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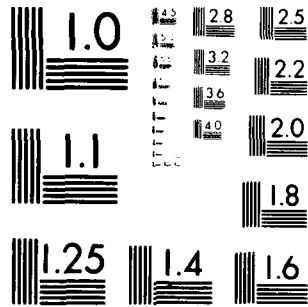
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FORT GORDON, GEORGIA
5-7 OCTOBER 1971.

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Final Report, In Seven Volumes
CONARC 1971 VOLUME VII.

SYSTEMS ENGINEERING SPECIALITY WORKSHOP

10 GENERAL RALPH E. HAINES, JR.
Commanding General
US Continental Army Command

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BRIGADIER GENERAL IRA A. HUNT, JR. Lucas R. Garner
Deputy Chief of Staff for Individual Training
US Continental Army Command

Robert S. Tiner
Edwin J. Galtrey

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SYSTEMS ENGINEERING SPECIALITY WORKSHOP

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SYSTEM ENGINEERING OF TRAINING WORKSHOP

**Presented by:
Systems Engineering Branch
U. S. Army Transportation School
Fort Eustis, Virginia 23604**

CONARC Training Workshop
5-7 October 1971

Systems Engineering in Training

Session #1 (90 Min)

"Systems Engineering Within the Armed Forces--A Status Report"

5 Oct	6 Oct		
1400-1425	1400-1425	Army	Major Tamer
1425-1445	1425-1445	Marine Corps	LTC Godfrey
1445-1505	1445-1505	Navy	Dr. Havens
1505-1530	1505-1530	Air Force	Mr. Neal
1530-1550	1530-1550	Break	

SCOPE: Each service element will present a brief but comprehensive status report concerning the utilization of systems engineering as a process for the design of curriculum. Presentation will identify problem areas and successes in the development and growth of the systems approach to course design.

"Overview of Course Design through the Systems Approach to Curriculum Development--a Survey of Contemporary Research"

5 Oct	6 Oct	
1550-1610	1550-1610	"Systems Approach to Course Design in the Civilian Community" Dr. Gagne
1610-1700	1610-1700	*Panel and Open Forum on Issues and Problems in Systems Engineering Major Tamer Mr. Vassos

*Panel will be composed of representatives of the armed forces and civilian community

SCOPE: An internationally known research specialist will review the development and current direction of the systems approach to course design in the civilian community. This presentation will be followed by a panel of representatives from the armed forces and civilian communities who will respond to questions in an open forum. Additionally, comments/responses to the systems engineering field survey conducted by USATSCH will be identified and introduced for workshop discussion.

"Unique Procedures and Techniques in Course Design through Systems Engineering"

6 Oct	7 Oct		
0830-0850	0830-0850	Systems Approaches to the Design of Curriculum	Mr. Foster
0850-0910	0850-0910	Administrative Innovations	Dr. Tiemann
0910-0930	0910-0930	Soft Skill Courses	Mr. Harvey
0930-0950	0930-0950	Computerized Aspects of Systems Engineering	Mr. Henry
0950-1010	0950-1010	Course Structure Concept	Dr. Gray
1010-1030	1010-1030	Open Forum Period	Major Tamer Mr. Vassos
1030-1100	1030-1045	Break	

SCOPE: Presentations by Army Service Schools will highlight unique procedures and techniques utilized in the system engineering process. An open forum will follow to gain further information and insights concerning these aspects to systems engineering. The presentations of Workshop Session #3 are keyed to the response and requests resulting from the systems engineering field survey conducted by the USATCH.

"Information Interchange and Future Directions in Systems Engineering"

6 Oct	7 Oct		
1100-1130	1045-1115	Commercial Approach to Systems Engineering	Dr. Hoyt
1130-1145	1115-1130	Discussion	Major Tamer Mr. Vassos
1145-1155	1130-1140	Views from CONARC	Mr. McDowell
1155-1215	1140-1200	Workshop Observations	Dr. Gagne
1215-1400	1200-1330	Lunch	
	1330-1500	Plenary Session	
		Workshop Summary and Critique	
	1500	Adjournment	

SCOPE: A presentation by this system development corporation identifying a unique approach to the systems engineering function. Future directions and comments will be explored in views from CONARC. Dr. Gagne will provide professional observations concerning attainment of workshop objectives

SYSTEMS ENGINEERING OF TRAINING SPECIALTY WORKSHOP

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BIOGRAPHICAL SKETCH OF SYSTEMS ENGINEERING

CONSULTANTS

Dr. Philip W. Tiemann - A education advisor to the U. S. Army Veterinary School and a faculty member of the University of Chicago.

Dr. Robert M. Gagne - A professor in the Department of Educational Research and Testing at Florida State University. He has been actively engaged in research on human learning for many years and is regarded as a leading authority in the field. His most recent books are The Conditions of Learning and Learning and Individual Differences.

SYSTEMS ENGINEERING WORKSHOP ORIENTATION
(An Introduction)

LTC Lucien R. Garneau
U. S. Army Transportation School
Fort Eustis, Virginia 23604

SYSTEMS ENGINEERING WORKSHOP ORIENTATION
(An Introduction)
LTC Lucien R. Garneau, USA

The U. S. Army Transportation School is proud to be a part of this conference and to have been selected to conduct the Systems Engineering Workshop. Perhaps I can set the stage for the Systems Engineering Workshop by relating a fable which is making the circuit in the Systems Engineering Field.

A Fable by Roger A. Kaufman

Once upon a time there were two pigs (a third one had gone into marketing and disappeared) who were faced with the problem of protecting themselves from a wolf.

One pig was an old-timer in this wolf-fending business, and he saw the problem right away -- just build a house strong enough to resist the huffing and puffing he has experienced before. So, the first pig built his wolf-resistant house right away out of genuine, reliable lath and plaster.

The second pig was green at this wolf business, but he was thoughtful. He decided that he would analyze the wolf problem a bit. He sat down and drew a matrix (which, of course, is pig latin for a big blank sheet of paper) and listed the problem, analyzed the problem into components and possibilities of wolf strategies, listed the design objectives of his wolf-proof house, determined the functions that his fortress would perform, designed and built his house, and waited to see how will it worked. (He had to be an empiricist, for he had never been huffed and puffed at before.)

All this time, the old-timer pig was laughing at the planner pig and vehemently declined to enter into this kind of folly. He had built wolfproof houses before, and he has lived and prospered, hadn't he? He said to the planner pig, "If you know what you are doing, you don't have to go through all that jazz." And with this, he went fishing, or rooting, or whatever it is that pigs do in their idle hours.

The second pig worked his system anyway, and designed for predicted contingencies.

One day the mean old wolf passed by the two houses (they both looked the same -- after all, a house is just a house.) He thought that a pig dinner was just what he wanted. He walked up to the first pig's house and uttered a warning to the old timer, which was roundly rejected, as usual. With this, the wolf, instead of huffing and puffing, pulled out a sledge hammer, knocked the door down, and ate the old timer for dinner.

Still not satiated, the wolf walked to the planner pig's house and repeated his act, Suddenly, a trap door in front of the house opened and the wolf dropped neatly into a deep, dark pit, never to be heard from again.

- Morals:
1. They are not making wolves like they used to.
 2. It's hard to teach old pigs new tricks.
 3. If you want to keep the wolf away from your door, you'd better system engineer.

The pig fable gives us the rationale for Systems Engineering. How I would like to give you the rationale that the Transportation School used in planning the Systems Engineering Workshop.

First of all, we took the primary purpose of the conference which was to "foster an extensive interchange of ideas and information relating to innovations in training" and built this into the program structure. This was accomplished by inviting participants from the Armed Forces, industry and the civilian community. Also, within the Army, we brought together the talents of several service schools to provide the breath of interchange we were seeking.

Since we are highly pleased and proud of the Systems Engineering team, the Transportation School has assembled, I would like to share with you our list of distinguished participants.

From the Service Schools we have:

Mr. Foster - Air Defense School

Dr. Tiemann - Veterinary School

Mr. Harvey - Infantry School

Mr. Henry - Quartermaster School

Dr. Gray - Engineer School

Major Tamer - Transportation School

Mr. Vassos - Transportation School

From CONARC we have incited:

Mr. McDowell

From industry we have

Dr. Hoyt from the System Development Corp.

From the other Armed Services we have:

LTC Godfrey - U. S. Marine Corps

Dr. Havens - Navy

Mr. Neal - Air Force

Additionally, we are pleased to have Dr. Gagne, an internationally known figure in education research from Florida State University, represent the civilian community.

Also, many of these distinguished people have brought some of their colleagues to assist them in their presentations and act as resource people to the participants of the Systems Engineering Workshop.

Secondly, we wanted the Systems Engineering Workshop to reflect the latest thinking, techniques, procedures and accomplishments in the Systems Engineering field.

This was accomplished by an extensive field survey consisting of a structured questionnaire sent to CONARC activities to gather the data necessary to meet this objective.

After analyzing the results of the field survey we were able to identify and select areas of interest and concern primary to those elements working in the field of systems engineering.

As a note of interest, it was amazing that the results of the survey identified a high degree of commonality in restricted areas of interests.

So, we built into the Systems Engineering Workshop as many of these areas as time would allow.

Additionally, we included this information in the handout material which will be found in the portfolios you will receive as a participant at the Systems Engineering Workshop. This was done so that you may be aware of these areas and seek resolution of your interests either during this conference or in your follow-up activities after the conference.

This leads us to the third element of our rationale - Interaction and future activity.

Total resolution of problem areas and development of area interests cannot be hoped for during this conference. Realizing this, we suggest two things which might help you in this area.

First, use every spare minute to interest and seek resolution whenever you can. Don't be cliquish and stick with your colleagues that came to the conference with you, but have meals and rap sessions with those individuals who can help you reach the objectives for which you are striving.

Secondly, realizing again that our time is limited, we will compile a Directory of Participants in the Systems Engineering field whom you may contact at your leisure as residual activity of our workshop to cultivate a relationship which will be of mutual benefit.

The last element in our program rationals was the identification of resources. Our most important resource is people and we are proud to bring you the best that we could find to make this the most professional workshop of it's kind.

Also, we recognize that the more we know about our work, the more we will be able to do. So, we have included a bibliography of selected publications which will stimulate your thinking and provide you with information necessary to perform your duties more effectively.

Therefore, you are encouraged to share your findings along these lines in order that we can add more to our warehouse of resources.

This then gives you some insight into what you can expect from the systems engineering workshop.

The Transportation School has assembled the best talent available in the field of Systems Engineering. We have even applied the principles of Systems Engineering in the planning of the Workshop. So you know it has to be good.

Now, there is only one ingredient left to be added to the Systems Engineering Workshop to make it one of the most meaningful experiences for you and that is your participation.

Henry Ford expressed this extremely well when he said: "Coming together is a beginning; keeping together is progress; working together is success." Now, we look forward to your participation.

SYSTEMS ENGINEERING WITHIN THE U. S. ARMY
A Status Report

Major Robert S. Tamer
U. S. Army Transportation School
Fort Eustis, Virginia 23604

Good Afternoon, I'm Major Tamer of the Transportation School at Fort Fustis. I would like to direct your attention to the TV monitors for a short introductory tape. As you see this tape, consider in your own mind a possible title of "Why Systems Engineering," or was a new approach to curriculum development needed. Although amusing, the tape identified two of the main reasons demanding a sophisticated approach to curriculum development within the Army. Graphically illustrated were the technological advances in military hardware and the need for advances in educational technology within Army training programs. The result of this recognition was the creation of the systems engineering function within the continental Army Command. But before going further what is systems engineering in the Army? In an attempt to bring us all to common ground, I feel a brief explanation may be in order due to the many concepts and views existing covering this subject. Systems engineering as a function includes all of the elements we formerly identified in curriculum development. Now these elements are formalized in a systematic and fully documented approach to curriculum development, or simply - A total approach to subject. But what does this process involve?

Systems engineering involves a through investigation into every factor or potential factor influencing an individual soldier's ability to perform his job at a required level in the field; it involves interaction and coordination with all governmental and nongovernmental activities charged with the actions you see here such as doctrine, plans and equipment. This activity culminates in follow-up research in an attempt to fully analyze the job tasks required of the individual soldier, and provides the basis for what must be taught and more important, what must be learned.

Curriculum developed utilizing this dynamic process results in greater efficiency in the utilization of resources, (both material and personnel;) greater effectiveness in constructing courses of instruction solidly based around those essential elements of the job identified in the field; in the structuring of courses best for learning and insures that the most effective instructional techniques, environment, methods and media are utilized and fully integrated. All this then, results in the conservation of all resources, training time and directs our instructional emphasis.

Some of the spinoffs of the systems engineering process include a purification of the job most structure and, curriculum objectivity to insure that biases, whether personally or professionally motivated, do not appear in the instructional process. Further this process provides a dynamic vehicle with which to individualize the instructional process at the grass roots level -- A key objective within Gen Haine's speech.

All this then is directed at the single purpose of systems engineering; -- To develop the best training program possible to prepare soldiers, our graduates, to perform at the highest level of productivity possible. So much for defining systems engineering within the Army; certainly it was a cursory overview of a highly technical, and detailed process.

But let's now look at some of the factors influencing systems engineering development with the Army. Systems engineering within CONARC training activities has its birth in February of 1968 with the publication of CONARC regulation 350-100-1. The graphically portray this development, I will draw on analogy between the growth of systems engineering and the growth of a child. Since this is common to all of us the transition should be easier.

Let's call our baby Systems Engineering. He was born during a turbulent period within the Army; one in which the Army was involved in a process of mobilization and mission orientation heretofore unheralded in our military history. And as all babies do -- systems engineering initially reflected the sum total of its environment. This environment was dominated by our Vietnam Mission Commitment and Selective Service Mobilization Program which developed around CONARC'S ability to train and provide soldiers with the requisite skills necessary to perform immediately at the entry level of their MOS. This mammoth responsibility was directed at providing graduates which required little or no on the job training. We could no longer depend upon field units to conduct on the job training to round out a soldier's school training and qualifications. Every element within the Army was completely and totally devoted to their mission commitments whether in Vietnam or in Europe where, by the way, our personnel draw down made it necessary for one soldier to perform as two. CONARC was charged with the challenge of producing soldiers capable of entry level productivity upon graduation. "Hands on training" was emphasized and this particular phrase became the focal point for commanders and military educators alike. Additionally, new advances and availability of educational technology made a new and totally integrated approach to curriculum development both necessary and mandatory.

Now as with everything new, we had a number of problems in developing our new baby -- Systems Engineering. First of all, the terminology utilized in describing the process and its interpretation fell on untrained senses. How do we use criterion, standard, matrix, etc. and more important what do they mean? The development of organizational concepts to conduct the function whether decentralized or centralized, was purely trial and error. Some CONARC elements established separate systems engineering branches and divisions, while others intergrated the function within the existing organization. Manpower needs as well as manpower authorizations and justifications were unknown and vague. Command emphasis was a necessity but too much could have resulted in a total production-oriented systems engineering program directed at developing facsimilies or regurgitated courses of instruction.

