

**SECTION 2 pt. 1 - 50 YEARS OF  
HUMAN ENGINEERING: BIBLIOGRAPHY**

- 1945-1954 - The Foundations of Human Engineering
- 1955-1964 - Preparing Man for Space Exploration
- 1965-1974 - The Vietnam War Years

# About This Bibliography

The unclassified publications of the Human Engineering Division over the fifty years of its existence are presented in ten-year intervals in the present document. During this time period, the division participated in many projects that had security classifications as did the documentation about the work. The bibliography necessarily omits the titles of documents that had security classifications.

Some of the research and development work of the Human Engineering Division is published outside of the government in the journals and proceedings of scientific and technical societies and other organizations, and as chapters in books. An appreciable part of the division's work also appears in official publications of the US Government. These publications by the government include books, such as *The Engineering Data Compendium* and *Human Factors Issues in Head-Up Displays*, as well as handbooks and parts of handbooks, military specifications and standards, special reports and technical reports.

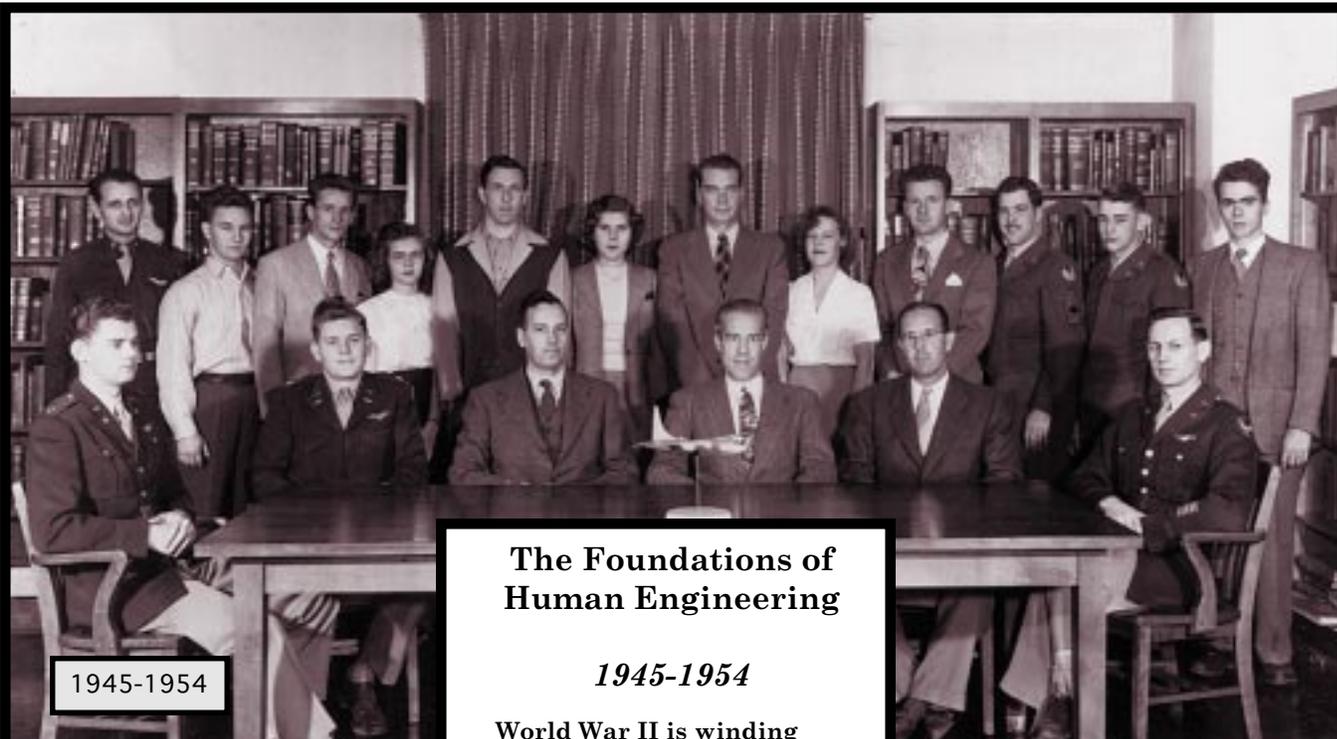
Technical reports are the Human Engineering Division's most common form of publication within the US Government. Prior to publication, these reports are reviewed by division personnel other than the authors, and permission to publish and release to the general public is granted only after examination by government personnel outside the Human Engineering Division. Technical reports by the division do not receive pre-publication peer review by individuals outside of the government, and division technical reports are neither as widely disseminated nor as readily available as journal articles.

However, technical reports are available to the public and have some advantages that sometimes make them a preferable form of publication. For example, there are no suitable journals for publishing tutorial reports, reports on research and development on military hardware, and extensive documentation on the data collections by the division's physical anthropologists on subjects such as human body dimensions and strength in executing various tasks. Technical reports can be considerably longer than journals will accept, hence they can report appreciably more details about the work. Technical reports permit publishing more pictures and other forms of illustration than are available in journal articles. Most of the pictures in the present document are excerpted from Human Engineering Division technical reports.

