Ga., February 1965.

Powers, Theodore R., and Harry Kotses, and Arthur J. DeLuca. Training Requirements for the General Military Science Curriculum of the Army ROTC Program, HumRRO Technical Report 67-16, December 1967.

Prophet, Wallace W. "The Human Factor in Army Aviation," Aviation Dig., vol. 13, no. 8, August 1967; issued as Professional Paper 43-67, September 1967.

Prunkl, Peter R., and Wiley R. Boyles. "A Preliminary Application of the Critical Incident Technique to Combat Performance of Army Aviators," paper for annual meeting of Alabama Psychological Association, Birmingham, Ala., May 1968; issued as Professional Paper 24-68, June 1968.

Rocklyn, Eugene H. "The Development and Test of a Special Purpose Foreign Language Training Concept," International Rev. of Applied Linguistics, vol. V, no. 1, March 1967.

Roeckelein, Jon E. Simulation of Organizations: An Annotated Bibliography, HumRRO Technical Report 67-14, December 1967.

Schulman, Richard M. "The Effect of Unidirectional Primary Word Associations on A-B, C-A Paired-Associate Transfer," Psychomomic Sci., vol. 8, no. 8, July 1967, issued as Professional Paper 3-68, January 1968.

Schulman, Richard M. "Paired-Associate Transfer as a Function of Ability Level in the A-B, C-A and A-B, B-C Paradigms," Psychol. Rep., vol. 22, no. 1, February 1968; issued as Professional Paper 11-68, April 1968.

Schulman, Richard M. Paired-Associate Transfer for the A-B, C-A, A-B, B-C Paradigms, HumRRO Professional Paper 38-67, August 1967; previously listed under the title, "Paired-Associate Transfer Between CVCs for the A-B, C-A and the A-B, B-C Paradigms Following a Low Degree of List I Learning," as paper for annual meeting of Eastern Psychological Association, Boston, April 1967; and published in Psychol. Rep., vol. 20, no. 3, Part 2, June 1967.

Seidel, Robert J., and Harold G. Hunter. The Application of Theoretical Factors in Teaching Problem Solving by Programmed Instruction, HumRRO Technical Report 68-4, April 1968.

Seidel, Robert J. "The Development and Maintenance of Optimal Learning Conditions," paper for symposium at American Psychological Association convention, Washington, September 1967; issued under the title, A General Systems Approach to the Development and Maintenance of Optimal Learning Conditions, as Professional Paper 1-68, January 1968.

Shoemaker, Harry A. The Functional Context Method of Instruction, HumRRO Professional Paper 35-67, July 1967; previously listed as published in IRE Transactions on Education, vol. E-3, no. 2, June 1960.

Showel, Morris. Development of Two Automated Programs for Teaching Military Justice to Men of Various Aptitude Levels, HumRRO Technical Report 68-8, June 1968.

Showel, Morris. "A Program for Developing Potential Noncommissioned Officers," paper for NATO Conference on Manpower Research in the Defense Context, London, England, August 1967; issued as Professional Paper 45-67, October 1967; based on a paper for Inter-University Seminar on Armed Forces and Society, University of Chicago, June 1967.

Smith, Robert G. Jr. "Individualization of Instruction--Issues and Problems," paper for National Society for Programmed Instruction convention, San Antonio, Tex., April 1968.

Stewart, Edward C. Simulation Exercises in Area Training, HumRRO Professional Paper 39-67, September 1967; previously listed as paper for 11th Annual Army Human Factors Research and Development Conference, Fort Bragg, N.C., October 1965.

Stewart, Edward C. The Simulation of Cross-Cultural Communication, HumRRO Professional Paper 50-67, December 1967; previously listed as paper for symposium of the German Development Institute, Berlin, Germany, March 1966.

Taylor, John D., and Wayne L. Fox. Differential Approaches to Training, HumRRO Professional Paper 47-67, November 1967; based on paper for NATO Conference on Manpower Research in the Defense Context, London, England, August 1967, and on paper, "Adaptation of Training to Individual Differences," for symposium at American Psychological Association convention, Washington, September 1967.

