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MEMORANDUM REPORT SDC 279-3-3

SYMPOSIUM ON PROJECT CADILLAC

New York University
Human Engineering Project
August 1950

SDC Human Engineering Project 20-F-4
Contract N6onr-279, T.O. III
Project Designation NR-784-006

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SPECIAL DEVICES CENTER
PORT WASHINGTON, L.I., N.Y

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INTRODUCTION

A Cadillac Symposium was convened at the Special Devices Center at Sands Point, Port Washington, New York, on 17 and 18 May 1950 for the purpose of reviewing the activities of the New York University Human Engineering Project.

Representatives of CNO, the Bureau of Aeronautics, the Naval Research Laboratory, the Operations Evaluation Squadron (VX-4), the Naval Air Development Center, and the Glenview Naval Air Technical Training Unit attended.

The laboratory facilities and gear were demonstrated during the two-day conference. A number of organizational and technical talks were presented by New York University personnel and by personnel of other Navy organizations.

Abstracts of the principal talks are contained on the following pages.

[redacted]

The Human Engineering Project Program — Dr. R. L. Chapman
NYU Technical Director

The Symposium was called to explain the purpose of the NYU Human Engineering project, to make a progress report, to describe the talents brought to bear on the problem, and to outline the kinds of answers that can be expected from the project.

The project is devoted to an evaluation of the human aspects of the airborne CIC system and the recommendation of improved design of components and improved operation of the system in general. Thus far, work has proceeded on the installation of the equipment and orientation of the crew and the experimenters. It is expected that the installation of the gear itself will not be completed until September 1950, Several experimental studies have already been finished, however: one on the evaluation of several suggested plotting aids, and two studies of the load that one scope operator can handle. In addition, consultations have been rendered to BuAer and to manufacturers completing gear for the installation.

NYU has brought together experimental psychologists, industrial engineers, and electronics engineers to contribute their various talents to this study. A crew of experienced CIC officers have also been assigned to the project to serve as subjects and as operational advisers.

The primary concern of the project is the proper design of individual pieces of gear, the discovery of the most efficient operation procedures, and the evaluation of the various man-machine linkages in the system. Secondarily, the study will yield information on tactical questions, on maintenance difficulties, and on the problems of selecting and training CIC officers.

The way in which the project has been set up insures that the answers that are found will be: pertinent and practical, because the Navy officers have been assigned as operational advisers; scientific, because of the background of the investigators; objective, because the results can be verified several times under laboratory conditions. The results will have application to more than this specific situation because the problem is being studied in a fundamental and thorough way. The results will represent the pooled judgments of men from the various progessions whose experience have a significant bearing on the project.

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The Electronic Equipment

David M. Goodman
Assistant Technical
Director, Electronics

The electronics section of Project Cadillac is under the immediate supervision of the assistant technical director for Electronics Engineering. One graduate engineer and two electronic technicians complets the staff in this section.

The functions of this section to date have been (1) the installation and maintenance of equipment supplied to the project by various activities, (2) the design of special electronics circuits and facilities required for project use, and (3) to serve the project in the capacity of electronics consultants. These three functions have been and will continue to be performed until the equipment needs of Cadillac III are fulfilled. It is then anticipated that a shift in emphasis of the various functions may be effected.

The progress made by this group during the period 1 December 1949 to 15 March 1950 was excellent. The laboratory space presently occupied by the project was made available the first week in December 1949. The office space was allocated and occupied, and inter-office communications system was installed, and the electronics equipment for Cadillac III was received from the Bethpage Naval warehouse in this first month. During January and February of 1950 the mock-up of the PO-1W hull was erected. Installed therein, and for the most part corresponding to the Lockheed aircraft layout, was the AN/APA-56 and the AN/APA-57. The intercommunication boxes for the CIC crew were likewise installed in their appropriate positions. Exterior to the hull, the radar simulating equipment was arranged to take the place of the basic radar, the APS/20A.

The major equipment components, with the exception of the CIC intercom were set into operation, thoroughly aligned and coordinated, and were made available for project use in the month of March 1950. Various minor projects were successfully completed during the same period to provide, amongst other things, simulated engine roar and a simplified communications system.

Upon installation of the sea return simulator, the height finder simulator, the radio simulator, and upon the completion of the CIC intercommunications system, an extremely flexible replica of the Navy's latest development in airborne CIC will be in operation in this laboratory.

[redacted]

Contribution of Naval Officers — Lt. D. L. Whittemore, USN
Senior Special Projects Officer
(Cadillac III)

The need for operationally trained operator-subjects for the systems studies led to a request that fleet CIC officers be assigned to the project. This resulted in the assignment of the following officers to the project:

Lt. D. L. Whittemore, USN	Land-based AEW Squadron CIC Officer
Lt. F. M. Guttenberger, USN	Aircraft Carrier CIC Officer
Lt. J. R. Zeitvogel, USN	Aircraft Carrier CIC Officer
Ltjg. M. Skees, USN	Aircraft Carrier ACO - Night Control
Ltjg. G. F. Bean, USN	Aircraft Carrier ACO

One additional officer has been requested and should report in August 1950. Lcdr. Robert W. Weber, in addition to the officers named, is serving as a technical advisor to the project.