The designations of technical reports can be confusing to people not acquainted with them. In addition to their titles, government technical and scientific reports are identified by technical report labels. AAMRL-TR-89-001 is an example of a report designation. The title of this report is Display System Analysis for the LHX Helicopter Applications. Here, the letters, the alphabetic preface, designate the laboratory or other government organization that published the report. The TR stands for technical report, the first set of numbers identify the year that the report was published, and the last set of numbers designate the report's chronological order in the publication year. The translation of the designation of the above example is that the report was published by the Armstrong Aerospace Medical Research Laboratory in 1989 and is the first technical report for the year. The report numbers do not take into account journal articles or other forms of division publications within or outside of the government.

Since the laboratory name has changed over the years and since other government organizations sometimes have published works of the Human Engineering Division, the acronyms of the alphabetic preface of technical reports can be confusing and require clarification. Some of the more frequent acronyms used in the designations of division technical reports are as follows:

<b>AF</b>	<b>Air Force</b>
<b>AAMRL</b>	<b>Armstrong Aerospace Medical Research Laboratory</b>
<b>AFB</b>	<b>Air Force Base</b>
<b>AL</b>	<b>Armstrong Laboratory</b>
<b>AMC</b>	<b>Air Materiel Command</b>
<b>AMRL</b>	<b>Aerospace Medical Research Laboratory</b>
<b>ASD</b>	<b>Aeronautical Systems Division</b>
<b>DTIC</b>	<b>Defense Technology Information Center</b>
<b>MRL</b>	<b>Medical Research Laboratory</b>
<b>TDR</b>	<b>Technical Documentary Report</b>
<b>USAF</b>	<b>United States Air Force</b>
<b>WADC</b>	<b>Wright Air Development Center</b>
<b>WADD</b>	<b>Wright Air Development Division</b>

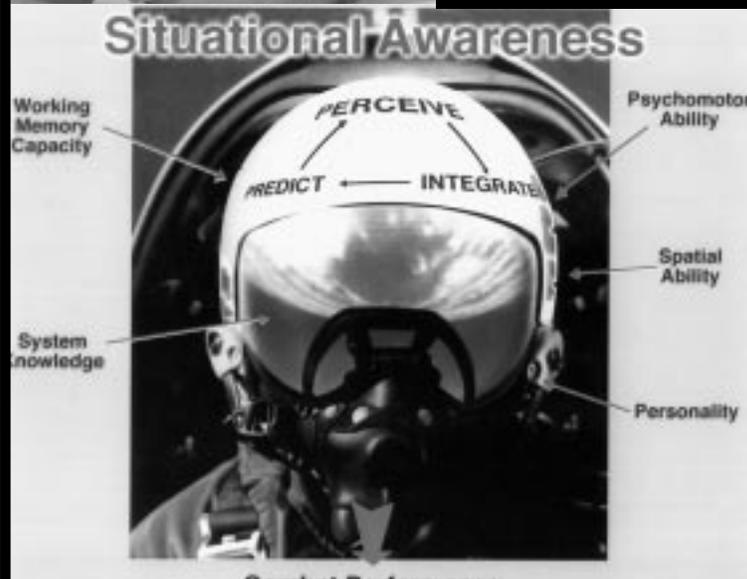


1945-1954

## The Foundations of Human Engineering

1945-1954

World War II is winding down. Performance of many weapons during the war has been disappointing. Human failure is evident, but serious questions are raised regarding the suitability of the design of many of these weapons for human use. A 29 May 1945 Air Staff directive dictates "that facilities be established for conducting scientific psychological research on problems of aviation equipment" at Wright Field, Dayton, Ohio. The Psychology Branch of the Aero Medical Laboratory is born and with it the fledgling field of human engineering.



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**CHECK READING GROUPS OF DIALS**

Measuring the effects of dial diameter on eye movements and the speed and accuracy of check reading groups of 16 engine instruments. The study was used to provide data on which to base recommendations for instrument panel design. The work was done by William J. White. Air Force Technical Report No. 5826 (1949)

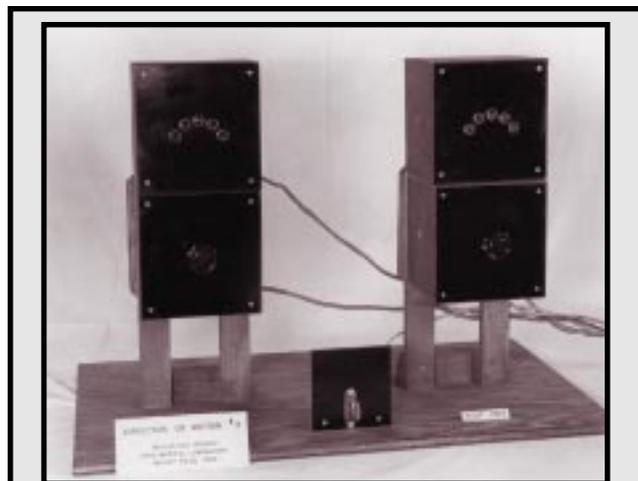
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**Barger, D. M., & Roush, R. G.** (1953). *A velocity modulated raster display for brightness discrimination studies* (WADC Technical Report 53-249). Wright-Patterson AFB, OH: Wright Air Development Center. (DTIC No. 23 712)

**Benepe, O. J., Narasimhan, R., & Ellson, D. G.** (1954). *An experimental evaluation of the application of harmonic analysis to the tracking behavior of the human operator* (WADC Technical Report 53-384). Wright-Patterson AFB, OH: Wright Air Development Center. (DTIC No. 38 148)

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#### RELATIVE ROTATION DIRECTION OF DIALS AND CONTROLS

Determining the effects of the relative direction of rotation of dials and control knobs on the speed and accuracy of adjustment in alternating the positioning of two semicircular dial indicators with rotary knobs. This was one of four experiments described in the report by Melvin J. Warrick. AF Technical Report No. 5812 (1949)

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**Lieutenant Colonel Paul M. Fitts, PhD**  
**Chief, Psychology Branch**

**1945 to 1949**

Lt Col Paul M. Fitts is generally regarded as the father of human engineering as a technical discipline.