If and when this were to happen, systems engineering would be reduced to nothing more than a new label or title. Since this new baby contained the majority of curriculum development responsibilities previously found within other established organizational elements, as well as those solely peculiar to systems engineering, duplication of functions was a fact. Defining and isolating staff responsibility for the all-encompassing seven systems engineering steps was necessary if manpower problems, organizational structure, and the development of standard operating procedures were to be realized. Additionally, it was imperative that formalized training of project engineers and the staff and faculty be initiated if systems engineering were to achieve its full potential. These problems were magnified by the initial resistance and lack of responsiveness of the supporting informational sources, so necessary to complete an adequate job analysis - and if all these problems were not enough to stump the finest systems engineering pediatrician, our baby was being staffed and restaffed just about every 12 months due to the personal turbulence associated with the rapid turnover of project engineers to meet mobilization requirements. This one problem may be the root cause for our systems engineering baby failing to meet the initial five year goals identified in CONARC reg 350-100-1 when considering the long duration required to systems engineer a course of instruction, compounded by the long training and experience required to make a project engineer productive, the rapid personnel turnover problem resulted in excessive expenditures of all resources and completely colored our babies progress. A good example of this problem could be deducted from the three years required to redesign the turbine engine repairman course of instruction and the 10 project engineers assigned the project during this period. This course could have been redesigned in one year by one project engineer. But, as Robert Ripley would say "Believe it or not," our baby, systems engineering, grew to childhood - and after two years of activity, Papa CONARC called for and reviewed his first report card. Papa CONARC doesn't appear to be pleased - Let's have a look at our boys process.

Well, I think this report card graphically portrays the crystallization period of systems engineering - as well as some of the ills still plaguing systems engineering's ability after two years to make the honor roll. Although we appear to have a failure in one area, this conference should improve our grade in this area. However, an overall passing grade is identified, including some of the areas responsible for this achievement. Also during this period, there was a plus factor in the tremendous awareness and confidence growing in the products or systems engineering. I think the teachers comment bears noting. As with all children, the inevitable occurred, in late 1970, as systems engineering arrived at limited productivity and adolescence. It was during this period that Papa CONARC found the

guidance directing the systems engineering function inadequate. We now began to face the facts of life identifying a need for new guidance and greater interaction. As a result, the Director of Instruction/Education Advisor Conference of March of this year. Papa Conarc recommended to the Chief of Staff of the Army the workshop we are now involved in come about. All Army agencies charged with implementing the systems engineering function have achieved a degree of success and reached various levels of maturity. Additionally, each of these systems engineering agencies individually resolved problems in streamlining procedures through standardization; developed new techniques including the increasing use of automatic data processing; broadened perspectives in total Army interaction; and shared the products of systems engineering both vertically and horizontally within the Army organizational structure. This increased activity has led to functional refinement of a quality product and the recognition so necessary to solve our manpower and organizational difficulties. Now the stated objectives of this workshop are directed at sharing these products of our total maturation. Therefore, it is imperative that our workshop interaction be extensive and meaningful and that we all grow to higher levels of productivity as a result. The folders you have received as a participant contain the catalytic elements of this sharing. We at the Transportation School, have found that the use of a comprehensive checklist as part of our systems engineering standard operating procedure insures product uniformity. We also use an Automatic Data Processing program which resulted in an estimated 60 man day time savings. These are only two examples of the elements of your packets which you may find beneficial and useful. Our process of maturation has firmly established systems engineering in the CONARC family but how do we arrive at adulthood?

That's a question we may find in a crystal ball. But I prefer to think a more approach will emanate from this assembly. But where is systems engineering now? In a pure numerical score card tally, we appear to have come a long way in meeting our systems engineering objectives by completing 240 courses of instruction out of a total of 720. But what does this tally really indicate when considering the tremendous and rapid changes coming about in the orientation of the Army today which will necessitate a change in our training philosophy. Increasing opportunities for unit preparedness training or on the job training, the emerging volar concepts and increasing demands for resources conservation demand we begin to re-examine what we have done as well as what is yet to be done to insure our products are economical, purposeful and reflects this new thinking. Additionally, we should begin to consider the joint development of school courses of instruction with formalized systems engineered on the job training packages to assist and enhance unit preparedness training programs. In this way, we can insure that combat readiness will not be affected

by reductions in school training time or the inability of individual units to develop or perform on the job training. Systems engineering within the Army is now in the process of growing to full capability although many of us may feel at times that systems engineering, because of changing influences, is in a state of Limbo. I assure you this is not the case.

Systems engineering is the dynamic tool by which our changing military commitments, philosophy and volunteer Army concepts can be realized. We have a tremendous challenge before us and I'm certain we can meet it.

SYSTEMS ENGINEERING IN THE U. S. MARINE CORPS

LTC Edwin J. Godfrey
U. S. Marine Corps
Washington, D.C. 20380

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THE MARINE CORPS AND THE SYSTEMS APPROACH TO TRAINING

In a summary of a systems engineering workshop survey conducted recently, 27 different topic areas of interest were noted. Although it was an Army survey, each topic represented an area the Marine Corps has struggled with, too. Rather than address any specific topic or problem area. A brief overview of the Marine Corps' effort with the "Systems Approach" is believed in order.

This overview with address three basic areas where the Marine Corps has applied or is applying the "Systems Approach:" Marine Corps formal schools; unit level training; and finally our recently developed computer-supported training management system called Gentras.

DEFINITION OF TERMS

Whether we address the "Systems Engineering of" or the "Systems Approach to" training, we are speaking of essentially the same process. There will be some difference in terms, and some difference in flow charts; but what we are really talking about is, instructional design starting with the identification of performance requirements, and working back through the selection of learning objectives, measurement criteria and instructional strategies. To a valid and meaningful program of instruction which we continue to validate through evaluation and feedback. That, of course, is an overly simple definition, but it does summarize a generally uniform view of the "Systems Approach" to training. An even simpler view is quoted below from a Marine Corps unit level training management directive:

- "1. Training is not an end in itself, it is a means of achieving desired performance on the part of units and individuals. To this end, the "Systems Approach" to training is simply an orderly and logical approach. A systematic approach to the design of instruction and the development of training programs.
2. In a unit level training program, training should not be conducted merely for the purpose of accomplishing a given amount of training. It should be conducted for the purpose of raising unit or individual performance from current levels of performance capability to desired/required levels."

In the case of our formal school training what we are really talking about is a workable means to bridge the gap between the needs of the field, and what is taught in our schools.

FORMAL SCHOOLS

In January 1969, after learning many lessons from the Army at Ft. Devens, the Air Force at Lackland, and a number of our better known civilian education specialists, the Marine Corps published an order entitled "Design of Courses of Instruction." Although at many formal schools either intuitively or through local policy. A form of systems approach to course design was already in effect. This Marine Corps orders - 1510.23 - presented the first time that the "Systems Approach" was directed as Marine Corps policy. It should be added that although this order applied principally to formal schools conducting enlisted ground training after boot camp. It nevertheless

laid the groundwork for subsequent expansion into unit level training, and ultimately into all areas of Marine Corps training and education. The order itself addressed such topics as: The new concept and its terminology; the collection of job data; the selection of learning objectives; the preparation of performance objectives; the preparation of criterion measurements; the selection of course content; the selection of instructional strategies; the evaluation of course content; testing and analysis; graduate followup; and the preparation of programs of instruction.

What the new order did, in effect, was require that all enlisted (ground) formal schools, over a several-year period, validate their programs of instruction, starting with what would amount to a "Table Top" job analysis process. Then working back through the systematic process of learning/performance objective selection, instructional strategy selection, and course design/validation. The process described in the order represented. Understandably, a considerable undertaking for all the formal schools involved. For most, it was a test undertaken with great reluctance, since it was an in-house effort which has to be accomplished by already overtaxed instructional staffs. Results have varied from reasonably satisfactory, to outstanding; but in virtually all cases, the result has proven well worth the effort. The quality and appropriateness of instruction has improved, and in many cases course lengths have been reduced.

The recent course validation/redesign effort, however, has in fact been a means which is serving to bridge the gap for our formal schools, from the traditional approach to instructional design. To an approach which can be supported by an advanced computer supported training model.

GENTRAS

Let me explain the last comment in more detail. Under the current program, job or task analysis is determined by "Table Top" analysis at the school itself. Although it may seek support from field commands. Since early 1970, the Marine Corps has been undertaking by separate action. A detailed comprehensive "Task Analysis Program" which over a several-year period is conducting an occupational field by occupational field analysis to identify those skills and that knowledge actually required on the job. The impact of this effort reaches many areas, only one of which is training. From the training standpoint, however, the impact is significant job performance requirements will be clearly identified, and validated, MOS by MOS. This in turn provides the trainers with a far more valid statement of training requirements than our school-level "Table Top" analysis could possibly give us.

In order to effectively utilize the task analysis output i.e., The validated job data - we have recently designed, in cooperation with IBM, a computer-based training management system called the General Training System, or Gentras. What Gentras will do, is close the loop between those who manage overall training. Those who conduct it, and those who use the end product, the "Field". Through maintenance of computer-based job data files, course data files, and a field evaluation feedback routine - each using compatibility performance/learning objective terminology, Gentras is designed to assure compatibility of job performance and the instruction actually presented in our formal schools.

The task analysis program makes available to Headquarter Marine Corp. detailed job descriptions and occupational field structure. Course information is provided by the schools. The training management system provides automated support for storing raw MOS, course and field evaluation data; and queries against this data base provide the capability for selecting and correlating this information to produce meaningful output. Using this information, Headquarter Marine Corp can determine apparent deficiencies in training and will. In turn, recommend changes to the schools. The schools, acting upon these recommendations will be able to place better trained personnel in the field. Through field evaluation of recent graduates, and by re-surveying field units, Headquarters Marine Corp will be able to further evaluate jobs, job structure and training effectiveness, whereupon the cycle may be repeated. Field evaluations will normally be conducted on a sample basis; however, they are always conducted for new courses and courses known to be deficient.

Centras has just begun implementation. Using as a pilot a recently restructured occupational field. We anticipate incorporation of all ground occupational fields and associated courses by the fiscal year 73/74 time frame.

UNIT LEVEL TRAINING

Our effort to bring Marine Corp training under the umbrella of the "Systems Approach" has not been limited to formal school training. Earlier this year, we published a unit level training management directive - MCO P1510.26 - Which served to translate the "Systems Approach" and our more complex design of course of instruction order into guidance which was feasible and meaningful to the unit commander and his staff officers involved in determining training requirements, and planning/supervising training programs. It addressed such areas as the development of command training program objectives. The design of instruction; programming training; unit training directives; and the development and conduct of instruction. The latter to include the selection/development of learning objectives. The selection of instructional strategies, and the evaluation of instructional results.

FUTURE

For now, we have our "Systems Approach" well on the road in all our enlisted formal schools both via our "Table Top" individual school programs, and via our Centras system. Unit level training, too, is now under the umbrella. Our next step is a revision to our "Design of courses of instruction" order to embrace all Marine Corps Training/Education - officer and enlisted, technical and professional. This we are doing now, in conjunction with the development of a supporting Marine Corps Instructor's Guide. Hopefully, by July of 1972, all Marine Corp Training will be under the purview of complementary Marine Corp directive based on the overall principles of the systems approach to training.

NAVAL AIR TRAININGS PILOT SYSTEM

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The word "Pilot" in the title of this paper is an acronym. It does not mean an individual who operates aircraft. The acronym Pilot stands for

Performance-centered
Individualized
Learner-Oriented
Training

Thus the Pilot System is a performance-centered, individualized, learner-oriented training system.

Performance-centered means to us in Naval Air Training that the object of all instruction is performance. Students are taught to do things or to behave in a prescribed manner.

Individualized has a two-fold meaning. At the present time it means that students do not receive instruction in regulated groups, all studying the same thing at the same time in lock-step fashion. By individualizing the instruction students can move independently, and "soft-scheduling" of instruction is a reality. Rigid patterns of group instruction can be dispensed with, and training aircraft, simulators, and buildings can be utilized on an even-flow basis. At a later date, individualized can mean a variable curriculum with individual tracking -- in exemption, validation, and remedial work as required by individual needs.

Learner-Oriented means that all instruction is addressed to and developed for the learner, and the principles of controlled self-discovery revealed in incremental fashion operates insofar as possible to let the learner teach himself. The learner is the principal participant. He responds and reacts continually and is continuously involved throughout the learning session.

Training is the "T" in the acronym and the primary reason for our existence in the Naval Air Training Command. Our job is to train pilots and flight officers for the fleets of the Navy.

The PILOT System is thus Naval Air Training's cut at an engineered training system, developed along the lines of the systems approach applied to the design of a total instructional system.¹

Origin and Development

The beginnings of the systems approach to training now identified as the PILOT System lay, for Naval Air Training, in the programed instruction movement that gained impetus in the Spring of 1964 in Naval Air Training. From a meagre beginning of four programed textbooks developed in-house the programed instruction movement developed in succeeding months to an inventory of 135 or more (perhaps 1100-1200 clock hours of learning time), and numerous comparisons were made between programed-textbook instruction and conventional-lecture discussion methods.

Because a methodology for making comparisons was fuzzy and lacking in general, an associate and I authored for the Command in 1967 a manual entitled Measuring the Effectiveness of Programed Instruction² that suggested various ways or procedures.

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1. Reference 1
 2. Reference 2

With this tool, we made dozens of comparisons. The conclusions were predominately the same; the lecture-discussion method would yield for us about a 60-65% correct on a post-instructional test. A good programmed text on precisely the same content would raise the mean post-test score to a level of 90% in about two thirds of the time.

But, despite the obvious fact that on identical material students earned significantly higher post-test scores when they learned with programmed materials, our aviation instructors still preferred, perhaps with some justification, the traditional position of influence in the front of the classroom. The programmed textbooks were thus not extensively used as the primary means of instruction to replace the lecture-discussion method.

In the interim, however, the seeds of discovery had sprouted. It had been perceived by many by this time that a well wrought programmed-learning sequence is in reality an incremental learning system in miniature. It contained like Van Leeuwenhoek's drop of water the essentials of a viable system. It contains (1) precisely defined behavioristic objectives (2) a practical, operable instructional methodology (3) a list of criterion performance measures which obviously relate to the original behavioristic objectives. Movement from the programmed-instruction concept to attempting the design of an engineered total instructional system was thus natural and perhaps inevitable.

In 1967 a team of four under my sponsorship published for the Command and eye-opening manual entitled Introduction to the System Approach.¹ This approach concepts to the Naval Air Training problem. But it served mightily in broadening the views of line aviators and training administrators to the possibilities and potentials of the systems approach.

The concept envisioned in this publication was audacious, chiefly because it suggested a backwards approach, so to speak, to the systems training concept. Actually, it suggested that a systems approach to training could be implemented at the lowest level of the Training program and grow upwards, so to speak. It suggested that any small segment of instruction could become a micro-system of learning that could participate, as it were, in the larger or macro-system; and that the classic approach to systems training could be obviated.

It appeared impossible at that time to attack the problem of over-all systems design for naval aviation, since at that time our Staff was at the lowest level of Naval Air Training. With the recent realignment of flag billets and Command combinations, our Staff has been elevated to senior status and control of all Naval Air Training. But a classic approach to systems training- that is, analyzing the tasks performed by the graduate of the training program and working backward to construct a training program inculcating the desired qualities -- was not feasible anyway. Thus

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1. Reference 3

our original assumption, naive as it might have been, was followed. We preferred to believe that there had to be some good qualities in our 60-year-old aviation training program; and that we could not shut down the old pipeline while we were designing and implementing a bright, shiny new one. Hence the PILOT System is being implemented from the bottom to the top and from the front to the back, rather than being promulgated from the top to the bottom and the back to the front. Of course, either of these positions is not entirely possible. A system must be engineered, at least in theory, at both the front and the back and the top and the bottom at the same time. If the system is indeed well engineered, any portion of it could be implemented at any level.