In addition to acting as subjects, the officers have contributed to the project in the following ways:

1. Providing liaison between NYU staff and the Special Devices Center.
2. Providing greater project security.
3. Providing operational advice and evaluation in experimental problems.
4. Aid in the cataloging of data obtained from experiments.
5. Aid in accounting for government furnished equipment.

Through mutual enthusiasm and close cooperation between the NYU staff and the officer personnel assigned, the results of the project will be not only scientifically pertinent but will also reflect the worth of the system in actual operational use. It should provide the best evaluation of the system possible under controlled laboratory conditions; thereby obviating the countless hours of flying time, which would ordinarily be a pre-requisite to an operational evaluation.

What is Human Engineering Research?

Dr. R. L. Chapman
NYU Technical Director

Human engineering received its main impetus from World War II when it was found that devices became so complicated that it was difficult for the human to operate them efficiently.

The Technical difficulties in the design of new equipment are so great that it is small wonder that the engineer restricts his efforts to building a gadget that he thinks a human should be able to operate. The performance obtained with equipment designed in this conventional manner clearly shows that we must deal with the operator as he is rather than as he should be. The individual has both physical and psychological limitations when working alone. When he works as part of a team, many difficulties arise that perhaps should not occur. But they do, nevertheless. When it is possible to minimize these difficulties by redesign, this must be done. We have come to realize that, perhaps unfortunately, improving the technical aspects of a piece of gear does not mean improved performance. We must consider the operator and his abilities as an integral part of machine performance.

It must be said that it is not necessary to be scientific in such an investigation as this, if one could be right. There are many embarrassments which have arisen, however, because a designer thought he was right, but wasn't. Thus, the scientist does not trust opinion and observation unless it is backed up by fact. The mark of success of this project as a scientific study will be that the same results can be obtained with a different crew of operators and with a different crew of experimenters as well.

This project's work falls into the category of "action" research, where effort is directed at practical and immediate problems. A great deal of information can be obtained very efficiently with research techniques, though they may seem at times to be slow. For instance, approximately 25 per cent of the project's time is spent on preparation for experiments, only 15 per cent on actual data taking, and another 35 per cent on analysis of data and writing of reports. An additional 25 per cent of project time is required for maintenance. The long way around, if this is the way to describe research methods, is often the shortest way home.

The Contribution of the Experimental Psychologists to the Evaluation of the Airborne CIC System

Dr. R. E. Taubman
Assoc. Tech. Director
Ass't Tech. Director,
Psychology

The Airborne CIC consists of a group of men and machines, which together must produce results. This team of man and machines is a system in which the human element is of vital importance. In studying this system, a psychologist can make an important contribution because of his training and experience in conducting research into human behavior. The CIC system in the PO-1W, though more complicated, is comparable to the men and machines in a production line. In the production line, the most efficient system can be found by corparing the work output of different man-machines arrangements. In the study of CIC systems, the methods of studying the system are essentially the same.

The first step in investigating a CIC system involves learning what work loads an operator can handle. Such a study has been completed and the salient results can be reported. The experiment was concerned with the relation between the difficulty of an AEW problem (work load) to the time necessary to report a new target (work output). It was found that the operator took longer to report a new target as the number of targets on the scope face increased. When no more than one or two targets were on the scope, the operator reported an additional target within one tenth of a minute; when fourteen targets were on the scope, however, he required one and a half minutes, on the average, to report a new target. The number of reports made per unit time (work output) did not change with an increase in the number of targets on the scope (work load) but remained constant. The number of points plotted per unit time also remained constant--one plot per scan. The time between successive reports on a given target was found to increase with the number of targets on the scope, so that with more than eight targets, one report per minute per target could not be made. Direct unaided estimation of range and bearing of targets showed a surprising degree of accuracy and reliability.

Industrial Engineering Aspects
of Project Cadillac

J. G. Adiletta
Harold Abrams

The field of industrial engineering affords certain techniques which can be applied to the CIC problem. Such standard techniques as time study, micromotion analysis, and the construction of multiple activity charts of men and equipment have been adapted to this special problem. These techniques will be used to gather data on which to base a redesign of the controls of individual pieces of equipment. The industrial engineering principles of motion economy serve almost equally as well for the military as the industrial situation.

Two studies, one on plotting aids, and one on the seating of CIC personnel, demonstrate more specifically some of the industrial engineering aspects of Cadillac III as well as some of the concrete results obtained by the staff of this project.