He received degrees in psychology from the University of Tennessee (BS 1934), Brown University (MS 1936), and University of Rochester (PhD 1938) prior to being commissioned in the Army Air Force as a first lieutenant in the Aviation Psychology Program in April 1942. During most of the war years, he served as Assistant Chief of the Psychology Branch in the Office of the Air Surgeon, HQ USAAF. His major function was providing direction for the several field units of the Aviation Psychology Program.

At the end of the war in Europe, Fitts was dispatched to Germany for a three-month intelligence mission to investigate the Luftwaffe approach to the use of scientific psychology in support of military operations. In 1945, he developed a plan for a psychological research unit that would address man-equipment engineering design problems that underlie aircraft accidents, bombing errors, and other such phenomena that are evidence of human failures attributable to poor engineering design. The Air Staff approved his proposal on 19 May 1945 and he became the Chief of the Psychology Branch of the Aero Medical Laboratory. He served in this position until 1949.

His subsequent career included Professor of Psychology and Directorship of the Aviation Psychology Laboratory at The Ohio State University, Professor of Psychology and Head of the Human Performance Center of The University of Michigan, and membership on several research and development boards.



At the time of his death, on 2 May 1965, Dr. Fitts was serving as a National Research Council scientific coordinator for human performance issues relative to the Manned Orbiting Laboratory. Dr. Fitts' many contributions to the Air Force are well documented in both the scientific literature and in the methods, techniques, and disciplines applied today in the development of Air Force weapon systems. It was in light of Dr. Fitts' profound influence on the technology and programs of the United States Air Force and the Harry G. Armstrong Aerospace Medical Research Laboratory, that Building 248, Area B, Wright Patterson Air Force Base, was memorialized in his honor as the Paul M. Fitts Human Engineering Laboratory.

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**Brown, K. T.** (1953). *Factors affecting rate of apparent change in a dynamic ambiguous figure as a function of observation time* (WADC Technical Report 53-482). Wright-Patterson AFB,

OH: Wright Air Development Center. (DTIC No. 34 415)

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What is now the Behavioral Sciences Laboratory began with the establishment of the Psychology Branch in the Aero Medical Laboratory at Wright Field in the closing days of World War II (August 1945). One of the first arrivals was Paul M. Fitts, then a lieutenant colonel, who was primarily responsible for organizing the new branch and served as its chief until 1949. Other psychologists among the initial staff were Robert M. Gagne, Walter F. Grether, Launor F. Carter, Judson S. Brown, John T. Cowles, William O. Jenkins, M.J. Warrick, Julien M. Christensen, A.P. Johnson, H.R. Van Saun, Glen Finch, and W.B. Webb. These and others among the early staff were members of the Army Air Force's Aviation Psychology Program, where they had worked on aircrew selection, training and rehabilitation. With the end of World War II many of the staff separated, and the branch became more stabilized with a staff of about 25 people.

— March 1965, "Human Engineering and Training Research Division," Behavioral Sciences Laboratory

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- Christensen, J. M.** (1947). *Aerial analysis of navigator duties with special reference to equipment design and workplace layout: I. Development of technique* (AMC Memorandum Report TSEAA-694-15). Wright-Patterson AFB, OH: Air Materiel Command.
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#### **WORKSTATION DESIGN AND OPERATIONAL EFFICIENCY**

**Navigator working in C-54 cargo aircraft from a report on the activities of navigators in the Atlantic and Pacific areas. This work was part of a project in which data on the activities of crew members under operational conditions were collected to determine minimum crew requirements and to make changes in equipment and workstations to increase operational efficiency. Julien Christensen performed this research. AF Technical Report No. 5771 (1949)**

Coakley, J. D., Fucigna, J. T., & Barmack, J. E. (1953). *A functional application of anthropometric data to the design of the workspace of PPI Scope Operators* (WADC Technical Report 53-3). Wright-Patterson AFB, OH: Wright Air Development Center. (DTIC No. 6164)