THE OVER-ALL STRUCTURE OF THE PILOT SYSTEM

The architectonics of the PILOT System are in place in naval air. The over-all shape of the system is clear. We have, working along the tree of logic, subdivided the total aviation training system into five subsystems:

1. The vehicle/platform
2. The environment
3. The human
4. The man-machine system
5. The weapons

The branch below the subsystem is the discipline, a collection of courses of a common nature, like aerodynamics. Below the discipline is the actual course of instruction. Courses of instruction are in turn subdivided into instructional units. These are the self-contained instructional micro-systems which are the avenue of learning for the student.

By using this kind of tree logic for systems identification and coupling each of these segments with an appropriate alpha-numeric designator plus groups for units identifies, instructional time, and method of instruction, we have devised an operable and unique alpha-numeric code designator for each micro-unit within the system. This basic code structure permits positive identification, and accountability on both a manual or computer controlled records keeping system. Our publication entitled "Alpha-Numeric Code for the PILOT System"¹ facilitates the encoding process.

The instructional content of the PILOT System is controlled by the same tree logic. The total system is governed, for example, by a set of over-all goals which of course are related to mission. The mission is prescribed by higher authority, but goals may be set by the commander of the system. Each sub-system has a segment of the over-all goals of fulfill, as do disciplines. Courses of instruction within the discipline must have educational objectives. Within the course of instruction are the instructional units which must assuredly be comprised of specific instructional objectives. Since we are building our PILOT System in detail from the bottom strata to the top, we have thus been most concerned with the specific instructional objectives.

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1. Reference 4

SPECIFIC OBJECTIVES AND CURRICULAR VALIDITY

Our scheme for stating specific instructional objectives for units from the start has been to couch them in the language of Bloom's Taxonomy of Educational Objectives. We sort the objectives into the three domains -- the cognitive, the affective, and the psychomotor. This scheme gives the instructor a plan of attack, so to speak only an expert can eat a pizza without first slicing it. Each objective is neatly written on a special form provided for that purpose. On this form is also a space to record the action of the friendly "murder board," a group of instructors and senior administrators specially constituted for this purpose. On an attached form is the criterion measure associated with and developed from the specific objective. The murder board acts not only upon the specific but also upon its related criterion item. If the "murder board" should approve of the objective and the item, it will then be included with other valid objectives of the unit. The criterion measure, written in triplicate, is then introduced into the testing sequence for the item, course, and phase. If the murder board should not approve the objective or the item, both are junked and the unit writer returns to his workbench for another one. These procedures and specimen copies of the software forms are published in our manual extitled "PILOT System Testing Software"¹(1971).

The procedures described above may impress the audience with its naivete inasmuch as it makes no claim to statistical vility. It does, however, function quite well, and its quality of curricular validity is perhaps the highest attainable. A greal deal of "crud" has been purged from the system by means of these murder boards.

The murder boards have helped to keep command goals, course educational objectives, and specific instructional objectives of units in closer alignment than ever before.

PREPARING FOR INSTRUCTION

With his list approved instructional objectives in hand, the instructor-technician sets to work hammering out his PILOT System unit. This is a bookley,when finished, that looks like this. The format for the unit is prescribed by our publication entitled "Model Unit for the PILOT System, Instructional Software"²(1971). The unit contains a pre-test, a list of objectives, a list of materials needed to complete the study, a programed or structured learning sequence, and a unit post-test, with complete directions and instructions provided for the learner.

Audio-visual support of the PILOT System at the present time is our toughest problem. We are limited almost exclusively to group showings of conventional training films in 16mm format. These are difficult to blend effectively with our individualized performance-centered system. Group showings are arranged, however, during the band of the training day. Providing adequate interaction with films utilized in this fashion is impossible, of course, except in actuality.

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1. Reference 5
2. Reference 6

Our long-range solution to the audio-visual problem is to provide individualized instructional TV cassette format single-concept television tapes cut precisely to the specifications of the instructional unit for which they will be made. The student would draw the appropriate instructional TV cassette with the instructional unit. He would go to the cassette players located at various spots in the learning areas, place the cassette in the player as instructed, and the player would make its presentation through an ordinary 11" color television set. Listening would be provided through an earplug. We envision one cassette-player/instructional TV set available for every three students under instruction. Perhaps two-thirds of the approximately 2,500 PILOT System units in the system will require the dynamic qualities that only a combination of motion and sound can provide.

The log-jam in the instructional TV cassette production business may be about to break up. According to Popular Science (Oct 1971)¹ both Sears, Roebuck & Company and Montgomery Ward will feature an instructional TV Tape player for home television sets. The instructional TV cassette manufactured by Cartivision will be backed up by a library of 850 tapes. The whole package is made by AVCO.

The central instructional TV recording facility now in existence under the control of the Chief of Naval Air Training will be expanded to service the instructional TV production requirements of the PILOT System. This central producing studio and staff would be capable of recording and distributing perhaps 20 to 20 single-concept instructional TV taped programs per week. The primary source of programs content would be the instructor-managers of various instructional units in the PILOT System.

Already under development for the instructor's use in presenting original content for instructional TV tapes is a workbook-like-publication for him to fill in to start his instructional TV taped program on its way to production. The workbook will be designed so that the instructor can relate his material in logical fashion to his specific instructional objectives and present it in story-board fashion. He would rough in the visual content in frames provided and would supply the narration in spaces associated with the video. We believe this workbook will provide the central recording studio the essential ingredients for completing the production and delivering the packaged cassettes within a few days.

EARLY RESULTS

The performance of the PILOT System is fully implemented courses has been good to excellent. The first course totally converted was Visual Flight Rules Navigation (Basic Prop), formerly a 30-hour lecture-discussion course. Under the PILOT System the course as converted to 17 instructional units. In June, 1971, 115 students proceeded through this course with mean-post-test performance of 84.62 per cent correct in mean time of 28 hours and 45 minutes.

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1. Reference 7

Also in June 1971 in our Basic Phase (JET) Instrument Flight Rules Navigation course, 82 students received a mean post-test mark of 76.2 per cent correct. This course contains 20 instructional units, whose content equates to 22 hours of lecture-discussion material. Instructional time under the PILOT format was approximately the same.

Both of the courses just cited are being extensively revised on a unit-by-unit basis, using the pre- and post-test data collected to bolster the weaker portions of the instructional sequence.

Better results have since been obtained in our Primary Phase courses. From 16 August to 16 September 1971 approximately 155 students naval aviators progressed through three courses in this phase that had been converted to and instructed in the PILOT format. The results in brief review were reported as follows:*

COURSE	CONVENTIONAL	PILOT	PRE-TEST MEAN	POST-TEST MEAN
	LECTURE- DISCUSSION	INSTRUCTIONAL TIME		
Flight Rules and Regulations	4	3.5	39%	89.66%
T-34 Engineering Systems	13	9.3	43.15%	92.76%
T-34 Aerodynamics	9	6.1	38.37%	91.50%

* Memorandum of Training Officer, NAS Saufley Field of 9-16-71

On the strength of these kinds of results, a dozen other courses of varying length are being readied in the PILOT format for implementation in the immediate future.

SUMMATION

In summation of comments on Naval Air PILOT System, the following points deserve mention:

1. The system itself was designed from the bottom-up. There was no classical approach to it. No task-analysis effort except at the course and unit level.
2. There is no electronic hardware associated with the system at the present time except for a trickle of instructional TV. There are no response-system mechanisms or information retrieval provisions. We are strenuously pushing for an individualized instructional TV cassette distribution and have good reason to believe we will be so funded in the near future.
3. The software exists predominately in printed booklet form and is generated in-house by regularly assigned academic and flight support instructors.
4. The results of the first five courses administered under the PILOT System format range from good to excellent.
5. Training administrators are afforded the best view of the training process they have ever had before. The low-performance areas in the system are readily identifiable.
6. The PILOT System requires a lot of hard work and great attention to detail, but the pay-off is good. It works.

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THE AIR FORCE SYSTEMS APPROACH TO TRAINING

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It is a pleasure to again present an overview of the current status of the application of the "Systems Approach" to Air Force training and education programs. Needless to say, much has happened in Air Force training since the last CONARC Training Conference at Fort Benning in September 1968. The Systems Approach to Training was then being applied only to Air Force technical training. Now it has been extended to apply to all Air Force Training and education programs. Our basic handbooks, Air Force Manual 50-2, Instructional System Development, was published in December 1970. Flying Training and Professional Military Education are now included under the systems approach planning umbrella. Through a marriage of personnel and training research and weapon system planning, the Air Force System Approach to Training has emerged.

Let us look at the Air Force training system so you will better understand the environment in which we live and work. Note that the Air Training Command, my parent command, is charged with the responsibility of recruiting and training the majority of Air Force personnel. However, keep in mind that the Air Force Academy and the Air University are primarily responsible for professional military education. Note also that Air Training Command carries out its responsibilities through flying training schools, four technical training centers, the USAF Recruiting Service, and one basic military training center. Note the location of Sheppard Air Force Base Technical Training Center, which has a key role in the Air Force Systems Approach to Training. First of all, our Training Center at Sheppard Air Force Base has the primary curriculum responsibility for the separate Air Force Training and Education Career Field and supporting resident and correspondence type courses and manuals. We are also responsible for development of the Air Force Manual on the Systems Approach to Training, which as mentioned above is Air Force Manual 50-2, Instructional System Development. Further, we are responsible for conducting several Air Force courses in this new technology of instruction and curriculum development. Let us now review some of our experience and problems in this pioneering effort.

Personnel and training research efforts from industry, Department of Defense agencies, the US Office of Education and other public and private sources have made great contributions to our Air Force program. However, since the early 1950s the Air Force has been using the concept of the weapon system, its subsystems and components. The human component must be considered at every stage of weapon system development, from initial conception to obsolescence of the weapon system--a "cradle to the grave concept." In 1962, Dr. Robert Gagne, who is our consultant in this CONARC system engineering workshop, brought together many important papers in the systems approach in the McGraw-Hill publication, "Psychological Principles in Systems Development." This classic text should still be required reading in this area. The Air Force Human Research Laboratories have also made great contributions to our efforts. We have drawn heavily from research

sponsored by the US Office of Education and from both the US Army and US Navy research projects in this area. Even with all this, I think it is obvious that we are putting into practice only a small portion of what personnel and training research indicates is the best of training technology. We are in the same position as the farmer who says "I ain't farming half as good as I know how."

Application of the "systems" approach to Air Force training programs has been stimulating and has forced us into new creative planning efforts. New training programs are being developed and existing courses revitalized through application of this approach. The weapon system designer begins with an operational requirement-- a statement of overall objectives to be achieved--and produces an arrangement of subsystems which will fulfill the operational objectives. A series of tests is then conducted to insure that the system does, in fact, fulfill the requirement. Let's look at an illustration of the events in a weapon system development cycle:

- Definition of System Objective
- Advanced Design
- Assignment of Functions to Man and Machines
- Task Description
- Task Analysis
- Job Design
- Job Aids
- Personnel Selection
- Individual Training
- Training Devices or Media
- Performance Measures
- Team Training
- System Training
- System Evaluation
- System Operational Stage

The development of a training program under the systems approach proceeds in a manner similar to the development cycle of a major weapon system. The Air Force "Systems Approach to Training," as explained in AFM 50-2, consists of the following interlocking steps:

- Analyze System Requirements
- Define Education or Training Requirements
- Develop Objectives and Tests
- Plan, Develop, and Validate Instruction
- Conduct and Evaluate Instruction

Before we go into a discussion of the Air Force Systems Approach to Training, let us look at some other models for curriculum development which influenced our thinking. An excellent training program development model was proposed as a result of a Department of Defense directed study of curriculum content. This study was conducted by the Human Resources Research Office (HumRRO) and consisted of the following seven steps:

- Conduct System Analysis
- Develop Task Inventory
- Develop Job Model
- Conduct Task Analysis

Derive Training Objectives
Develop Training Program
Monitor Trained Product and Modify Curriculum as Required

One other system development model to which I call your attention for comparison with the Air Force model is that specified in your CONARC Regulation 350-100-1, which consists of the following steps:

Job Analysis
Selecting Tasks for School Training
Training Analysis
Developing Training Materials
Developing Testing Materials
Conduct of Training
Quality Control

This Army system engineering (course design) model also influenced our Air Force development. Thus we see in all these different models much similarity, yet varying emphasis on different steps. All of them reflect different interpretations or applications of the systems approach to course development.

The Air Force Systems Approach to Training suggests a rigid step-by-step system, however, there will always be variations in the order or number of steps, depending upon the specific situation and the nature or complexity of the training involved. There is much interaction between steps. It may be necessary to backtrack and reaccomplish or modify an earlier step when it is discovered that it does not provide the necessary input for a later step. The manner of application and the degree of detailed development can be expected to differ; however, the underlying principles of this systems approach will remain unchanged. A brief description of these steps follows:

Step 1 - ANALYZE SYSTEM REQUIREMENTS

There are obviously many factors in an operational system which must be considered. An understanding of the system within which each job is to be performed is necessary including the operational or working environment, the missions of the system of which the job is a part, and the functions of the system components. The man and machine functions and interface or interrelationships of the various system are analyzed. Important sources of information for training need are the weapon or support system job performance requirements. Properly developed statements of job performance requirements describe the operational context, quantitative and qualitative limits, and critical factors of job performance. In the analysis of job tasks, it may be necessary to propose reallocation of tasks to different job specialties or even to combine certain job specialties on a particular weapon system or support system. System analysis places the job toward which training is to be designed in the proper perspective or the objectives, requirements and environment of the operational system. This step provides the initial documentation of job performance requirements which forms the basis for all training course development.

Step 2 - DETERMINE EDUCATION OR TRAINING REQUIREMENTS

This step represents a major decision in training program development. When the job performance requirements are known, it is necessary to determine which requirements will be met through personnel reassignments of already qualified individuals, through formal school training, or through on-the-job training. The most efficient and cost effective method of meeting the requirement will be selected. The entire skill level progression and on-the-job training and formal school requirements are considered at this time. Training standards are published and become the guide for resident school planning, correspondence courses and On The Job Training. It should be emphasized that the Air Force Specialty Training Standard (AFR 50-34) outlines the training required to achieve various skill levels with job specialties. Through its use, individual training (both formal school and on-the-job training) is standardized and the quality of training is controlled.

Step 3 - DEVELOP OBJECTIVES AND TESTS

The list of tasks, knowledges, and attitudes provided through the previous step will be carefully reviewed to determine currency, accuracy, and adequacy. Criterion objectives must be carefully determined from a detailed analysis of the job or task listing in the Training Standard. Criterion objectives should describe a job-related performance and the conditions under which it should be observed or measured. Because the learning objectives are based on a detailed analysis of the job for which the students are to be trained, only essential and relevant objectives are included. Once criterion objectives have been developed, the enabling objectives (or intermediate knowledge, skills or attitudes) required to reach the terminal, criterion objectives are identified. All objectives then are essential, and the proficiency measurement tests or device should thoroughly measure each and every objective.