1. Plotting Aids:

Five methods of obtaining the bearing and range of one target relative to another were evaluated. These methods were: the mechanical cursor head modification, visual estimation, a 360° plastic overlay disc, a 180° plastic overlay disc, and the offset slew method which makes use of certain electronic features of the repeater scope. The results showed that 360° disc was relatively faster and more accurate than the other devices tested. Its use would be recommended in preference to the other devices in the present stage of design; however, the further development in specific ways of the mechanical cursor head was suggested.

2. Seating Survey:

A survey of the seating needs of CIC console operators was conducted so that seating specifications, which would lessen fatigue and minimize distractions due to physical discomfort, could be submitted. The specific recommendations made included these points: the physical dimensions of the seat proper, the materials with which the seat should be covered, and the design and placement of the adjusting controls, and comments on the necessity of reducing the transmission of vibration to the operator.

The Team Concept

Capt. J. R. Poppen
Naval Air Development Center
Johnsville, Pennsylvania

The appropriate organization for accomplishing the terminal stage of development of a gadget or a procedure, is a vertical team composed of exponents of all the various specialties involved in that development. This is a very important concept which developed during the last war. I want to express the conviction that, in this type of project, the essential thing is to have a vertical team composed of specialists, each of whom is his own specialized ability to this thing as a whole. I think that a team such as you gentlemen represent in Cadillac III is well formulated.

Human engineering is also of tremendous interest to flight surgeons. The broad concept of integrating specialties to the development of equipment which people can use to its best advantage, is of tremendous importance because it results in increased practical effectiveness. I am happy therefore to see the degree to which human engineering has been utilized in this project.

I really believe that naval aviators with CIC experience and ability have a very important place as a team member on this project and can contribute very materially to indicating what is desirable, what is good and what is not good. The naval aviator should accept the principle of being a part of this team; he not only can contribute to such projects, he is also improved by this experience.

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The Objectives of the Team

Commander Veazey
CNO Op 413

Captain Poppen has talked to you about the "team" and I will now try to tell you something of the team objectives.

The major objectives of the Airborne CIC team were clearly established recently, when, as some of you probably know, the Research and Development Board, functioning directly under the Secretary of Defense, allocated primary responsibility for research and development in the field of Airborne Early Warning and Airborne CIC to the Department of the Navy. Our team objective in this regard is made doubly important to the country as a whole due to the fact that the other military services have discontinued practically all activity in this endeavor. The work of the team is vital to the nation because with the one exception of Airborne CIC, we know of no other method by which so much early warning data can be gathered, evaluated and utilized in so little time.

I will now attempt to illustrate some of the future uses of the system, and hence "team objectives." The installation and operation of the basic radar early warning system for the continental U.S. is the responsibility of the U.S. Air Force. The installations have progressed just beyond the planning stage at this time. It is planned to utilize the services of the AEW or Airborne CIC planes in the overall system and it is interesting to note that if our country were faced with the threat of an air attack in the immediate future, a large measure of the early warning for the United States would be dependent upon the AEW and Airborne CIC planes we are presently working on.

Needless to say, we are considerably beyond the planning stage in our program. The aircraft so employed in any case would include some of the products of the work being prosecuted here at the New York University Airborne CIC project.

As you probably know, we are now working on a moving target indicator so that we can detect targets through land reflection and recent tests are very encouraging. I believe that I am safe in saying that the day the Navy perfects airborne moving target indication will be the same day that the Canadians and our own sister air service will come to the Navy for as much equipment and know-how as is possible to get.

From the foregoing, you can be assured that your team objectives are high, so stick together and work together as a team and when the going is rough, just remember how little early warning our country has today and what it will have in the future through the medium of a successful airborne CIC program.

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Concluding Comments

Mr. V. J. Sharkey
Human Engineering
Project Engineer

Project Cadillac is one of several sponsored by the Special Devices Center in the application of human engineering principles to the design of operational equipment and systems. This is one of the methods employed by the SDC in solving training problems. Frequently training difficulties may be lessened by redesigning and modifying present equipment with the limitations and capabilities of the human operator clearly in mind. Then too, future problems in training may be obviated by optimal design and arrangement at the outset.

Two questions have come up during the course of these meetings which I feel should be answered now. The first pertains to the target date. Our prime interest now is the system that is being installed in the PO-1W aircraft. Our immediate purpose is to determine how we can get the most out of what we have. Our ultimate goal is to assist other development agencies in arriving at the optimal airborne CIC that is capable of development within the next five years.

The second question pertains to the method by which the results of the studies being conducted by NYU will become available to you and to others interested in this general area. As each phase of the work is completed, a technical report is prepared and is distributed by the Special Devices Center. You are all on this distribution list. Memorandum reports in answer to specific questions submitted to the project will be sent to authorized individuals.

We shall plan to have another symposium such as this when the work has progressed to the point where it is indicated that another meeting is desirable.