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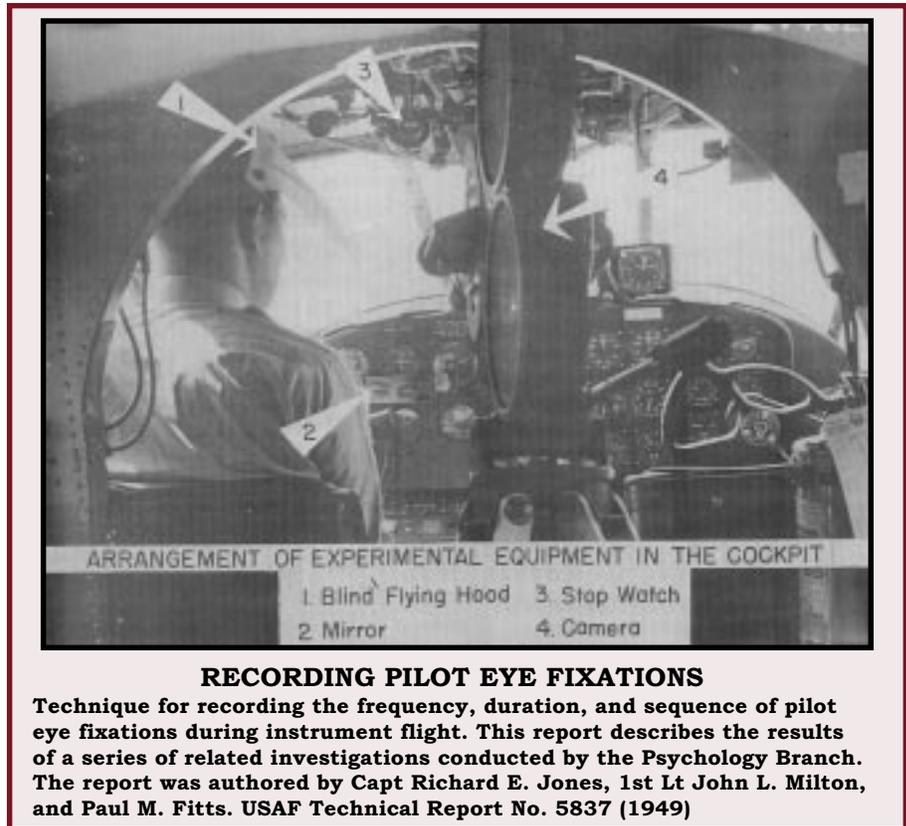
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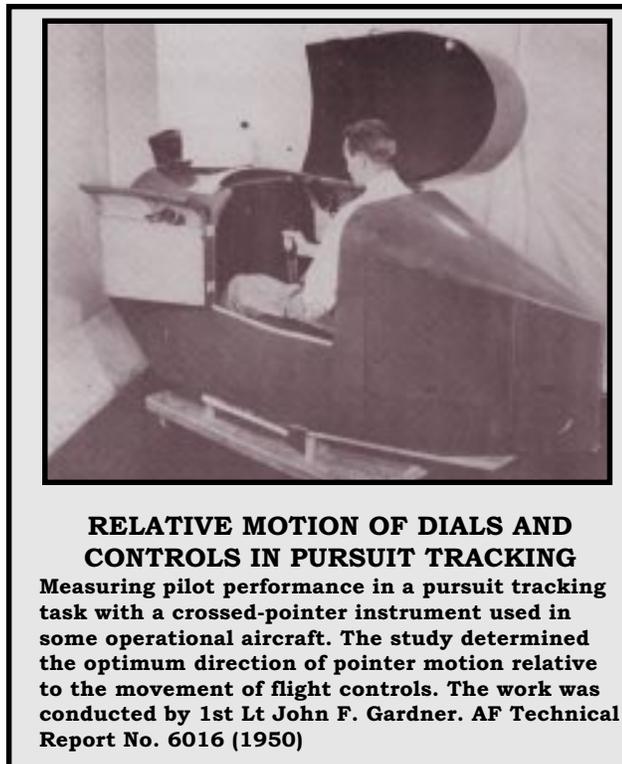
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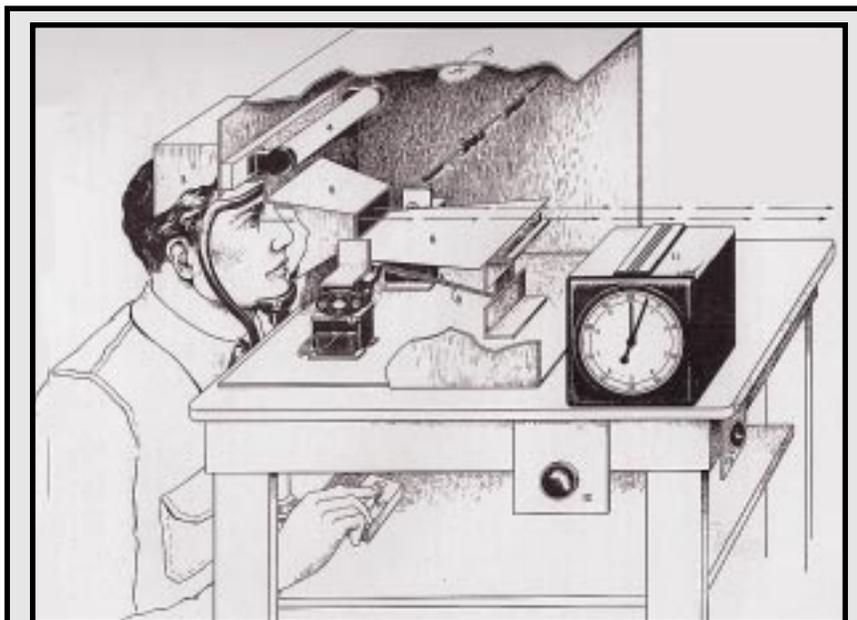
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#### PAINTING AIRCRAFT FOR EASY VISIBILITY

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**As the Psychology Branch prospered, it also grew in size and in breadth of its responsibilities. Initially the branch had only three sections, one working on problems of visual displays, another on controls, and the third conducting flight research, first in a C-45, later in a C-47, and currently in a C-131 and two C-135 aircraft. In 1948, a new Systems Research Section was added, headed by Julien M. Christensen, now Chief of the Human Engineering Division. A Training Research Section was added in 1951, headed by Gordon A. Eckstrand. This has since grown into the Training Research Division. In the course of time other new activities were initiated which led to setting up new branches for "Maintenance Design" and "Environmental Stress."**