Thomas, Francis H. "A View of Man's Role and Function in a Complex System," paper for annual meeting of Alabama Psychological Association, Birmingham, Ala., May 1968; issued as Professional Paper 25-68, June 1968.

Upchurch, Harley M. "Some Guides to Interpretation of the Figures on School Enrollment Among Americans

Overseas in the 1960 Census of Population," paper for annual meeting of American Statistical Association, Washington, December 1967; issued under the title, Some Guides to Interpretation of School Enrollment Figures Among Americans Overseas in the 1960 Census, as Professional Paper 8-68, March 1968.

Whitmore, Paul G., and John A. Cox, and Don J. Friel. A Classroom Method of Training Aircraft Recognition, HumRRO Technical Report 68-1, January 1968.

Wright, A.D., and T.R. Dixon. "Knowledge of Results in Schematic Concept Formation," paper for annual meeting of Southwestern Psychological Association, New Orleans, La., April 1968; issued as Professional Paper 17-68, June 1968.

Zook, Lola M. "The Role of the Technical Editor in His Professional Development," paper for symposium at International Technical Communications Conference, Society of Technical Writers and Publishers, Los Angeles, May 1968; issued as Professional Paper 19-68, June 1968.

Collected Papers Prepared Under Work Unit ENDORSE: Effects of Controlled Isolation on Performance, Presentations and Papers, 1958-1961, Professional Paper 6-68, February 1968.

Collected Papers Prepared Under Work Unit ARMORNITE: Human Factors in Armor Operations Under Conditions of Limited Visibility, Professional Paper 12-68, May 1968.

Collected Papers Prepared Under Work Unit FORECAST: Development of a Method of Forecasting Training Demands Imposed by New Electronic Weapon Systems, Professional Paper 16-68, June 1968.

Collected Papers Prepared Under Work Unit LIFT: Army Aviation Helicopter Pilot Training, Presentations and Papers, 1959-1964, Professional Paper 18-68, June 1968.

Collected Papers Prepared Under Work Unit RADAR: Training of Radar Operators and Maintenance Personnel, Presentations and Papers, 1955-1957, Professional Paper 20-68, June 1968.

2E. HUMAN RESOURCES RESEARCH OFFICE BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

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COGAN, Eugene A., Assistant Director for Reporting; Ph.D., U.C.L.A., 1951, Psychology; Sigma Xi; Psi Chi; APA; AAAS; NGA, WORC; AMSC.

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MC CLELLAND, William A., Associate Director; Ph.D., University of Minnesota, 1948, Psychology; Phi Beta Kappa; Sigma Xi; Fellow, APA; Fellow, AAAS; DCPA; MPA; PS; AERA; Certified, DCPA; Licensed, Virginia.

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SMITH, Charles W., Business Administrator; JD, George Washington University, 1953, Law; D.C. Bar.

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SHUFORD, Doris B., Technician; BS, Hampton Institute, 1959, Chemistry.

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TREXLER, Robert C., Senior Staff Technician; BS, Massachusetts Institute of Technology, 1954, Electrical Engineering; IEEE; PG; HFE; EM.

WAGNER, Harold, Research Scientist; Ph.D., New York University, 1968, Psychology; Psi Chi; Sigma Xi; APA; EPA.

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BOYCAN, George G., Research Associate; MA, University of Detroit, 1967, Psychology.

COOK, John G., Senior Technician.

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ENGEL, John D., Research Associate; MA, University of Detroit, 1966, Psychology; KPA

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SHELDON, Richard W., Research Scientist; Ph.D., State University of Iowa, 1961, Psychology; APA.

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WRIGHT, Donald L., Research Associate; MA, Ohio University, 1965, Psychology.

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FOX, Lynn C., Research Assistant; BA, Gettysburg College, 1963, Psychology.

FOX, Wayne L., Research Scientist; Ph.D., University of Arizona, 1966

Psychology; Sigma Xi; Psi Chi; WPA.

GERJUOY, Herbert G., Senior Staff Scientist; Ph.D., State University of Iowa, 1953, Psychology; Sigma Xi; APA; PMS; AAAS; MPA; EPA.