Step 4 - PLAN, DEVELOP AND VALIDATE INSTRUCTION

Using the objectives developed in the previous step, the most appropriate teaching-learning activity should be planned for each of these objectives, based on principles of learning. This action would include a determination of the most efficient and effective teaching media and the most appropriate supporting training equipment, materials and other audiovisual aids. The course teaching-learning, activities, should then be sequenced for the best learning relationship and use of resources (time, facilities and equipment.) In general, it means that, when possible, the learner moves from the simple to the complex, from the known to the unknown, from the concrete to the abstract. During this step, programmed texts, study guides, workbooks, instructor guides and lesson plans are developed. Whether the selected activity is a lecture, film strip, a tape, a series of slides, a performance project, a programmed test, a script for a movie or a combination of several of these, the planner knows that the activity must prepare the student to gain specific knowledge

and skills. Concurrently with the development of training materials, other actions will be taking place. Facilities will need to be obtained and/or modified to accommodate student and trainer installation. Trainers need to be built and/or installed, and supplies will have to be procured. Instructors will also have to be obtained and trained. The validation process will also take place during this step. After a system has been developed and validated, the system is ready for operational use. Course materials should continue to be revised until the acceptable standard is reached.

Step 5 -CONDUCT AND EVALUATE INSTRUCTION

The final step is the most important one in terms of the continuing success of a course. Primarily a course is evaluated in terms of student attainment or non-attainment of the stated objectives. The evaluation process includes both internal and external procedures such as student grades, performance tests, student critiques, and supervisor's opinions obtained by interviews and questionnaire surveys. Thus a training program is in a constant, continuing revision and updating process.

APPLICATIONS OF THE SYSTEMS APPROACH

The Air Force Systems Approach to training is now being applied to all types of courses--technical, flying and professional military education. Some studies of existing technical courses under the systems approach have been in depth, while others have been only token efforts. Many courses have been reduced in length as a result. Others have been increased in length, so do not automatically expect to reduce courses. Greatest savings are expected through reduction in the individual student trainee time required to complete their assigned courses. Average annual savings of about \$1,000,000 per year at each of our Air Force technical training centers have already been achieved. Progress has been slower than anticipated, and it is expected that at least another three years will be required to complete the review of all technical courses.

While the major emphasis in application of the systems approach has been in technical training programs, application to C-130E Aircrew Transitional Training within the Tactical Air Command achieved not able results. Specific objectives were derived from a task analysis of the aircrew members' jobs. The training program was prepared to develop proficiency in the specific duties required. Much greater use was made of self-instructional, self-pacing materials, including a variety of audiovisuals. The training program was conducted, evaluated and revised over a six-month period. Results included the following: (1) Classroom instruction was reduced about 50% (2) flying hours were reduced from 45 to 35 hours; (3) length of training was reduced 37% per trainee; (4) and verified annual savings of about five million dollars were realized.

Other Air Force flying training program in which the systems approach is being applied in depth include the A-7D aircrew training programs and both the undergraduate pilot and navigator programs. Progress to date indicates that a reduction in flying hours will be possible, with increased amounts of flight simulator time and greater usage of multimedia and self-pacing materials.

Problems encountered included lack of understanding of the systems approach and concepts, terminology, and misconceptions as to time and effort required to implement the new procedures. Training programs

for various levels of management have been sent to major Air Force installations to teach the systems approach to training. Training directives are being revised to reflect the systems approach. All new training course curriculum documents must indicate whether or not the systems approach has been used. Additional guidelines and revisions to AFM 50-2, Instructional System Development, are now under consideration.

The benefits from the Air Force systems approach are many, The student has a better knowledge of what is expected of him and why. The instructor has a better knowledge of training goals and objectives. Supervisors and administrators have a better "yardstick" or training and educational program effectiveness. The users of our graduates can also expect better qualified graduates at reduced costs. It has been a real pleasure for me to share these Air Force experiences with such a dedicated group of training managers and executives with similar problems. I'm sure that we in the Air Force will benefit greatly from this exchange of ideas on systems engineering through this CONARC training workshop. May I compliment you on the progress you have already achieved.

SYSTEMS APPROACH TO COURSE DESIGN IN THE CIVILIAN COMMUNITY

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It's a pleasure to be with you and hear the various presentations in this session. There is a hand out, that's being distributed which sort of gives an outline of what I have to say about system development in the civilian sector. As I have listened to the other presentations I realize that all of them indicate that they have accepted the systems language and the ideas of systems engineering and that's a very impressive thing to me to hear that. I am reminded of the fact that one shouldn't think that there are great developments out there in the civilian world that are necessarily greater than those that are going on within the military services. This table that I handed out to you has a column on the left which lists the stages in man machine system design. That's just sort of for reference purposes. Now the next column indicates the stages in educational system development and uses the kinds of words that are common in that sort of enterprise at least they are, I think, very well understood when system development is carried out in civilian schools and courses and so on. Then, in the final column I have tried to list the kinds of techniques that are available to carry out educational system development in the civilian sector. It may be of interest to you...someone asked me this question and I might try to answer it here as best I can. Where does system development go on in the schools or in the school systems of the civilian sector? Well, it goes on in a lot of places. It may go on, of course, in an individual school. Teachers of this school may decide or may become interested in developing a particular course and then they find a way to get enough time, through the cooperation of their principal or their superintendent to devote their time to this kind of development. To an increasing extent, system development is being undertaken by school systems and, of course as you know, there is an enormous variation in the size of school systems throughout this great country of ours and some of them are very small and some of them are quite large and naturally the larger ones are the ones that usually have the resources that enable them to undertake system development. Then, of course, it is undertaken by support from the Federal government in a number of ways. There are, as you know, regional laboratories in various parts of the country and they are engaged in course and curriculum and sometimes total school development. They may undertake the undertaking to develop a new curriculum in elementary mathematics or a new curriculum in reading and many other examples of that sort. So I'd say, that system development goes on in many places in the civilian sector and it exhibits a great diversity - as great a diversity or perhaps more, than you have, and is exhibited in the kinds of presentations I have heard in this session. One of the problems, of course, in that diversity in trying to select out of it what is best and trying to put into effect what is best and trying to get it, as the word is, disseminated. I am not sure that "disseminated" is the proper concept but try to get

it used - it's not easy because, as you know, between and among schools there is no command authority. They all have their own authority and so they all have their own ideas and it is a very difficult process to get new ideas, even well-developed ideas.

Accepted throughout a large segment of the school community in the civilian sector. Maybe you have an advantage over this, I am not sure, but certainly that is the case. You know you are dealing with hundreds of individual school systems and they just don't have any relation to each other. They are supposed to be locally controlled and so it's very difficult to disseminate new development among them. Going back, then, to the table, I have tried to list here in the final column, as I said, a number of techniques that are available at the various stages of educational development. Now this might be applicable to development if we were talking about a single school. You know one might want to say, "Let us take this school, which is not a very good school, and make it into a really good one," or "Let us take this school and have it a school that uses individualized instruction in which its surriculum is designed according to system principles." That's possible - not that there are many instances of that sort but there are some. Equally well, I think, or almost equally well - these techniques apply to the development of single courses or perhaps sets of courses that form a curricula such as those. I'd say, such as a curriculum in elementary science. If we were going to talk about system development of entire school systems, we would have to deal with a somewhat larger context that would include aspects of finance and management of school systems and these are not represented here, I just wanted to make that clear. This deal with the smaller units such as courses curricula or at the most, you know, a total school program. Now, these techniques that are available, I think, the ones that are listed here and I will try to say a word about them as I go on, these techniques are available. Some of them are old, as you see. Some of them are fairly new, and others are really not quite developed yet even but they are the kind of things that seem to me to have appeared in the various literature and the various projects and other things that I have had contact with that go on in system development so far as the civilian sector is concerned. Often times, looking at the table again, one wants to begin a development activity by being concerned with the systems purpose. Obviously one does that when he is talking about a reference system or something of that sort. What about a school system? You know, are you concerned about that, ~~mmmmh~~ (affirmative), you do that. Now, I think you are, you have some ways of getting from users who are going to ultimately employ the trainees some idea of what the purposes should be. I am not sure, how systematically that's done. Sometimes I think

it's done quite systematically and sometimes less so in your situation. In the case of the civilian sector, it isn't often done.

One depends upon writers on educational philosophy or national commissions of various sorts. You probably have all heard about something, I think, called the seven cardinal principles which were formulated by a national commission back in 1919, I think it was. They are pretty good. You know, they are not bad. They're really quite good. The language sounds a little obsolete but the meaning is not bad. And there have been various attempts like that by educational writers coming down through the decades up to the present, and you find people like John Gardiner writing about this - not so many years ago. So there is a dependence, I think, upon educational philosophy.

There is another way to do it and that is to try to involve the parents in this decision. What is it that you want the school to do? It's not a bad idea. It has been tried in a number of places.

I think that it has to be done rather carefully, because in a sense, I would say, you don't want the parent to get involved in the details. If you do that then the whole thing might go to pieces. But you want them to be able to express their values about what on earth is this school all about, anyway? When you ask parents this question with respect, for example, to elementary school, the studies show that the thing they are likely to put at the top on the list is the mastery of basic skills: reading, writing and arithmetic. Close to that would be a kind of being-able-to-get-along-with-other-people sort of value that parents hold. These kind of things have turned up again and again in various parts of the country and it's an interesting fact. So that's one way to go about this business of finding out what the goal of such a system would be. It hasn't been used widely, but it has been done. What about operations design or system design? Well, I'll skip over these rather rapidly here. There are, of course, standard curricula that have been around for a very long time, and when one undertakes to make a new design, it isn't often that he departs, really, from these standard curricula. Now, whether that is good or bad, I'm not so sure. But I would be inclined, I think, to think it's time, perhaps, that we looked at this more intensively. Nevertheless, many development efforts start with the notion there is this standard curricula for working with an elementary school. The kids are going to be learning reading and arithmetic and social studies and science and that's it, you know, it's kind of rigid. O.K. Similarly, one often starts with certain accepted school management procedures. Now, there are some new ones here that are being developed also. New ways of managing schools that, perhaps, take into account the new ideas of accountability - new methods of personnel management which might take these notions into account. These things are being developed. Let me spend a little time on system design in terms of a little bit more detail here. There is what I call "output analysis" and this means analyzing what is supposed to happen in terms of the outcomes of learning. And that you have heard, I am sure. Other speakers have

spoken of various schemes for doing this. It's a very necessary part of system development, I believe. You need some categories of learning outcomes. Of course, there are performance objectives. That is the next category. The relation between these two, I think, should be fairly clear. The performance objectives may be, you know, for any given course may amount to hundreds because they are all individual things that need to be learned. Output analysis gives you some kind of categorization of these so that you can deal with them in terms of the kinds and conditions that are needed for learning. "Learning task analysis" - well, that also, I find, has been mentioned by several of your speakers and there are techniques for doing that. There is also something which I call here "staffing analysis" - sometimes called "differentiated staffing" - and there are ways of analyzing the total personnel or even the total funds available to a school, and at the same time, looking at the kinds of tasks that need to be performed. You will recognize this as, you know, a task analysis kind of thing that lead to what is called "differentiated staffing," which means, you know, not just the teacher and the students here but some kind of aide and sub-professional and other kinds of clerical activities differentiated among the staff of the school. A number of schools are trying out developments of this sort.

Well, I am really running out of time here and I think you can follow the other kinds of techniques that I have mentioned here. Perhaps one of the things that I would emphasize as a very important development which I know is very relevant to what you are doing and one which you use, at least frequently if not totally, is what are called here "criterion reference tests" and "criterion reference assessments." This is the kind of thing that I think will make considerable difference in the ways schools operate. If they are able to develop instruments or ways of assessing student achievement that are truly related to what the students have learned, specifically what they have learned, you have these things in the form of performance tests which are, usually at least, criterion reference kinds of tests. I think I see a great deal of promise in this kind of development in the civilian sector because, it seems to me, it will finally sort of close the gap between what the teacher is doing and what the outcome is and can be observed or measured to be as far as the student is concerned. So - O.K. I think I would sum up, perhaps by saying, you know, there are a lot of techniques here - some of them are still being worked on. I am sure you have had many lists and I can't really want to impose another one on you. I would simply say you can compare many of the things here that are on this list with those that you have heard about from other speakers. Some of them, perhaps are a little different. People in the civilian sector continue to work upon the refinement of these techniques just as you do, in many cases, in your own course development efforts.

SYSTEMS APPROACHES TO THE DESIGN OF CURRICULUM

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Good morning. I would like to introduce my presentation on Systems Approaches to the Design of Curriculum by showing you a short segment of the Principles and Practices of Instructional Technology course. This is a 15-lesson sound-tape, film strip, and programmed workbook presentation that we use at the U. S. Army Air Defense School as part of an orientation to systems engineering. I am not here to sell the course although it has been enthusiastically received at Fort Bliss and provides an excellent foundation for developing systems engineering skills, particularly in the area of constructing behavioral type objectives. This segment I am about to show provides a good lead-in to the design of instruction.

How then, should we go about the design of instruction that will result in effective learning? I say with a systems approach. Why a systems approach? Well, as Dale G. Hamrens says in the Oregon State System of Higher Education publication, "The Contribution of Behavioral Science to Instructional Technology," and I quote, "Because it is the most powerful and efficient means presently available for determining precise learning requirements and arriving at the most effective plan for eliciting the desired learning outcomes in an orderly fashion."

I think we are all in agreement with this or we wouldn't be here. A systems approach provides a logical, planned development of instruction. It facilitates the specification of training objectives and sub-objectives in terms of student behavior.

There is no best systems approach. A multitude of literature on systems approaches attests to this. Let us briefly examine some of these. Some of you heard a status report on systems engineering as it is presently conducted by each branch of the Armed Forces yesterday afternoon so I will not dwell on the Army, Navy, Marine Corps or Air Force systems. Let me outline some other approaches. I might point out that in researching for this presentation, I found that all systems approaches had one basic point of commonality; that terminal objectives and sub-objectives must first be established and the instructional system designed from there. Or as H. Del Schalock says in "The Contribution of Behavioral Science to Instructional Technology," "Instruction takes its focus, content and often its form from the nature of the outcomes that is being pursued. For this reason, decisions regarding the design of instructional experience must be tied to learner outcomes."

Dr. Leslie J. Briggs, in his "Handbook of Procedures for the design of Instruction," (1970) has developed a systems model for the design of instruction. He points out that there is a characteristic order in which three major components of instruction are designed.

(SHOW SLIDE #1)

1. Specification of instructional objectives.
2. Development of tests measuring attainment of these objectives.
3. Selection of media and design of instructional materials.

The model for the design of instruction consists of 10 steps:

(SHOW SLIDE #2)

1. State objectives and performance standards.
2. Prepare tests over the objectives.
3. Analyze objectives for structure and sequence.
4. Identify assumed entering competencies.
5. Prepare pre-tests and remedial instruction.
6. Select media and write prescriptions.
7. Develop first draft materials.
8. Small group tryouts and revisions.
9. Classroom tryouts and revisions.
10. Performance evaluation.