**— March 1965, "Human Engineering and Training Research Division," Behavioral Sciences Laboratory**

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**"One of the more unusual projects was flying in a wing-tip turret experiment. There was a pod out at the end of the wing on a B-17 where you sat throughout the flight. It was pretty frightening out there, with nothing but space on one side of you, and the realization that escape would be difficult, if not impossible. And of course, you always thought about the possibility that they would drag the wingtip on the landing. The data collected was mostly introspective—whether you could manipulate controls, whether the buffeting would be too severe, whether you would get sick. When I flew it was not particularly rough, but the wing still wobbled up and down a lot. I was in constant intercom contact, and if I had become sick, they probably would have aborted. Fortunately, that never happened. I don't think they ever pursued the concept of the wing-tip turret much beyond those early experiments."**

**"In a way, we initiated the area of man-machine dynamics modeling. With the publication of Wiener's book on cybernetics, Fitts interested one of the generals here on the base and the people at AFIT in the subject. Then I was sent to Europe to interview persons involved in the area over there. That was in 1947-48. I remember we sponsored the first seminars in man-machine dynamics, along with Frank Taylor of the University of Indiana. George Frost later wrote a nice summary of the area in the *Human Engineering Guide To Equipment Design*."**

**— Melvin Warrick, Associate Director  
Human Engineering Division**

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#### AN EARLY AIRCRAFT SIMULATOR

**John F. Gardner** serving as experimenter and **Walter F. Grether** serving as the subject in an aircraft simulator. Five different instruments are being compared for accuracy and reading speed. WADC-TR-54-236 (1954)

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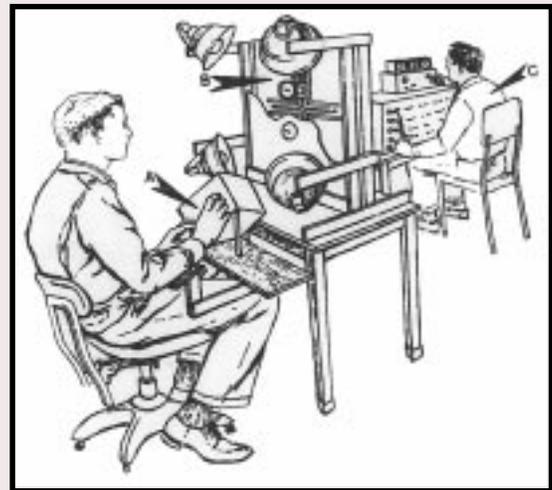
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#### **EFFECT OF DIAL SPACING IN PURSUIT TRACKING**

**Testing eye-hand coordination in a dual pursuit task in a study of the effects of arrangement of instrument pointers and the distance between them. The three experiments described in this report were conducted by Paul M. Fitts and Charles W. Simon. AF Technical Report No. 5832 (ATI No. 147788) (1952)**

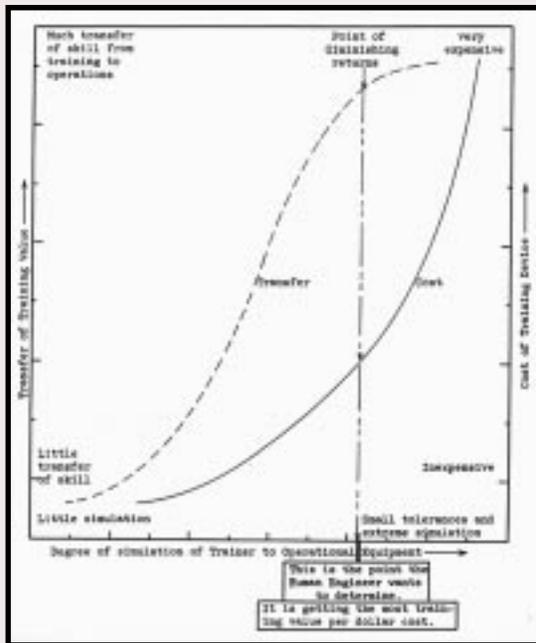
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Thus it came about that in late August of 1945 a group of us assembled at the Aero Medical Laboratory and set about the task of planning a new research program in Human Engineering. It was characteristic of Paul that he had things well thought out in advance. He had studied the statistics on aircraft accidents, bombing errors, and other evidence of human failures attributed to poor design. He was familiar with the wartime work of a few psychologists in this country and in Great Britain dealing with equipment design problems. He had thought of approaches, such as field studies, to obtain a better understanding of research needs. He had also thought of many experiments that were just waiting to be done.

— Walter F. Grether, Chief  
Psychology Branch, 1949-1956

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### ENGINEERING SIMULATION AND TRAINING EQUIPMENT DESIGN

A graph of the relationship between degree of engineering simulation, cost, and value of transfer of training in training equipment design. This graph is from a handbook on training and training equipment design compiled by Robert B. Miller. WADC-TR-53-136 (1953)

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**Walter F. Grether, PhD**  
**Chief, Psychology Branch**  
**1949 to 1956**

In July 1945, Dr. Walter F. Grether, Major, US Army Air Force, joined Dr. Paul Fitts in establishing the Psychology Branch, Aero Medical Laboratory, Wright Field, Ohio.