GOFFARD, S. James, Senior Staff Scientist; Ph.D., University of Minnesota, 1949, Psychology; Phi Beta Kappa; Sigma Xi; Phi Kappa Phi; APA.

GRIMSLEY, Douglas L., Senior Scientist; PhD, Syracuse University, 1964, Psychology; APA;AAAS.

KERN, Richard P., Senior Scientist; PhD, State University of Iowa, 1953, Psychology; Sigma Xi; psi Chi; APA; WPA; AAAS.

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MC FANN, Howard H., Director of Research; PhD, State University of Iowa, 1952, Psychology, Sigma Xi; Fellow, APA; WPA; AAAS; PS; AERA.

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KUBALA, Albert L., Senior Scientist; Ph.D., University of Texas, 1956, Psychology; APA.

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PROFESSIONAL MEMBERSHIP ABBREVIATIONS

AAA	American Anthropological Association
AAAA	Army Aviation Association of America
AAAS	American Association for the Advancement of Science
AAP	Association of Aviation Psychologists
AAPOR	American Association of Public Opinion Research
AAPSS	American Academy of Political and Social Science
AAPT	American Association of Physics Teachers
AATSP	American Association of Teachers of Spanish & Portuguese
AAUP	American Association of University Professors
AAUW	American Association of University Women
ABEPP	American Board of Examiners in Professional Psychology
ACM	Association for Computing Machinery
ACPA	American College Personnel Association
ADI	American Documentation Institute
AERA	American Educational Research Association
AHS	American Helicopter Society
Ala. PA	Alabama Psychological Association
AMA	American Management Association
AMS	American Men of Science
AMSC	Army Mathematics Steering Committee
AOPA	Aircraft Owners & Pilots Association
APA	American Psychological Association
APGA	American Personnel and Guidance Association
AS	Asia Society
ASA	American Sociological Association
ASCD	Association for Supervision & Curriculum Development
ASS	American Sociological Society
AStA	American Statistical Association
AUSA	Association of the US Army
CAREL	Central Atlantic Regional Educational Laboratory
CC	Cosmos Club
CCC	Conference on College Composition
DAVI	Department of Audiovisual Instruction
DCPA	District of Columbia Psychological Association
EIA	Electronics Industry Association
EM	Engineering Management
EPA	Eastern Psychological Association
ESA	Eastern Sociological Association
FPA	Florida Psychological Association
GPA	Georgia Psychological Association
HFE	Human Factors in Electronics
HFS	Human Factors Society

HRB	Highway Research Board
IAAP	International Association for Applied Psychology
IEEE	Institute of Electronic and Electrical Engineers
IMS	Institute for Management Sciences
IPMA	Inplant Printing Management Association
ISB	International Society Biometerology
KAF	Korean-American Foundation
KPA	Kentucky Psychological Association
LSA	Linguistic Society of America
MAA	Mathematical Association of America
MGA	Military Government Association
MLA	Modern Language Association
MPA	Midwestern Psychological Association
NCTE	National Council of Teachers of English
NEA	National Education Association
NGA	National Geological Association
NRC	National Research Council
NSPI	National Society for Programmed Instruction
NSPRA	National School Public Relations Association
NSSC	National Society for the Study of Communication
NSTA	National Science Teachers Association
NVGA	National Vocational Guidance Association
ORSA	Operations Research Society of America
OS	Orton Society
PG	Professional Group
PMS	Psychometric Society
PPA	Professional Photographers of America
PS	Psychonomics Society
PSA	Pacific Sociological Association
QB	Quiet Birdmen
RAS	Royal Asiatic Society
RESA	Research Society of America
ROA	Reserve Officers of America
SEPA	South-Eastern Psychological Association
SGSR	Society for General System Research
SIAM	Society for Industrial & Applied Mathematics
SID	Society for International Development
SO	Society of the Optimates
SPSSI	Society for the Psychological Study of Social Issues
SSPP	Southern Society for Philosophy and Psychology
SSS	Southern Sociological Society
STWP	Society of Technical Writers and Publishers
SWPA	South-Western Psychological Association
TESOL	Teachers of English to Speakers of Other Languages
TPA	Texas Psychological Association
USNI	United States Naval Institute
VPA	Virginia Psychological Association
WAA	Wisconsin Archeological Association
WFS	World Future Society
WLC	Washington Linguistics Club
WORC	Washington Operations Research Council
WPA	Western Psychological Association