Dr. Briggs emphasizes the importance of behavioral type objectives and presents their development as a three step process:

1. Writing objectives which meet three criteria.
2. Selecting appropriate objectives.
3. Organizing objectives from general to specific.

The first step points up the necessity of objectives meeting the 3 criteria of conditions, task and standards. In other words, the objectives must convey the conditions under which the students will perform; the specific task he will perform; and the standards of acceptable performance.

There is emphasis on considering the learner's needs and wished in making a selection of appropriate objectives. It also points out that the subject areas, research, future operations and experience should also contribute to making selections. Once selected, the objectives must be organized and sequenced.

(USE BLOCKS TO SHOW "FLAT" STRUCTURE)

This might take the form of a "flat" structure with unit objectives resulting in course objectives.

(USE BLOCKS TO SHOW "HIERACHICAL" STRUCTURE)

Or a hierarchical structure where subordinate competencies lead to specific behavioral objectives resulting in course objectives.

(USE BLOCKS TO SHOW "VERTICAL" STRUCTURE)

And finally the sequencing may be vertical with the accomplishment of one objective leading to the next in a fixed sequence. This allows for the transfer of learning from objective to objective.

Once the course objectives, unit objectives, and specific behavioral objectives have been developed, evaluative test would be prepared. Dr. Briggs suggests that these be used for two purposes:

1. For tryouts and revisions of first draft materials, thus evaluating the materials.
2. For classroom use to evaluate student performance - whether the objectives have been met. This will also contribute to further improvement of the materials.

The next step of the design model calls for analysis of the objectives^o so that instruction may be appropriately structured and sequenced. This analysis required the identification of subordinate competencies down to the lowest level or until each competency represents a single type of learning. Then it calls for identifying the types of learning involved in the competencies so that instruction can be most effectively sequenced, generally moving from the simple to the complex. The competencies would be numbered in the order in which they will be taught. It is then necessary to identify the entering competencies, those things that the student may already know or be able to do. Identification of entering competencies would require renumbering of the remaining competencies.

Dr. Briggs suggests that the selection of media should give consideration to learner characteristics. This would be quite difficult in military instruction where students have such varied backgrounds and experience. Unless we were considering individualized instruction. In this model, media is selected for each competency of each objective. After media selection, a prescription is developed which outlines how the media will be integrated with the subject content in the teaching learning situation.

The next step is to prepare first draft materials based upon the prescriptions developed in the previous step. The final step then is to conduct a "formative" evaluation with tryouts of the draft materials with individuals and groups of learners, followed by tests to evaluate the materials and to identify needed revisions.

This particular model is quite similar in procedures to the systems engineering currently practiced by CONARC schools.

Another systems approach I would like to discuss is one developed by Dr. Sydney J. Drumheller in his "Handbook of Curriculum Design for Individualized Instruction - A Systems Approach." Like most of the instructional technologists, Dr. Drumheller emphasized the use of behavioral objectives which will result in student actions which are both observable and evaluable. He divides objectives into two categories, "ends" objectives which are terminal and "means" objectives which are transitional.

"E"

"M"

(CITE EXAMPLE OF SWIMMING - WATERWINGS)

These two main categories are further divided into four sub-categories:

1. Objective complexes - one or more terminal objectives which may be sub-divided for instructional purposes.
2. Sub-objectives - used when larger terminal objectives are broken down to a series of simpler ones.
3. Prerequisite objectives - relate to knowledges, attitudes, or skills necessary to accomplish the terminal objectives.
4. Isolated objectives - "nice to know" material.

Dr. Drumheller has modified Benjamin Bloom's Taxonomy of Educational Objectives, giving it a stronger structure so that it can be used to identify terminal sub-objectives when the terminal objectives are known. He modified the taxonomy by establishing six major categories (of objectives): knowledge, comprehension, application, analysis, synthesis and evaluation. The six major categories are then divided into sub-categories, which in each case, range from dealing with specifics to abstractions. The taxonomy can then be used to analyze behavior and identify objectives.

In designing his curriculum model, Dr. Drumheller established 5 classifications for objectives:

1. Sequence level - Defined as those objectives requiring two or more courses to achieve.
2. Course level - those objectives requiring two or more units to achieve.
3. Unit level - These objectives (from the Application level of the taxonomy) describe the integrated complex expected to result from the instruction.
4. Sub-unit level - Sub-units are sequenced into a procedure for establishing the unit terminal behavior complexes. The sub-unit objectives will focus on the comprehension, analysis, synthesis, and evaluation levels of the taxonomy. The final sub-unit is concerned with polishing the terminal behaviors.
5. Rudimentary level - composed of knowledge, affective and psychomotor elements. Rudiments provide the focus for analysis, the building blocks for synthesis and a sounding board for evaluation.

There can be anywhere from 2 - 10 sub-units; Dr. Drumheller's model consists of five. Rudimentary objectives (knowledge) are involved in all sub-units. The first sub-unit serves to orient the learner to the unit terminal behavior objectives complexes. He will be required to respond using knowledges to indicate that he has in fact, identified and comprehends these terminal objectives. He may recognize some sub-terminal objectives that he has achieved or some that he still needs. He is not expected to reach any sub-terminal objectives in sub-unit II, but will be required to reach a group of sub-terminal objectives in each of the other sub-units.

As the learner progresses through the various sub-units, the behaviors from previous sub-units are included to provide reinforcement. Thus, as the learner moves to higher level objectives, there is automatic reinforcement of lower level behaviors.

The second, third, and fourth sub-units center on analysis, synthesis, and evaluation respectively. In analysis, the learner identifies elements, relationships, and organizational principles in simulated tasks related to the complexes. In synthesis he synthesizes complex-oriented responses to simulated or contrived tasks related to the complexes. And in evaluation he appraises performances by himself or others, on tasks related to the terminal behavior complexes.

The fifth or last sub-unit is devoted to polishing the learner's performance until he demonstrates the terminal behavior. It is the only sub-unit that has mastery of the behavior complex as a major emphasis. When a student can perform at this level of proficiency he has completed the unit.

Dr. Drumheller points out that some "nice to know" objectives may be desirable to interest and motivate the student; but he emphasizes that too many "nice to know" (isolated) objectives will degrade the unit of instruction.

There are numerous design models that could be discussed and analyzed, but those I have examined are quite similar in procedures, and the two I have outlined here are typical. The question is - will current system approaches produce the courses of instruction we need? There is no doubt that all of the approaches, properly employed would result in well constructed courses of instruction; however, I believe that military instruction needs a stronger orientation toward an individualized approach. Dr. Drumheller's design model does this to a large extent but I think there must be greater emphasis on selfpacing.

To accomplish this, media selection takes on a prime importance and I think it should come earlier in the design approach than it does in most models. I feel that media selection is the key to affective self-paced individualized instruction. Perhaps we should be giving much more consideration to what Robert Heinich calls "mediated" instruction in his monograph. "The Systems Engineering of Education II: Application of Systems Thinking to Instruction." He distinguishes between "mediated" instruction (where the media teacher presents the instruction). He points out that too often in the past, media were considered only as "aids" to the instruction, which may be due to "the tradition of the teacher as the sole arbiter of what is used in the classroom." As instructional technology and media development have advanced, the teacher has been fearful that he would lose his classroom authority and responsibility to the media. I am sure that all of you can recall much instructor grumbling when military schools adopted educational television. Dr. Heinich recommends a shared responsibility between the teacher and the media and as he states, "the teacher of the future will be a very vital subsystem in the total instructional system and he must be trained to function in that capacity."

Dr. Heinich feels that technology will force the transfer of classroom teachers from one side of "mediation" to the other, and he predicts that in 20 years (1985) perhaps 1/3 of the teaching profession will be engaged in preparing materials with little or no direct face to face contact with students.

Since 1965 when Dr. Heinich's monograph was published, events would certainly seem to support his prediction. Great strides are being made in computer assisted instruction and the use of educational

television and programed textbooks has been expanded. I believe that this is the direction our systems design must take in the immediate future, more emphasis on individualized instruction with greater use of media which will permit self-pacing.

Certainly a systems approach is the most efficient way to design curricula, but with students of such varied background, experience, and ability such as we have in military schools the instruction must be geared to the individual, and self-paced, individualized instruction appears to be the answer.

At any rate there is a fertile field for educational technologists and instructional designers to experiment in the development of a design model oriented toward recognition of individual differences and the use of a variety of media which will permit maximal self-pacing and produce a well trained, effective product.

ADMINISTRATIVE INNOVATIONS

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The Medical Department Veterinary School initiated a long range plan for further development of its instruction in the Fall of 1967. The plan was based upon a systematic model of the school's mission. Briefly, we identified two areas of concern -- the school, at left, and the real world, at the right -- with trainees turned out as job incumbents. The key usefulness of our model is that we acknowledged making a host of assumptions. We assumed that exposing trainees to instruction prepared them to contribute on-the-job. Our long range plan was simply to develop the mechanisms to get some formal feedback from the real world to verify assumptions we were making.

A first step was to identify the level of performance being achieved by our present trainees. Feedback from the real world cannot verify anything if we don't know where we already are. Notice something else. Our assumptions have been based upon the best advice available officer and enlisted instructors with years of experience conscientiously design and offer the best instruction they can. There's a lot of good going on here. But it doesn't hurt anyone to verify that!

We had just begun to implement these ideas when we came upon CONARC Reg 350-100-1. It provided support for the plan -- even a term for our verifying assumptions, Quality Control. It also posed some problems. We're a small school. Trying to implement systems engineering -- SE -- is like the crew of a speeding train trying to remodel while enroute. Nothing can stop while the steps of SE proceed.

Our first administrative problem was and still is to generate what the academic community calls "release time" -- to get some of our people away from the pressing routine -- free to analyze tasks, to upgrade performance tests, and to improve instruction -- hopefully by putting together what I call instructional capital -- carefully developed materials or sequences of known effectiveness which can be re-used, preferably by other instructors. In short, such material or sequences support instructors in attaining success -- their trainees succeed.

Another administrative problem is that the steps of SE must be completed by people who have some idea of what they're about -- or all the carefully generated release time is wasted. So we began in-house training on SE -- learning how to do it while slowly applying the steps to our basic enlisted course. We began with the basic course -- reasoning that any increase in trainee skills would influence the SE effort in all other courses, that is, the training of supervisors depends upon how well their men are able to perform.

During the planning phases of SE, we ran into one huge problem. Our existing organization was based upon major subjects we taught red meats, fruits and vegetables, and so on. We found little empires and these had us working at cross purposes -- with effort wasted in duplication and overlap.

¹ A presentation by the U.S. Army Medical Department Veterinary School to the CONARC Systems Engineering of Training Workshop, Ft. Gordon, Georgia, October 5 - 7, 1971.

Basically, we found responsibility for instructional policy decisions at the command level and we found these decisions being made at the bottom level -- by the instructors, and in some cases, other support personnel. How did this happen? Well, our POLs contained the usual general remarks providing no specific guidance. By design, instructors did their own thing. They wrote lesson plans, conducted instruction, and evaluated trainee performance with their own tests. Class monitoring revealed charm, platform manner, the level of ventilation and other useless information -- but command was not sure what the instruction accomplished in that closed loop at the bottom.

We dealt with these problems in two ways. We created an Ad Hoc Committee for SE, which I'll return to in a moment, and we recognized the need for a structure to support SE -- so we designed one. In place of the almost autonomous subject-oriented departments, we planned two instructional and three direct support departments. We implemented this in January of 1970. After the initial shock, things began to work and, strangely enough, to work better -- to eliminate much of the duplication and overlap. As we regained our nerve, we began to talk about a SE department.

Now, there's nothing in the staffing guide which specifically provides for such a creature -- so we pulled together all related duties and, in our manpower survey in August of '71, successfully justified our SE department. A duty description is included in your handout.

Let me turn to the second issue. The command created an Ad Hoc Committee for Se consisting of the DI and the five department heads. The Committee conducts preliminary review of task analysis data and complete review of any revision in training objectives and testing. After review and command approval, instruction redesign may begin.

Our task analysis are taught to apply behavior analysis procedures that is, to identify the types of learning in order to specify appropriate conditions of instruction and testing of trainees. When we train our analysts, we sort out types of learning following a modification of Professor Gagne's taxonomy. Looking at stimulus-response pairs as basic units, our analysts record and report their observations in terms of such discriminations which trainees must make. In the case of multiple discriminations, S-R pairs may be represented in a table -- or, when sequential tasks are involved, as chains or serial memory.

Beyond these types, the analysts deal with complex cognitive learning -- types which require trainees to deal with new situations not met in training. In other words, these are always beyond memory -- no matter how efficient memory might be. Some of you may refer to this as the ability of training to transfer to new situations. Above concept learning, we identify principle applying -- equal to Gagne's rule learning -- and problem-solving, situations which may require trainees to find -- to discover -- the rules which apply.

Once tasks have been described in such terms, training policy decisions can be made in a rational way. But notice the problem here. The language of behavior analysis is foreign to those who must make decisions. For this reason, the Ad Hoc Committee members have spent some 50 hours in SE instruction. In effect, they learn to translate analysis information into policy.

Here's an example -- a summary of an actual Committee review of a job of all enlisted veterinary inspectors -- that of preparation, use, and safeguard of their government inspection stamp. In your handout, portions of the analysis are reproduced.

The first type -- content analysis -- was based upon existing documents and instruction. It identified several types of learning. As example, we include the behavior chain of setting up an inspection stamp with required numbers.

An example of a multiple discrimination is recognition of several inspection stamp. An example of a conceptual task is understanding what "sufficient" means with respect to the rule that inspectors must stamp a sufficient number of items in an inspected lot.

To translate such information into policy, the Committee's first step is to require verification that a training need exists. Working from the content analysis, our analysts contacted supervisory personnel in the field to verify a training need. The results of interview analysis are summarized in your handout. Briefly, supervisors want trainees to know when to stamp what, and how much, and how to safeguard their stamp.

The Ad Hoc Committee's next step is to look at the fit between content and interview analysis data. To their dismay, they noted in the first case that the most significant performance expected of a trainee -- that he know when to stamp -- was completely assumed and never taught or tested during formal instruction. An objective was written and the evaluation department directed to prepare performance tests for the training objective.

In the second case, interview analysis did verify the "how much" requirement of stamping. But the committee found that existing instruction merely caused the trainee to memorize the official directive -- the requirement that a "sufficient" number of items be stamped. The problem is -- what is the trainee's concept of "sufficient"?

Here's a slide from our Jabberwock program teaching the how-to-do-it aspect of dealing with concept learning. A trainee on-the-job might not recognize "sufficient" if it came up and bit him.

The Ad Hoc Committee is able to locate inadequacies of this type and take corrective action when its members are able to recognize the different types of learning involved. Corrective action required visual examples of "sufficient" -- a variety -- also examples of "insufficient" -- to make sure trainees have the concept.

As a third example, the Committee found that existing instruction in recognizing a variety of stamps was not verified by interview analysis, but directives do impose a job requirement in this respect. The Committee recommended that existing training on this task be replaced by a job aid -- a wallet-sized card with these stamps and their names -- issued to each man.

In the fourth case, locating training requirements not disclosed by any analysis is a problem irrespective of the system of training design we use. But given the analysis thus far, the Committee did notice a few oversights -- for instance, teaching a trainee the proper way to ink a pad, a behavior chain.