Grether and Fitts attracted such greats from the US Army Air Force's Aviation Psychology Program as Judson Brown, Launor Carter, John Cowles, Glen Finch, and Albert Johnson (and briefly, Robert Gagne and Wilse Webb). Grether stayed with the branch and replaced Fitts as the branch chief in 1949, a position he held until 1956, when he became the civilian director of the Aero Medical Laboratory's newly formed Behavioral Sciences Division. This division encompassed both the Engineering Psychology Branch under Julien Christensen and the Training Research Branch under Gordon Eckstrand.

During his 11 years there, the Psychology Branch engaged in a broad range of pioneering research, including fatigue effects during long duration flights, pilot error caused by non-standard control and display arrangement and shape, poorly designed altitude displays, and feasibility of seating pilots in the prone position. Grether also performed original research, such as his study of human errors occurring as a result of reading the standard three-point altimeter. The study provided a solid basis for his conclusion that errors could be greatly reduced by adopting a single pointer display. This type of display is now standard in most aircraft.

Grether retired from civil service in 1975 and the USAF Reserves as a colonel in 1976.

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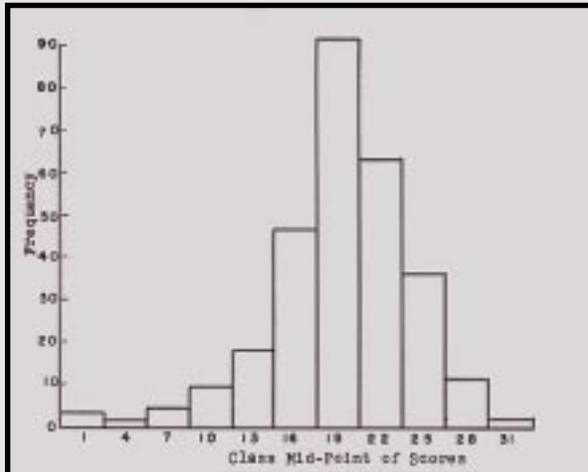
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### ASSOCIATING CLOUD TYPES WITH FLYING HAZARDS

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**29 May 1945...directive to the Commanding General, Air Technical Service Command, Wright Field, Dayton, Ohio . . . stating: "It is desired that facilities be established for conducting scientific psychological research on problems of aviation equipment. Because of the intimate relationship between psychological, medical, physiological and biophysical research problems, it is believed that this psychological research project should be established as a branch of the Aero Medical Laboratory."**

— Air Staff Directive

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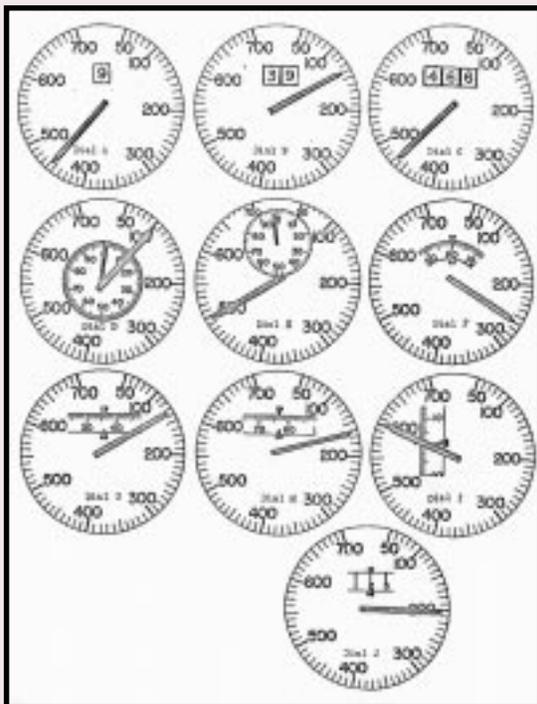
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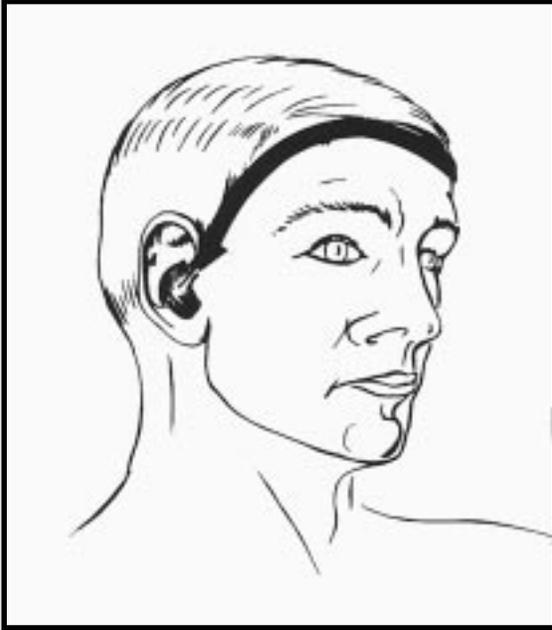
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#### DESIGNING AIRSPEED INDICATORS FOR READING SPEED AND ACCURACY

Airspeed indicators used in a study comparing reading speed and accuracy to determine the best design for these instruments. The work was done by Maj George E. Long. USAF Technical Report No. 5836 (1949)



#### HEAD DIMENSIONS FROM NOMOGRAMS

The bitrignon-crinon arc head dimension was one of 12 head size measures in a study that provided two nomograms for determining the most accurate estimate of each of the dimensions based on known values of head length, breadth and circumference. Study completed by Edmund Churchill of Antioch College and Gilbert S. Daniels. WADC-TR-53-14 (1953)

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Although engineering psychology had its birth during World War II, the level of research effort in the United States was on a modest scale until after the end of the hostilities in August 1945. This low level of effort was apparently deliberate, because it was recognized that only during a prolonged conflict could the benefits of such research be realized. Obviously, the time lag between initiation of engineering psychology research and the design, manufacture, and deployment of new or redesigned equipment is relatively long, often five years or more. Thus, during wartime, it was more profitable for psychologists to concentrate on other types of research, such as selection and training, with faster payoff.