2F. CENTER FOR RESEARCH IN SOCIAL SYSTEMS

Washington, D.C. 20016

Research Area I	Research Area Leader	Date Started	Date Completed
Social and Behavioral Research Relevant to Military Policy and Army Doctrine Development	Dr. A.E. Dahlke	(see below)	Continuing

Research Area I is composed of three work units:

(1) Applicability of Social and Behavioral Science Research to U.S. Army Activities in the Developing Countries. Date Started: August 1967.

(2) Civil Affairs Functions in an Insurgent Environment Before and Following Introduction of Nonindigenous Friendly Forces. Date Started: October 1968

(3) Changing Roles of the Military in Developing Nations. Date Started: January 1962

The first work unit has as its goal the identification, categorization, analysis, tabulation, and isolation of research in the social sciences which is relevant to Army missions and activities in the developing areas.

The second work unit is designed to assist in the revision of U.S. Army military civil affairs doctrine.

The third work unit is a continuation of several subcontract studies concerning the role of the military in social and political change in developing societies. These studies were undertaken by researchers at other universities under CRESS monitorship. They include efforts in military and historical sociology, predictive modeling, and elite studies.

Research Area II	Research Area Leader	Date Started	Date Completed
Military Civic Action and Community Relations: Military and Cultural Implications	Dr. Norman Smith	(see below)	Continuing

Research Area II is composed of three work units:

(1) Criteria for Selection and Assessment of Military Civic Action Programs. Date Started: August 1967

(2) ROKA Civic Action in Korea. Date Started: August 1967

(3) Improving Relations Between Military Units and Local Communities. Date Started: July 1964

The first work unit will attempt to develop a clearer understanding of civic action: its definitions, objectives, programs and effectiveness. Once the working descriptions are established, criteria for assessing the effectiveness of military civic action programs can be identified. The criteria will be evaluated against data previously obtained from a field survey and subsequently applied to data collected in a second study being conducted in Korea. The test of the criteria against two different cultures will reveal the feasibility of generalizing assessment criteria.

The second work unit (ROKA) will consider the effects of military civic accion on the indigenous population of Korea.

In the third work unit, knowledge derived from a recently completed descriptive review of Community Relations Advisory Councils will be used to develop an instrument for periodic assessment of relations among members of Community Relations Advisory Councils.

Research Area III	Research Area Leader	Date Started	Date Completed
U.S. Defense Operations in Foreign Cultures	Dr. Spinks	(see below)	Continuing

Research Area III is composed of three work units:

(1) Intercultural Communications Guides. Date Started: July 1958

(2) Characteristics of Selected Societies Relevant to U.S. Military Interests. Date Started: August 1967

(3) Studies of Africian Groups. Date Started: August 1966

The first work unit is involved in continuation of a series of Intercultural Communication Guides designed to assist U.S. personnel in accomplishing their missions abroad where interaction with peoples of foreign cultures is a demanding requirement.

The second work unit identifies and analyzes problem areas in the social systems of selected countries that may be relevant to U.S. military interests.

The third work unit is a continuation of studies which focus on urban, military and intellectual groups within the countries of independent Black Africa.

Research Area IV	Research Area Leader	Date Started	Date Completed
U.S. Army Psychological Operations	Mr. William Carr	(see below)	Continuing

Research Area IV is composed of six work units:

(1) U.S. Army Psychological Operations Requirements World Wide. Date Started: August 1967

(2) Development of a Critical Target Analysis Information for U.S. Strategic Psychological Operations in Southeast Asia. Date Started: August 1967

(3) A Systematic Framework for Psychological Operations. Date Started: August 1967

(4) Development of a Methodological Guide for Tactical Use by Psychological Operations Units. Date Started: August 1967

(5) The Application of the Associative Group Analysis Technique to Psychological Operations. Date Started: August 1966

(6) Beliefs and Habits of Certain Foreign Populations of Significance for Psychological Operations. Date Started: August 1967

The first work unit is to estimate world wide requirements for U.S. Army psychological operations in the time frame 1970-1977.