Analysis procedures which identify job requirements by type of learning can be used to verify training requirements, to identify areas of under and over training, and to make rational training policy decisions.

Notice how our organization keeps these decisions from slipping into the old closed-loop at the bottom. Training objectives go to evaluation as well as to instruction departments. Evaluation both prepares and administers our testing. If trainee performance is inadequate, the whole process is open to command review. Are the tests appropriate to the objectives? If so, what's the problem with instruction? Is time inadequate? Are procedures at fault?

Enlightened command reaction must prevail. Putting the finger on instructors is not our purpose. It is to provide administrative support to release instructors to work with SE people to improve the quality of instruction. Also at this point, diagnosis of individual trainee testing has resulted in a weekly retraining procedure followed by retesting. This is one of the innovations which has helped to cut our academic loss of trainees by fifty percent.

Returning to our new structure -- we were ready to SE with effect. The next question was, "Who does the work?" Here's the course schedule we faced in '69. Eleven basic enlisted courses. Three three-week refresher courses. Three-ten-week advanced enlisted courses. Five basic officer courses and a variety of advanced and special officer courses.

Look at just the enlisted situation. Usually, there are four courses at once and the 12 instructors who cover these average over 13 hours on-the-stump each week. That jumps to about 17 hours in June. And each man teaches his specialty in three courses. The changes in scheduling overlap -- the shift of relative convening weeks -- causes constant shuffling of course sequencing so someone is not teaching in two or three courses at once. Similar problems exist with respect to lab space scheduling.

In addition, SE is more than filling out task analysis forms, rewriting objectives, lesson plans, and POIs. The guts of SE is providing instructors with adequate support so they can stop lecturing in lab periods. It's getting trainee hands on equipment -- their butts out of the chairs. It's realistic performance testing. This means changing the mix of instructor scheduling -- small grouping

for labs, some big lectures, and some multiple instructors assigned as resource people during practicals. It means consistent advance planning to schedule the precious resource of instructor time in a manner dictated by the type of learning involved during each hour of each day in each course. The guts of SE requires that instructor scheduling must float free from the outmoded concept of the platform hour -- and this is more traumatic than the dollar floating free from gold.

But no flexibility when assigning instructors or rational sequencing of instruction can prevail with this kind of course scheduling. But the resistance to consider change was unbelievable. For discussion, we put together the optimum schedule. We put the basic and advanced courses in a set pattern to get instructor scheduling under control, planned this ten-week sequence five times a year, and planned to double the input into the basic course -- required by reducing from ten to five the number of times it was offered.

I won't go into the traumatic days of selling this idea. Most valid objections turned out to be instances of the administrative tail wagging the training dog -- for example, insistence we couldn't work out pay records in the necessary week. We developed a procedure spreading that job out over the entire eight weeks -- and pay people are delighted.

The most frequent question asked is why Washington bought this plan. Basically, because they have more flexibility now. No longer do they fuss with adding or cancelling scheduled classes. They simply increase or decrease input into the basic classes -- knowing we are organized to accept up to 110 students with our concept of variable sections within courses.

It took some time to get the new schedule into operation -- with the advanced courses back to back through the year. Only four will be offered in '70. We began to look at our advanced courses in relationships to our three different refresher courses. For a variety of good reasons, we divided the advanced course into five two-week modules. Then we expanded the total refresher course from three separate three week courses -- nine weeks, to ten weeks, divided into the same modules.

Now we offer field commanders a flexible option. They can send a man for refresher training by topic -- for any number of these five modules. As time permits, the man can return for remaining modules.

With respect to rational systems engineering, our options are now open. We schedule our twelve enlisted instructors to accommodate the learning requirements of these two courses. They always occur in the same configuration so weaknesses in scheduling may be corrected the following period.

We are releasing staff time for SE -- with a department to work closely with instructors, hopefully for developing the kind of high quality, reusable instructional capital that can be upgraded continuously. Individually, these are little things -- sequences of

color slides to support visual discrimination training in the labs, handout materials of proven effectiveness, short self-instructional lessons -- but the cumulative effect of such bit by bit effort will improve the whole school. The intent of systems engineering of training is instructional innovation -- and that seems to be about 90 per cent administrative innovation.

SOFT SKILL COURSES

**Mr. Charles Harvey
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THE USAIS APPROACH TO SYSTEMS ENGINEERING SOFT SKILL COURSES

Topics discussed will be as follows:

1. How do you list tactical concepts and leadership qualities or characteristics in a task inventory?

We list them as supporting skills, knowledges, or attitudes which are later applied during CPX'S, FTX'S and other training.

2. How do you establish the job standard for such tasks as take an enemy position, prevent awol's and stop the bleeding?

We have experienced combat veterans advise us in establishing implied or derived standards.

3. How do you establish valid training conditions and training standards?

We try to simulate realistic situations as much as possible. We must establish attainable and maintainable standards, which are usually short of perfection.

4. How do you evaluate the student's achievement of Soft-Skill objectives and the effectiveness of the course in teaching these objectives?

Although some objective tests are given, evaluation is mostly subjective. Corrective actions are taken immediately when course structures are defective.

This discussion is followed by a brief review of the three forms USAIS developed for use in systems engineering its courses:

1. FB Form 125 - Task/Subtask (SKA) inventory and selection sheet
This form serves a dual purpose in listing both task inventories and SKA inventories.
2. FB Form 126 - Training analysis information sheet
This form serves to record the training objective, the criterion and the learning analysis.
3. FB Form 24 - Systems engineering course design sheet
This form summarizes the training objectives into lessons and describes the manner in which the class is conducted.

COMPUTERIZED ASPECTS OF SYSTEMS ENGINEERING

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DEFINITION FOR A TASK INVENTORY

You are already quite familiar with the concept of the task inventory and the fact each task has associated with it certain skills, knowledges, and attitudes that must be present if the task is to be carried out successfully. Each school, I'm sure, has developed a technique that works reasonably well for it in managing the rather voluminous data that's accumulated in this aspect of systems engineering.

We would like to share with you the concept of the automated task inventory that was developed jointly by the Quartermaster School and Hum RRO in Project STOCK. We have applied the technique to two MOS's for which we are proponent. There is still work to be done on one of the courses, but the automated task inventory technique is operational at HumRRO.

When systems engineering first began there was a considerable debate over what constituted a task--how grossly or how definitively an action should be described in a task inventory. We tried to position ourselves somewhere between statements such as the following:

Large: Operate a storage facility

Small: Enter quantity on card

Some of you may have arrived at definitions that you can live with, but as far as I know a good definition of a task has been a bit elusive. My feeling, after admittedly inadequate sampling, is that task statements have tended to be fairly large and broad in other schools. As you will see, we have adopted the best of both extremes. Now the concept we have used is a fairly simple one and, while it doesn't define a task, it does help to define what a task inventory ought to look like.

The task inventory is not just a record--a list--of what is being done by the man who holds an MOS.

It is not just a source of information for a questionnaire that will go to the field.

Most importantly, the task inventory is a means of communication initially between the systems engineer or analyst and the guy who is responsible for developing a course: the writer of the lesson plan, the instructor.

Ultimately the task inventory is a means of communication between the course director and the instructors and other members of his staff who design the methods, teach the course and evaluate the students on a day to day basis. What goes into that task inventory must make eminently good sense in terms of the kind of communication required between the course director and the instructional staff.

HOW TO STRUCTURE A TASK INVENTORY

I have seen task lists that looked like grocery shopping lists. Each task appeared to be listed randomly as it occurred to the analyst.

As a result each task tended to stand alone and independent of those that preceded and followed, and each task appeared to be of equal value as far as its importance was concerned. There is no

built in value discrimination in grocery list outlines. For that reason systems engineering includes a step called "Selection of Tasks for Training", and under "Training Analysis" we worry about "clustering" and "sequencing." Now we can't eliminate those steps completely but we can simplify them by organization of the task inventory.

Instead of picturing a grocery shopping list in which each item on the list is more or less independent of the other items, imagine an outline format following somewhat the same principles of outlining that you learned in freshman high school English. (Remember, our intent is to communicate to the instructional staff what it is that needs to be taught and what skills and knowledge need to be present in order for a student to perform the task required of him.)

We might visualize a task for one of our supply MOS's, for example, that would read something like this:

SLIDE 5

"Issues non-expendable supplies." Now this task might satisfy most task definitions but it falls short of communicating all we would like to know about what must be taught and how it must be taught and evaluated. That task by itself ignores the many steps that must be taken to perform it and the skills and knowledges that support it.

SLIDE 6

It ignores the reference documents that must be understood and handled to perform the task.

SLIDE 7

It ignores the paper work that must be managed to perform the task.

SLIDE 8

It tells us nothing about the skills required in locating alphabetic and numeric information, or

SLIDE 9

in being able to operate a typewriter at a minimal level.

SLIDE 10

It tells us nothing about the student's ability to transcribe information accurately or

SLIDE 11

to do simple arithmetic.

It does not tell us what part of the total operation is critical enough to demand virtually perfect performance (such as transcribing Federal Stock Numbers), and what part of the operation can permit error (such as the spelling of nomenclature).

SLIDE 12

Our hierarchical task list, then, structured in the manner of a freshman English outline, takes the major task and subdivides it into as many levels of subtasks as are required to define the task exactly. Broadly stated

SLIDE 13

tasks are followed by successively smaller subtasks that describe the performance of the broader task in enough detail that the instructor will know what must be taught and tested.

SLIDE 14 (BLANK)

For that reason it serves as a rather exact means of communication between a course director and his instructional staff. But because of the outline structure, the course director need only deal with the levels of detail (perhaps the broadly stated tasks) that suit his purpose. The numbering system, as you will see, makes this possible. The fact that the task inventory is quite definitive does not prohibit variations in the sequence of objectives when variations make good sense from an instructional point of view.

TRAINING IN FUNCTIONAL CONTEXT

Now we have adopted the concept of "functional context" training,

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which means that we feel that a student who is learning skills for particular circumstances will, in general, learn better and faster if the circumstances are present in the learning situation.

SLIDE 16

When a job is analyzed into its subject matter content (rather than into genuine tasks) the student finds himself in a conventional classroom learning principles and theories that he may not need when he goes to work. (I should point out that the act of making a task list doesn't guarantee that the tasks will be job related.) "Functional context" also means that when particular skills and knowledge must be taught the student, they should be taught at the time they are needed and to the extent needed for the student to be able to perform the tasks successfully.

SLIDE 17

When it's necessary for a student to receive specific instruction in connection with his task training, he should get the individual treatment he requires. On-the-job training is "functional context" training. We would like for our classroom training, in time, to simulate real life in as realistic a fashion as possible. "Functional context" training brings on-the-job training to the classroom.

SLIDE 18

Our task list then must analyze tasks as they are performed in enough detail to communicate clearly. The task list must be carefully supplemented with the

SLIDE 19

skills and knowledges required to support each task, and the two together--tasks together with skills and knowledges--

SLIDE 20 (BLANK)

define for the instructor the content of training.

COURSE MANAGEMENT WITH A COMPUTER

Now we've indicated that our task inventory would be computerized and handouts have been provided showing a typical computer listing of items in the task inventory.

The fact that the task inventory has been computerized in no way eliminates the basic effort required in creating the task inventory to begin with. It seems apparent to us that course management after the task inventory has been completed will proceed in a much more orderly fashion and that work will eventually be saved. This will become apparent when Dr. Wagner shows you just what the task inventory includes. The tasks and subtasks listed in outline fashion represent a kind of logic that permits the addition or deletion of entire blocks if necessary. The course director will be able to study course logic and alter it as he sees fit. The problem of updating a systems engineered course has lacked a completely satisfactory solution until now. With this printout the course director will have a highly visible outline of the course in front of him that will let him update any or all of his systems-engineered course at any time.

Having a course structured in the kind of outline form I have described serves two other important purposes.

In the first place the "functional context" structure describes in considerable detail the way in which practical exercises, problems, or simulations should be developed in order to be thoroughly realistic.

The second benefit to be gained from the outline structure is that tests, examinations, and graded practical exercises should be performance oriented following the logic of the outline. Evaluation instruments, if they follow this kind of logic, should tell us clearly whether or not the student is qualified in the job we are trying to teach him to do.

Now I would like to ask Dr. Wagner from HumRRO to tell you about the entries that are included on our automated task inventory.

DESCRIPTION OF TECHNIQUE

Up to this point, Mr. Henry has discussed our approach to the development of an automated task inventory, and the structure that we have imposed upon it by employing the concept of functional context of functional context training.

I would now like to discuss the specific items of information that we utilize in our procedure, and how these entries can then be employed in course design. (As I briefly discuss each of these items, you might refer to the handout which was provided to you earlier. The second page of your handout explains, in more detail, the meaning of each item that I discuss).

An extract of our computer print-out begins on the third page of the handout. As you can see, the task description makes up a major portion of it. Each statement has associated with it a ten-digit identification number. Ten digits were selected to provide the flexibility for as much hierarchical structuring as we thought necessary to adequately reflect the requirements of the relevant tasks.

Each task and task component statement is cross-reference in the column labeled REF with a doctrinal publication governing this activity. When a change occurs in a regulation, the task can be quickly and easily updated to reflect the change.

The next field in our print-out contains a description of the enabling knowledge required to perform an activity. This is followed in Column A by a code which indicates if there is an enabling skill requirement. It is when tasks are reduced to their components that specific knowledges and skills needed to carry on the task become evident. These knowledge and skill entires provide information to training program developers of the intensive practice or remediation which may be required at certain points within the program.

Judgments of the importance or criticality of the particular tasks are to be coded and listed in Column B. These judgments, along with the frequency of performance information that will be recorded in Column F enter into the processes of selecting tasks for training, and determining performance standards to be met in the course. Recording this information and displaying it utilizing our technique enables training developers to more easily identify the required tasks for training and to derive performance standards. These standards would then be recorded in Columns G and H. The decisions made for selecting training tasks are to be noted and coded in Column D.

The last page of your handout is the recording form that we use in our procedure. The task description statements are not recorded on this form, but rather on ordinary plain white paper. Identification numbers are then assigned to them. The number of each specific item is then recorded on this sheet (the recording form) and the additional information entered as it is obtained.

Now I would like to concentrate my discussion on the entries in Column C, Course Location, and Column E, Test Item Location. In our opinion, it is of little value to apply a systematic mechanism to the development of training content if there is no way of checking to see that this mechanism is being utilized properly. We have set up a procedure that we call a "discrepancy analysis" in which the tasks selected for training (the training objectives) are checked against course content. In a similiar manner, the test items are recorded as they apply to each of the tasks or task components. Each of every narrative lesson plan and each item in every test is examined and the location recorded next to the appropriate corresponding task or component. One can then come up with lists of discrepancies between training objectives, course content, and test items. These discrepancies can be ultimately resolved by the training program and test developers. By employing this discrepancy analysis procedure in our course design activities, we have provided a quality control checkpoint during curriculum development. It is in this regard that the print-out document serves as a control device to ensure correspondence between the job and the content of the course, and also between the course content and the test item coverage. Thus, we ultimately arrive at job-related training and performance-oriented examinations of student capabilities.