— W.F. Grether, 1968, "Engineering Psychology in the United States," *American Psychologist*

Paul most certainly was among those engineers and scientists who served to give initial impetus and direction to an infant, interdisciplinary "human factors" area of endeavor. But without the wisdom, diligence, and dedication supplied by Dr. Fitts, human factors might not have survived its infant years.

— G.F. Rabidean, Editor, June 1965, "Paul M. Fitts Memorial Issue," *Human Factors Society Bulletin*

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"I was discharged from the US Army Air Force here at Wright-Patterson in March 1946. I had been working with the Aviation Psychology program while in the military. When I came on board Walt Grether was the Psychology Branch Chief and Julien Christensen was there, still in uniform. The actual staff at that time was just a handful of people. I had not known Paul Fitts, strangely enough, but he had been in Washington and, of course, knew about me. Chris and I had worked for the so-called "Trade Test" division—which was part of the Adjutant General's Office—on the problem of selecting aircrew and ground crew personnel. Chris was assigned here in uniform, and I had originally come here just to be discharged. But because the branch was here, and the work appealed to me, I stayed.

\*\*\*

"My first project was the population stereotype for stimulus-response compatibility studies. Later, other people named parts of the results "Warrick's Law." I did the basic research then and Chris worked on applied problems."

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"One of the more memorable people I worked with was Bill Biel. He came here after the war as my boss. He was most inspirational, protective, and friendly; the friendship continues to this day."

— Melvin Warrick, Associate Director  
Human Engineering Division

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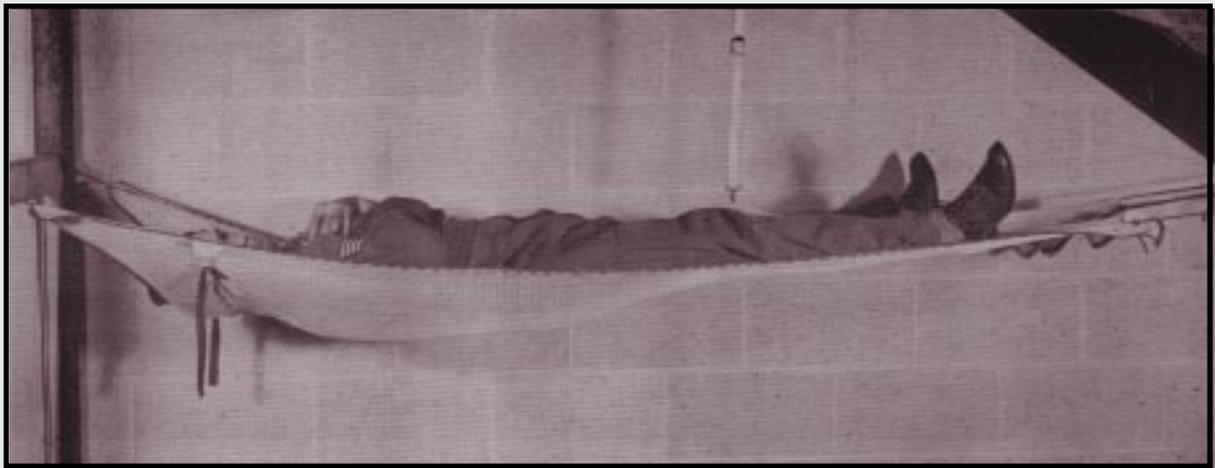
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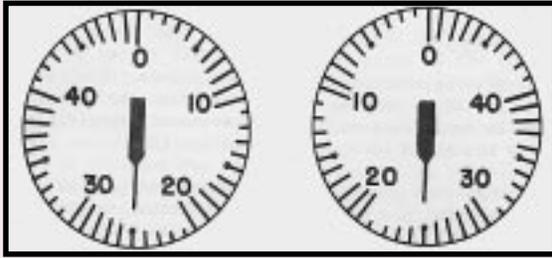
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#### DESIGNING A HAMMOCK FOR BOMBER CREWS

A hammock for the B-36 aircraft designed with anthropometric data for Air Force crew members. The report contains detailed instructions for placing and installing the hammock. The work was done by H.T.E. Hertzberg and Gilbert S. Daniels. Memorandum report MCREXD-720-143 (ATI 122 733)(1949)



#### DIAL READING ACCURACY

Examples of staircase instrument scales used in a study of their effects on dial reading accuracy. The investigation was done because pilots were making dial reading reversal errors in reading a navigation plotter. The work was done by Julien M. Christensen. Memorandum report MCREXD-694-1-P (1948)