The second work unit will identify those questions that should be used as EEI to collect information required in the conduct of psychological operations. EEI will be grouped in categories which will be determined by the research agency after analysis of potential target populations and be written in a simplified form to permit assignment to one or more collection agencies.

The third work unit is an exploratory research effort to develop a systematic framework for overall psychological operations organization and activities, clearly showing the interrelationships of the component parts of the system in a manner which will enable the Army to integrate its part more effectively into the total national effort.

The fourth work unit is to develop practical methodological guidelines whereby the psychological operations staff officer can evaluate attitudes in localized overseas areas where only limited information exists with a reasonable degree of accuracy. Once these guidelines are developed and tested a field guide will be formulated. A primary application of the field guide will be for RSYOP Research and Analysis to provide input on the local population which can then be incorporated into PSYOP planning and operations.

The fifth work unit is using a recently developed research method--The Associative Group Analysis (AGA)--by which valid cultural information can be collected on psychological variables (meanings, images, attitudes, value orientations) important to the Third Mission. One subtask collects communication-relevant data on 3 audiences of a foreign country. A second tests the impact of AGA communication material on foreign groups. A third develops a data bank starting with the collection of U.S. baseline data as the first step.

The sixth work unit is concerned with the effect of certain folk beliefs on the behavior patterns of selected groups in foreign populations.

Research Area V	Research Area Leader	Date Started	Date Completed
U.S. Operations in Unconventional Warfare, Internal Defense and Development, and Internal Security	D. M. Condit	(see below)	Continuing

Research Area V is composed of five work units:

(1) Internal Security. Date Started: February 1964

(2) Combating Insurgent Infrastructure in Southeast Asia. Date Started: July 1964

(3) Strategic and Tactical Factors Underlying Internal Defense and Development. Date Started: January 1963

(4) Utilization of Military Assistance Program Equipment by Developing Nations. Date Started: August 1967

(5) Predicting the Occurrence of Riots. Date Started: February 1968

The first work unit provides information to the Office of the Provost Marshal General that assists in the evaluation of doctrine concerned with civil, paramilitary and military police operations in internal security problems related to overseas internal defense and development.

The second work unit seeks to review the problems confronting U.S. military assistance to selected Southeast Asian countries and examine techniques and their effectiveness in combating and destroying the insurgetn infrastructure. With these techniques and other relevant findings of behavioral science research in mind, the study will propose modified guidelines for use in the South Vietnam effort. The conclusions reached in this phase will then be evaluated in the dissimilar environment of a second Southeast

Asian Country.

The third work unit carries on research designed to increase understanding of the processes involved in internal conflict in order to provide a realistic basis for U.S. Army planning, policy formulation, doctrine, and operational decisions in the performance of its internal defense and development mission.

Assessment of the capability of military personnel in developing nations to maintain and operate U.S. Army equipment furnished under the Military Assistance Program is the objective of the fourth work unit. The possibility of continuing or improving this capability will be assessed as will be the historical record of equipment utilization.

This work unit is conducted as Institutional Research with a three-fold aim: first, to develop a methodology for analyzing and predicting the occurrence of riots in the United States; second, to predict where and when riots are likely to occur; and third to explain why they occur.

2F. CENTER FOR RESEARCH IN SOCIAL SYSTEMS BIBLIOGRAPHY OF PUBLICATIONS SINCE LAST CONFERENCE REPORT

BAKER, R.K. A study of military status and status deprivation in three Latin American armies, Oct. 1967. DDC No. AD 661-086.

BITTICK, M., N. CURRIER, H. BERRY, and J. MORSE. CINFAC Bibliographic review, supplement no. 14, Aug. 1967. DDC No. AD 667-421.

BITTICK, M., N. CURRIER, H. BERRY, S. DANIEL, and J. MORSE. CINFAC Bibliographic review, supplement no. 15, Nov. 1967. DDC No. AD 668-681.

BITTICK, M., N. CURRIER, H. BERRY, S. DANIEL, and J. MORSE. CINFAC Bibliographic review, supplement no. 16, Feb. 1968. DDC No. AD 669-949.