There are some other special features of our computer program, which might be of interest to you. When one makes up a listings of tasks and their components, there are often times several separate

major tasks that include within them component sequences that are identical. In order to aid the course designer as he works with the task analysis document, each of the steps required for performance of a major task should be recorded in the context in which it occurs. There is a routine within our set of programs which permits the computer to search the records and select statements that we have identified in a certain way, and then insert them within the desired context. This technique greatly aids the work of the task analysis.

Thus, curriculum developers provided with this print-out are given a device which is designed specifically for training development purposes and, in addition, is convenient to use.

It is our belief that the approach we have taken is flexible enough to be useful to a variety of programs within the CONARC training system. We have not developed any panacea for systems engineering a training program. As you can see, much work is required to obtain the information for our print-out, and to perform the discrepancy analyses. However, we feel that we have made a modest contribution toward systematically and conveniently arranging the information necessary for adequate course design and development. We hope that you will find in our approach some applicability to your needs.

COURSE STRUCTURE RATIONALS

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GENERAL

This presentation received its impetus from a statement found in paragraph 17b, CON Reg 350-100-1 - "Remember at all times, however, that it is the structuring of the training objectives that is important not the rationale used in arriving at that structure." This statement when taken at face value infers that the rationale underlying structure is of little significance. It is the opinion of this school that course structure effectiveness from the learner's viewpoint has a relationship to rationale. In other words this school is hypothesizing that in regards to learning effectiveness indices (grades) an optimum course structure rationale will result in a higher order of learning effectiveness and that an optimum course structure rationale can be identified for predetermined types of courses.

While these hypotheses have not been subjected to complete scientific testing, considerable thought and effort have been expended in arriving at basic parameters which should be fundamental in the eventual pursuance of statistically proving or disproving the hypotheses. It is these parameters that will form the basis for these remarks and provide the substance for the following objectives of this presentation:

- a. To standardize course structure components.
- b. To provide a basis for course structure rationale.

These objectives dictate discussing the following.

- a. Systems Engineering Context
- b. Course Structure Components
- c. Course Structure Alternatives

SYSTEMS ENGINEERING CONTEXT

At the risk of being too simplistic and redundant, the position of determining course structure in applying the basic steps of the Systems Engineering of Training as found in CON Reg 350-100-1 is herein reiterated. We know fundamentally that the course structure determination action is included in the third basic step of the System-Training Analysis. This step requires these actions:

- a. Identifying the job conditions, standards and supporting skills, knowledges and attitudes.
- b. Converting the job requirements to training objectives and criteria.
- c. Developing the course structure.
- d. Developing a course evaluation concept.

COURSE STRUCTURE COMPONENTS

Faced with the proliferation of labels to identify the components of a course, this school has adopted a hierarchy of components which has clarified the proliferation. This hierarchy of components is very simple. It consists of the following in progressive inclusive order: lesson, block, segment and course.

A lesson is an integral package of learning experiences built upon a structure providing for an introduction, presentation, application and check-up which is designed to contribute to or tally accomplish the training objective as defined on a Training Information Sheet. The subject matter content of a lesson consists of one or more learning elements listed on the Learning Analysis Sheet

that supports a Training Analysis Information Sheet. The lesson title is synonymous with the subject identification listed under a program of instruction annex.

A block is an identifier of one or more related lessons which is defined for the purpose of providing first line and intermediate levels of supervision with a framework for quality control assessment.

A segment is an identifier of one or more related blocks which is defined for the purpose of providing top management with a framework for quality control assessment. Segments normally have a direct correlation with instructional organizational elements.

A course is the sum of all segments heretofore identified.

COURSE STRUCTURE ALTERNATIVES

For the purpose of pursuing course rationale, the structure alternatives pursued in this section give direction to the segment identifiers of a course. This section is essentially related to the hypothesis stated in paragraph 1 - that an optimum course structure rationale can be identified for predetermined types of courses. Preliminary effort related to this hypothesis has consisted of developing a course types matrix using the factors of student experience and learning, the application of this matrix to the local curriculum, the identification of a variety of course structure alternatives, and of developing a course type-structure matrix using the factors of course type and structure alternatives.

The course types matrix contained in Figure 1 incorporates the following defined factors.

- a. Student Experience Factors. Every learning situation must consider what skills and knowledges the learner brings with him when he enters the learning environment. These factors for the purpose of this matrix are broken down into three discrete levels as follows:
 - (1) Entry Training Only (BCT/ROTC). This factor identifies the training population whose Army experience has been limited to either Basic Combat Training for enlisted personnel or Reserve Officer Training Corps participation for officer personnel.
 - (2) Advanced Individual Training (AIT). The training population assigned to this factor have completed the entry training described in (1) above and an additional MOS-producing course. They have had no unit experience.
 - (3) Entry, AIT and Unit Experience. This factor encompasses the previous two factors and includes some quantity of unit experience.
- b. Learning Factors. What students learn in a training and/or education program may be defined in a variety of ways. Today's learning environment places a premium on skill development to job performance vs the past emphasis on academic skills and knowledges. For the purpose of this matrix skill development is broken into the following two categories:

- (1) Soft Skills. These are job-related skills involving actions affecting primarily people and paper, e.g., inspecting troops, supervising office personnel, conducting studies, preparing maintenance reports, preparing efficiency reports, designing bridge structures.
- (2) Hard Skills. These are job-related skills involving actions to physical things., e.g., adjusting rifle headspace, timing an engine, operating a bulldozer, conducting preventive maintenance on an aiming circle.

COURSE TYPES MATRIX

STUDENT EXPERIENCE FACTORS	LEARNING FACTORS	SOFT SKILLS	HARD SKILLS
Entry Training Only (BCT/ROTC)		1	2
AIT		3	4
Entry, AIT and Unit Experience		5	6

Figure 1

The application of this matrix to the local curriculum has resulted in the following typology.

<u>TYPE</u>	<u>COURSES</u>
1	4-5-C20 - Engineer Officer Basic Course
	4-5-C1 - Engineer Officer Basic (Nonresident/Resident)
2	35E20 - Special Electrical/Electronic Device Repair
	41B20 - Topographic Instrument Repair
	41K20 - Reproduction Equipment Repair
	51L20 - Refrigeration Equipment Repair
	52B20 - Mobile Electric Power Generation
	52C20 - Power Pack Specialist
	62B20 - Engineer Equipment Maintenance
	62C20 - Engineer Missile Equipment Maintenance

TYPECOURSES

81B20 - Construction Drafting
81C20 - Cartographic Drafting
81D20 - Map Compiling
82E20 - Topographic Computing
12E20 - Atomic Demolitions Enlisted
51G20 - Soils Analysis
82B20 - Construction Surveying
83D20 - Process Photography
83E20 - Lithographic Platemaking
83F20 - Offset Press Operations

3 4A-F1 - Engineer Construction Officer
4L-0663 - Engineer Equipment Officer
4A-7130 - Facilities Engineering Management
4M-7915 - Topographic Engineer Officer

4 4E-F1 - Atomic Demolitions Munitions Officer
2E-F39 - Nuclear and Chemical Target Analysis
030-F1 - Special Forces Engineer Training
35E30 - Senior Special Electrical/Electronic Device
Repair
52B30 - Mobile Electric Power Generation (Precise)
52D20 - Gas Turbine Generator Repair
62B30 - Engineer Equipment Repair
62C30 - Engineer Missile Equipment Repair
81D30 - Photogrammetric Compilation
612-F1 - Mobile Assault Bridge/Ferry Maintenance
662-F3 - Utility Element Maintenance MUST

5 4-5-C22 - Engineer Officer Advanced
4-5-C23 - Engineer Officer Advanced (Nonresident/
Resident)
2E-F27 - Engineer Staff Officer Refresher
4-5-C8 - Engineer Field Grade Officer Refresher
7K-F2 - Disaster Recovery
710-F1 - Engineer Noncommissioned Officer

6 4-5-C30 - Engineer Graphics Warrant Officer
Intermediate
7K-F10/440-F1 - Fallout Shelter Analysis
4A-F4 - Engineer Construction Contracting
4M-F1/412-F2 - Advanced Geodetic Surveyor
4L621A/612F2 - Engineer Equipment Repair Technician
Engineer NOO Basic

While the range of course structure alternatives is wide, this school has identified the following eight as representative. Associated with each alternative is an example drawn from the local curriculum.

<u>ALTERNATIVE</u>	<u>EXAMPLE</u>
1. Hardware	<ul style="list-style-type: none"> a. Surveying Rods b. Abney Hand Level c. Dumpy Level d. Transit e. Telescopic Alidade
2. Tasks	<ul style="list-style-type: none"> a. Maintenance of gasoline and diesel engines b. Maintenance of generator body, cab and frame assembly c. Maintenance of generator electrical assembly d. Maintenance of generator control panels and housing cubicles e. Maintenance of generator governing and AC voltage regulating systems
3. Functions	<ul style="list-style-type: none"> a. Supply b. Administration c. Maintenance d. Research and Development
4. Environment	<ul style="list-style-type: none"> a. Construction Engineering Battalion b. Combat Engineering Battalion c. Civil Works District
5. Proficiency Levels	<ul style="list-style-type: none"> a. Basic Cartographic Drafting b. Advanced Cartographic Drafting
6. Knowledge Areas	<ul style="list-style-type: none"> a. Mathematics b. General Subjects c. Map Reading d. Methods of Instruction
7. Duty Areas	<ul style="list-style-type: none"> a. Generator Set Operation b. Generator and Site Selection c. Generator Set Installation d. Organizational Maintenance of Air Cooled Gasoline Engines, Generator Sets AC and DC, and Control Panels
8. Systems	<ul style="list-style-type: none"> a. Manually Controlled Fixed Power Plant b. Automatically Controlled Fixed Power Plant

With the previously identified course typology and structure alternatives, a course type - structure matrix has been developed with the entries thereon being purely judgmental at this point in time. This matrix is portrayed in Figure 2.

COURSE TYPE - STRUCTURE MATRIX

STRUCTURE ALTERNATIVE	1	2	3	4	5	6	7	8
TYPE	Hardware	Task	Functions	Environment	Proficiency Level	Knowledge Areas	Duty Areas	Systems
1		X	X	X			X	
2	X	X					X	X
3		X	X	X			X	
4	X	X					X	X
5			X	X		X	X	
6	X	X					X	X

Figure 2

COMMERCIAL APPROACH TO SYSTEMS ENGINEERING

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This paper covers the systems engineering of training of a new major weapons system, Safeguard, by the System Development Corporation (SDC) in accordance with CONARC Regulation 350-100-1, Systems Engineering of Training.

The project included:

- (1) TASA Data collection at six manufacturers plant locations by teams of SDC and manufacturer personnel.
- (2) Data Base Development utilizing a 360-67 computer and the SDC Data Management System computer programs.
- (3) Job structure analysis to determine recommended duty positions and MOS's.
- (4) POI development.

The problems resolved included:

Selecting unique tasks for training from a large data base; controlling the step processes required in instituting and updating the system engineering process by means of the task string listing; and the development of POI in the absence of a defined and approved job structure by modular construction of a baseline POI.

The computer is used in the process of establishing the data bank selecting tasks for training and reporting and controlling the POI development as it progresses. The computer is also used to establish the data audit trace which is a complete record of the systems engineering process. It shows the training decision for every task in the data bank, the associated job Task Data Cards, Training Analysis Information sheet, each PIO the task is in and whether a trainer evaluation has been made.

At this time, the training analysis has been conducted on over 6500 tasks. Selected for training are approximately 1,050 unique tasks and 600 filler tasks. The training analysis for the over 10,000 tasks expected in the data bank will be completed by July 1972.

The results of the TASA project will be the training requirements for resident and on-site training to include both on-line and off-line maintenance and maintenance operations.

SYSTEMS ENGINEERING WORKSHOP OBSERVATIONS

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I have listened to your presentations with an enormous degree of interest and I think they leave little doubt that you are all committed to, and are also pursuing vigorously, the systems engineering approaches to designing instruction in your courses. Really, there are many things that I could comment on and I have little trouble, I guess, deciding what are the most important things to say. Obviously that's what I should be doing. I guess one impression that I have that's sort of interesting and perhaps something that you might attempt to use - there is considerable diversity in the techniques that you have reported. There's a great deal of commonality in the aims that these techniques have, but, at the same time, a great deal of diversity. For example, how does one describe objectives most conveniently? Or how does one decide upon the different categories of learning outcomes? We had several techniques mentioned. These among others. Or how does one go about the planning of lessons, the sequencing of skills to be learned? Or how does one design proper measures or use proper assessment techniques?

It seems to me you are coming to a point where you might want to aim for optimization of these techniques, rather than for greater diversity of them. Now, in this respect, I think you differ from the civilian sector. There is a similar diversity in the civilian sector, as I am sure you are aware. You can find schools that are trying individualized instruction and, in fact, they are trying all kinds of individualized instruction. You can find schools which say, "We are stating performance objectives." And you'll find great diversity in that and how they do it and so on. And you can find nongraded schools and graded schools and traditional schools, I suppose, although it would be difficult to say just what a traditional school is. There is great diversity, also, in the civilian sector. Perhaps you have a difference here, perhaps you have an opportunity which is better than exists in the civilian case, of trying to achieve an optimum set of methods. Perhaps you could adopt this as a goal. You may be able to work towards the optimizing of these techniques that you have described and overcome the disadvantages of diversity. And there are disadvantages to diversity, it seems to me. A workshop like this, of course, is one step in that direction. Here you exchange information. You find people know certain kinds of techniques that fill in a gap that you have been aware of and that you have been struggling with. You can obtain this information. And exchanging this information is one way, or one step, in that direction. I would think that another possibility would be you might try to establish some task forces, I would assume they would have to be inter-service, which try to achieve statements of optimized methods, of going about these various techniques that make up systems engineering. There is also the role, as I am sure you realize, of a higher headquarters in this. Now, I think that certainly one needs to be aware that there is an

advantage to having command authority in this kind of situation. On the other hand, I think that such command authority should be very much aware of the desirable aspects of diversity, so there are ways, it seems to me, of achieving optimized methods and an optimal system and there are ways that are good and there are ways that are not so good, because certainly, I think any higher headquarters is not interested in restraining the creative efforts of its subordinate schools or instructors or training supervisors or whatever. For example, if a higher headquarters were to say, "What we would like to have is individualized instruction," it could proceed, it seems to me, and this is probably kind of wild and I don't suppose that would happen, but it could proceed by saying, "O.K., Schools, we are going to supply you with students now at any time. They might report on any date and they are supposed to start their instruction immediately and they are supposed to continue their instruction until they have won certain criteria which you have established." Well, it seems to me, that kind of a directive would, in fact, force people to use individualized instruction. It wouldn't tell them how to do it, you see, but it would say that has to be done because every individual has to be treated as an individual, even to the extent of when he reports to the school and when he reports to become trained in whatever speciality it is. So that may be an example of the kind of directive that would, I think, bring about a change. At the same time, it would not be restraining on the particular methods, particular ways, an individual school's directors and so on would use to bring it about, but it would, I think, assure that this aim would, in fact, accomplished. That is just an example. It may be not a very practical one.

One other thing that I thought I ought to comment on was that it is apparent that you are coming up against the hard question of soft skills. I think there's a very important distinction to be made between hard skills and soft skills, although for some purposes the distinction between hard and soft might be appropriate in terms of whether or not hardware is involved. I don't think that, that distinction fully captures perhaps, the importance of what is meant in various schools and in various situations. Actually, it may be that soft skills are not really skills and that may be the problem.

What about the distinction between hard skills and soft skills? Let me try a definition. I would say, hard skills are those capable of these which can be assessed as learning outcomes by tasks which make possible the decision that they have or have not been learned. Or perhaps, that they have or have not been learned to some specified criteria. But soft skills are not like that. I think soft skills are those capabilities whose assessment yields evidence of more or less, of better or worse, and I don't know whether there is, in fact, a specifiable standard or criteria against which these can be assessed. For example, an individual has a more or less positive attitude towards, let us say, some desirable quality like dependability. Or he

behaves in a leadership situation more or less well. Some are better than others, and it isn't possible to say, "This is the criteria." Now, you will find on this handout a set of categories which, it seems to me, illustrate some of these differences that I am trying, at this point, to emphasize. If you see, under "Intellectual Skills" ... look at that first. These are the hard skills. As far as I can see these are the ones about which you can say you know, we can formulate specific objectives and say the individual has learned them or he has not and that's it.

Now, motor skills are often treated that way and so they probably belong in the hard skill category, too, although even to put them there requires a little bit of adjustment. Motor skills, as I think is well known, continue their improvement with practice over long periods of time. And so, what we are doing when we put motor skills in the category of hard skills, is, in fact, we are saying, "Oh, well, he does it well enough and I can specify a criteria here, and if he does it that well, O.K." But I suppose we should have this mental reservation about that, and if I provided him practice on this motor skill he could get better and better at it so far as anyone knows over a very long period of time. However, that is incidental. I think motor skills do belong in that category.

Now, what about verbal information? Well, that's a puzzle. You think about it as a hard skill and again, I think, it is - but only if again you adopt a kind of an arbitrary, perhaps, but a criteria which satisfies you. Now think ... here is an example. Suppose you say, I have a course. I don't know whether you deal with these kinds of courses or not, but suppose you say, "I have a course in history and I am teaching these students about the American Revolution." All right, "I want to teach them about the American Revolution." But what? How much do you want to teach them about the American Revolution?

Well, perhaps you can say, "All right. I want them to be able to state three reasons for the origin of the American Revolution." All right, if that is a satisfactory standard, O.K. But why three? Why not one? Why not 2? Why not 32? You see, it's very difficult to set a standard or a criteria for the learning of verbal information. We have to adopt rather arbitrary standards, so I put verbal information in a rather questionable category, as to whether or not it's a hard skill. I do that because I recognize that knowledge... you see, the accumulation of verbal information is generally referred to as knowledge and knowledge, you know, just accumulates for a long, long time and it gets added to in many ways. Now, how much information does anybody need? Is a very difficult thing to specify and I am not sure that it belongs in the category of hard skills, although I think that there are many instances that you have mentioned in the case of your specific aims for your courses where, in fact, it can be treated that way.

Now, we come to some things. Let's consider the other two categories that are here: attitudes and cognitive strategies. Now here is where you really get into trouble. I do not see, at the moment, how these can be handled as hard skills or how they can be system engineered by means of the same methods that you are using for others. I believe that we need ... I say, "we" - I am just as concerned about this as you are - I think that we need new methods to handle these things and I think that if you try to force these kinds of things into the hard skill use with the hard skill techniques that you will be unhappy. We'll all be unhappy. It won't work. We need a larger technology here to handle these categories.

Let me say a little more about attitudes. Attitudes are very important things. Some of you have mentioned this in some of the discussion previously. You want the trainees that you deal with, not just to have rather specific attitudes about being careful to turn off the equipment, you want them to have a positive attitude toward their job. You want them to have positive attitudes toward their branch of service. You want them to have positive attitudes toward the kind of career that they are in. How are these things established? Well, I don't think, you know, that the methods that have been described will handle this, particularly because, it seems to me, that one of the requirements for learning attitudes, I think, is a human model. And again, this has been mentioned this morning. It seems to me that however much information we provide and however carefully we sequence or arrange the learning of subordinate skills, we will not achieve this matter of establishing or changing attitudes which is a very important part of what you're dealing with when you talk about soft skills.

I think it requires a human being. It requires a human model. Certainly the evidence shows one that, you know, that the things that don't work in teaching attitudes are the providing of information or the speaking to people somewhat as I am doing to you. You know, I can say to you, "Look! You should always be honest," or "You should always be prompt," or "You should always be a leader," and you know that that is ineffective. That does not work and, Goodness knows, the Army has had plenty of examples of that during, perhaps, many years of its existence - the Army and the other services as well. What does work, according to the evidence that I see, is the use of a human model. The individual... I don't know what happens. You know, I don't know how to explain it, He identifies, perhaps with this other human being and he models his behavior, it you want, he models his in such a way that he acquires a general tendency to respond positively or negatively, or more or less positively or negatively, toward some object or event or person. And that's the kind of thing that seems to me to be critical for the establishment of an attitude. Another factor which is, I think, equally critical is the personal experience of success. You see, will this individual like the job that he has chosen?

Will he like to do the kinds of things that he has chosen to learn to do? Well, one factor in this is his personal experience of success. Now, several of these things indicate, you see, the importance of the instructor ... of the instructor or other leaders in the military community and I don't think that that is a lot of baloney. I think that that's true .. that there is human modeling and that this is a very important part of what must be attended to if we want to establish attitudes. This is a general category that I give to this kind of thing.

Now cognitive strategies ... you see, I have been relieved to find out that much of what you have been talking about when you talk about leadership is the ability to formulate and think out the solution of problems. That's really what it is. In other words, you are trying to train your men ... your officers to think That's really what it is about. You want them to solve certain kinds of problems. And we had this morning a description of the kinds of things that occur in these soft skill courses.

You are trying to teach officer ... well, how do they go about taking an enemy position? Well now, that can't be taught as a skill. You are asking an officer to solve a normal problem in that situation and so, I think, again, here is another area that may require an expansion of your technology, of my technology, of anybody's technology in order to handle this. How do we handle this now? Well, the only way I know to handle it is to provide opportunities for practice in a variety of problem situations ... you know, simulations, or whatever. That's what we do: that's what people in the schools do. Nobody knows how to do it any better than that. Maybe some day we will, but we don't now know how to do this. Now, of course, there are subordinate skills in this. If, in fact, you are trying to teach the individual to solve a problem having to do with the letting of blood or the use of a tourniquet, then obviously, there are some simple ordinate skills that can be specified. He has to know what a tourniquet is and how to use one, and things of that sort, but these do not, in themselves, allow him to solve this problem. You are presenting him with a novel problem-solving situation, and you want him to bring to bear on that situation varieties of knowledge from all fields in whatever brains he has, you know, whatever creative, ingenious kinds of thinking operations he has. This is what I mean by cognate of strategies. So, how do you go about the instruction cognitive strategies? And this is very important in the soft skills area. Well, you must do it, I think, by providing these opportunities for solving novel problems. I wish that there were a way that could be specified. You see, having analyzed that situation, the answer to that is, in contrast to what can be done with intellectual skills, we don't know how to analyze that situation. We simply do not have the psychological knowledge that enables us to say, "What are the components of good thinking?" We don't know that and I think that

that means, "Sure there are limitations." Practically what it means is you have to put people in as realistic situations as you can in order to give them opportunities to be challenged to bring to bear on those situations the intellectual resources that they have and that get developed in that particular way. Now, speaking of that, of course, it would seem to me doubtful, you see, that you can develop these in a single course. It doesn't work that way, I think, it takes time and it takes many opportunities for problem-solving and thinking and these things get better. Somebody said, as the individual gets more mature, he gets better at it, so I doubt whether it can be developed in a single course. You know, that's true in the civilian sector, too. You cannot give a course in how to think. There is no such thing. It's ridiculous to think that you can. Again, you can establish certain subordinate skills that contribute to it. Yes, but you really cannot give a six-week course or a two-week course in how to think. It takes experience. It takes a lot of experience in problem-solving situations to get the individuals to be able to think well and this is, I think, what the aim of such soft skill courses might be.

So, I would suggest two different principles here I think you may find ... that ... well, at least, you might keep them in mind because, at the present time, this is the way it seems to me.

One is that precise, analytic specification and measurement techniques should be used for hard skills. Hard skills can be and should be, treated as hard skills - not as soft skills, O.K.

The second principle is precise, analytic specification and measurement techniques are not suitable for soft skills. They are probably inappropriate and a different set of system engineering techniques may be needed. The main thing, I believe, at this point, and certainly your presentations have caused me to think about these things very deeply ... the main thing it seems to me probable is that the worst mistake to make is to mix them up. You deal with the hard skills in one way and you can ensure their mastery and, I believe that that should be done. Now, I think back to my experiences in the Air Force twenty years ago, say, and we were dealing in a certain sense with hard skills and our observations were they were being taught to a large extent as soft skills and that's not good. We thought that then. So, you know, I am delighted to know that there has been such an enormous amount of acceptance of the idea that hard skills can be treated as hard skills and they can be analyzed as hard skills and they can be taught as hard skills and measured as hard skills. And that's a bad mistake, to make, I think, to treat them as soft skills. On the other hand, I think that the distinction is very important and I sort of doubt whether you will find complete success or satisfaction in trying to teach soft skills like hard skills.

I think you need a larger technology and one that, you know, is beyond the framework most of which you have emphasized in the various presentations that I have heard.

I don't want us to forget that the human being is an enormously flexible organism ... that he can think and he can be stimulated to be ingenious and creative and this, after all, we don't want to lose these. We don't want to restrain him in using these capabilities that he has and that he is able to develop. So, by all means, we should give him the fundamental capabilities that he needs. These are the hard skills but we should be careful, I think, to also give him the opportunities to develop these other things which we call soft skills.

SYSTEMS ENGINEERING WORKSHOP SUMMARY

Although time will not permit another systems engineering Pig fable, I do feel it necessary to recognize Mr. John Myers, Mr. Harris, Sgts Roff and Roby of the Southeastern Signal School for their contributions in making our Workshop a Success.

Now in developing a summary of the Systems Engineering Workshop we must identify the objectives established and the level of success achieved. Extensive interaction and sharing of Systems Engineering philosophy procedures and techniques were our stated objectives. Our purpose was directed at enriching and purifying the systems engineering function within CONARC in an attempt to fully capitalize the potential available. Our workshop opened with presentations from our sister services identifying the status of the systems engineering function and its future directions within their service. It was apparent that each of the military services have made significant strides in developing the function and, including CONARC, is now ready to expand their systems engineering horizons. We are in complete agreement as to the great potential systems engineering possesses in dealing with individualization of instruction, methods and media utilization and the total integration of the instructional process. And, since we were all at the same basic levels the need for developing continuous channels of communications for sharing our developing systems engineering functions between the services was identified. We are indeed grateful to LTC Godfrey of the Marine Corps, Dr. Havens of the Navy, and Mr. Neale of the Air Force for - through them, we have opened these channels of communication, which will undoubtedly prove mutually beneficial.

Having knowledge of the new directions in curriculum development, research was essential if we in the military were to achieve our stated objectives. Dr. Gagne of Florida State University provided our workshop with a stimulating overview of the research being conducted which will certainly influence the future directions of systems engineering development within CONARC. Criterion referenced assessments in the development of systems engineered courses, criterion referenced evaluation techniques and the direction towards accountability techniques in determining the attainment of goals are some of the futuristic outlooks.

Our workshop developed around those major areas of concern as identified by our participants, and the presentations of some of the solutions developed by individual CONARC elements. Resolution of our manpower problems and revision of our guiding regulation were not considered although universally addressed as problems. These two problems are in the process of resolution by the CONARC staff. The problems that were considered and developed within the workshop primarily related to the unique procedures and techniques developed by various CONARC elements, industry and the civilian community to solve these problems. Methods and Media selection and individualization of instruction were two of the main problems discussed.

As we all know, the systems engineering function involves a myriad number of interrelated activities. Our workshop maximized the specialized techniques developed within the military and civilian communities to solve the more pronounced problems plaguing systems engineering development. It is hoped that these techniques will provide short-cuts based on the vicarious experiences we have shared. Additionally, our workshop identified the majority of areas for concern necessary for complete development of the systems engineering function. In laundry list fashion, this slide contains some of the problems that were identified and must be solved if systems engineering is to meet its full potential. Recognition of these areas for concern is the first and most important step in Problem Solving. Our workshop has provided a dynamic tool or apparatus to deal with resolution of these problems based on a national capability rather than individual capability. We achieved this potential through the development, and identification, of a residual pool of systems engineering talent that will be, on a continuing basis, available to participate in solving our problems on a joint basis. We feel this spin off of our workshop is of the utmost importance and will accelerate the systems engineering function within CONARC. The CONARC Systems Engineering Program is now in a state of transition and growth, as Dr. Lessinger stated, a new Beginning. We in Systems Engineering feel this new beginning will provide the essential ingredients with which to achieve our individualization of instruction goals, while conserving resources and in achieving our stated Volunteer Army Concepts while maintaining the highest state of combat readiness necessary to meet our national defense responsibility.

Systems engineering is the vehicle I believe Dr. Lessinger was considering when identifying the need to shift from developing ideas and concept and putting them into action.

In considering Gen Haines guidance during his opening remarks, we ants of systems engineering are on the Ball.

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SYSTEMS ENGINEERING WORKSHOP HAND-OUT MATERIAL

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SYSTEMS ENGINEERING WORKSHOP HAND-OUT MATERIAL

1. Systems Engineering Workshop Orientation (An Introduction)
LTC Lucien R. Garneau (Not Available)
2. Systems Engineering In The U. S. Army - A Status Report
Major Robert S. Tamer
COORDINATION DATA SHEET (Available)
USATSCH USE OF ADP FOR TASK SELECTION (Available)
3. Systems Engineering In The U. S. Marine Corps
LTC Edwin J. Godfrey (Summary Available)
4. Naval Air Training's Pilot System
Dr. Charles B. Havens (Presentation Available)
5. The Air Force Systems Approach To Training
Mr. William S. Neale (Summary Available)
6. Systems Approach To Course Design In The Civilian Community
Dr. Robert M. Gagne⁹
SYSTEM DEVELOPMENT IN EDUCATION (Available)
SAME NOTES ON TYPES OF LEARNING OUTCOMES (Available)
7. Systems Approaches To The Design Of Curriculum
Mr. James L. Foster (Summary Available)
8. Administrative Innovations
Dr. Philip W. Tiemann (Summary Available)
9. The USAIS Approach To Systems Engineering Soft Skill Courses
Summary (Available)
FB Form 125 - Task Selection Sheet (Available)
FB Form 126 - Training Analysis Information Sheet (Available)
FB Form 24 - Systems Engineering Design Sheet (Available)
10. Computerized Aspects Of Systems Engineering
Dr. Harold Wagner and Mr. James E. Henry (Summary Available)
11. Course Structure Rationale
Dr. Charles O. Gray (Summary Available)
12. Commercial Approved To Systems Engineering
Dr. William G. Hoyt (Summary Available)
13. Systems Engineering Workshop Observations
Dr. Robert M. Gagne⁹ (Not Available)
14. Systems Engineering Workshop Summary
Major Robert S. Tamer (Not Available)