BITZ, I. A bibliography of English language source materials on Thailand in the humanities, social sciences, and physical sciences, June 1968. DDC No. AD 671-612.

BJELAJAC, S.N., and U. PAOLOZZI. A compendium of unconventional warfare data: operational areas, characteristics of guerrilla operations, essential elements of information (U), June 1968 (CONFIDENTIAL). DDC No. AD 391-134L.

CENTER FOR RESEARCH IN SOCIAL SYSTEMS. CINFAC Bibliographic review: supplement no. 17, June 1968. DDC AD No. not yet assigned.

CENTER FOR RESEARCH IN SOCIAL SYSTEMS. Supplement to the work program: fiscal year 1968 (U), Oct. 1967. DDC No. AD 389-106L.

CENTER FOR RESEARCH IN SOCIAL SYSTEMS. Work program--fiscal year 1968. DDC No. AD 668-268.

CONDIT, D.M., B.H. COOPER, and OTHERS. Challenge and response in internal conflict: vol. III, the experience in Africa and Latin America, April 1968. DDC No. AD 668-825.

CONDIT, D.M., B.H. COOPER, and OTHERS. Challenge and response in internal conflict: Vol. I, the experience in Asia, Feb. 1968. DDC No. AD 666-747.

DURR, J.C., L.H. CLARK, A.H. HESSLER, A. TERAUDS, and E.J. THRASHER. Intercultural communications guide for the Republic of Korea (U), July 1968 (CONFIDENTIAL). DDC No. AD 391-346L.

FITZGERALD, J.A. Systems analysis: applications to the non-western political process, March 1968. DDC No. AD 669-029.

JONES, A., M. BITTICK, and N. CURRIER. A selected bibliography of crowd and riot behavior in civil disturbances (second edition), July 1968. DDC No. AD 672-075.

LOWRY, R.P. (editor). Problems of studying military roles in other cultures: a working conference (U), Sept. 1967 (FOR OFFICIAL USE ONLY). DDC No. AD 821-869L.

MUNSON, F.P., J.E. BRENT, A.H. HESSLER, C. NEEDLES, J.R. PRICE, and A. TERAUDS. Intercultural communications guide for the Republic of Vietnam (U), Sept. 1967 (CONFIDENTIAL). DDC No. AD 384-693L.

ROSENTHAL, C.F., and B.A. WILSON. Civic action in Indonesia 1961-1964 (U), CINFAC SIR 558, July 1968 (SECRET). DDC AD No. not yet assigned.

SENS, A., and J.M. DODSON. Research notes on the socio-political characteristics and attitudes of the population of Thailand (U), Dec. 1967 (CONFIDENTIAL). DDC No. AD 387-530L.

SMYSER, W.M., M.C. CONLEY, B.H. COOPER, S.M. FALLAH, N.A. LaCHARITE, and E.M. MURPHY. Internal defense: an annotated bibliography, May 1968. DDC No. AD 669-747.

SPINKS, C.N., J.C. DURR, and S. PETERS. Characteristics of selected societies relevant to U.S. military interests: North Vietnam, part II (U), June 1968 (SECRET). DDC No. AD 390-732L.

STOWELL, J.H., H.M. SILVERBERG, A.D. SENS, and A.A. MARCHANT. Kingdom of Thailand: selected vulnerabilities and propaganda opportunities (U), March 1968 (SECRET). DDC No. AD 388-390L.

WILSON, B.A. Typology of internal conflict: an essay, May 1968. DDC No. AD 669-018.

In Press:

SZALAY, L.B., C. WINDLE, and J.E. BRENT in collaboration with W. PASTERNAK. Variables affecting cultural meanings assessed by associative group analysis, Sept. 1968. DDC AD No. not yet assigned.

WILSON, L.C. and D.S. HITT. A selected bibliography of the Dominican Republic: a century after the restoration of independence, Sept. 1968. DDC AD No. not yet assigned.

2F. CENTER FOR RESEARCH IN SOCIAL SYSTEMS BIOGRAPHICAL DIRECTORY OF PROFESSIONAL PERSONNEL

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U S GOVERNMENT PRINTING OFFICE : 1969 O—333-404