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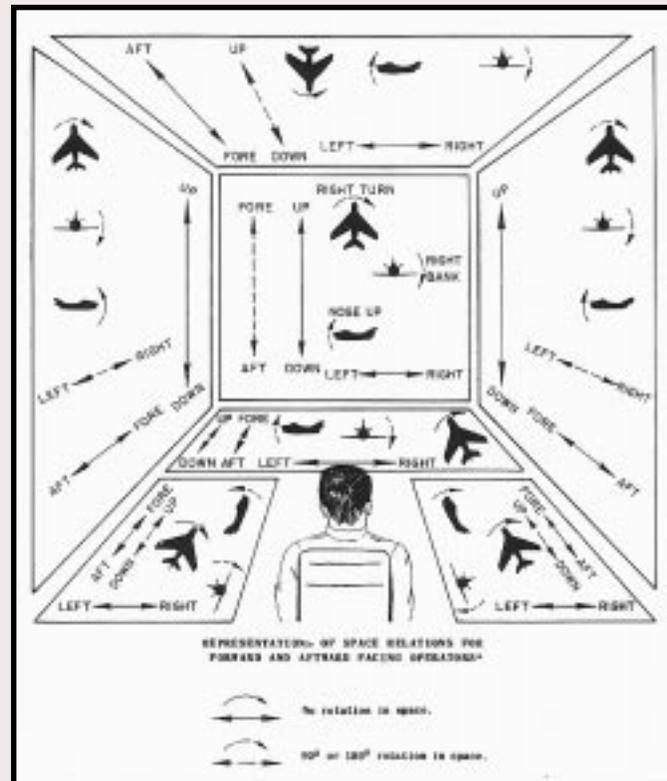
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**“Many of Lt Col Fitts’ early experiments dealt with the design of air crew stations...The controls and displays in WWII airplanes were similar in shape, design, and location. If a flight member mistakenly grabbed the wrong control, an aircraft accident or bombing error could result.”**

— C. Bates, May 1985  
*“Human Engineering, Yesterday and Today,”* *Civilian Employees Reporter*

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### VISUAL PRESENTATION OF INFORMATION

Instrument panel layout representations for forward- and rearward-facing operators from a report on the visual presentation of information prepared under Research and Development Project Number 7180, Human Engineering Applications to Equipment Design. The authors were Charles A. Baker and Walter F. Grether. WADC-TR-54-160 (1954)

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**I have never known any professional and fully scientific psychologist who excelled Fitts in his ability to explain the contributions of human engineering to modern military and space problems.**

— Leonard Carmichael, Vice President for Research and Exploration, National Geographic Society, June 1965, "Paul M. Fitts Memorial Issue," *Human Factors Society Bulletin*

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## Preparing Man for Space Exploration

*1955-1964*

Sputnik will become a household word, and a daring young president challenges his nation to put a man on the moon and return him safely in the ensuing decade. The challenges are immense. Lt Col Fitts has left his indelible stamp of excellence on the Psychology Branch and moved on. The Grether years further fanned the flames of scientific excellence. The future of the Human Engineering Division is now turned over to Dr. Julien Christensen, ably assisted by Dr. Melvin Warrick.



## Situational Awareness



1955-1964

Combat Performance

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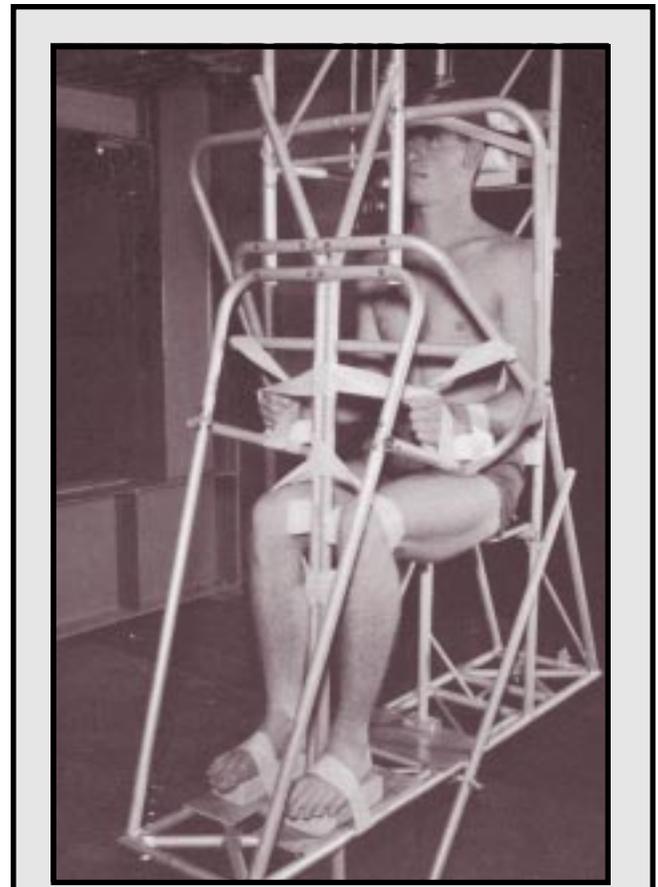
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#### **DETERMINING THE CENTER OF GRAVITY OF AN AIR CREWMAN**

One of 118 subjects restrained in a pendulum apparatus to determine the center of gravity and moment of inertia of a sample of U.S. Air Force air crewmen. Subjects were selected to be representative in stature and weight of the Air Force population. The work was done under Task 718408, "Anthropology for Design" by J. DuBois, W.R. Santschi, D.M. Walton, C.O. Scott, and F.W. Mazy of North American Aviation, Inc. AMRL-TR-64-110 (1964)

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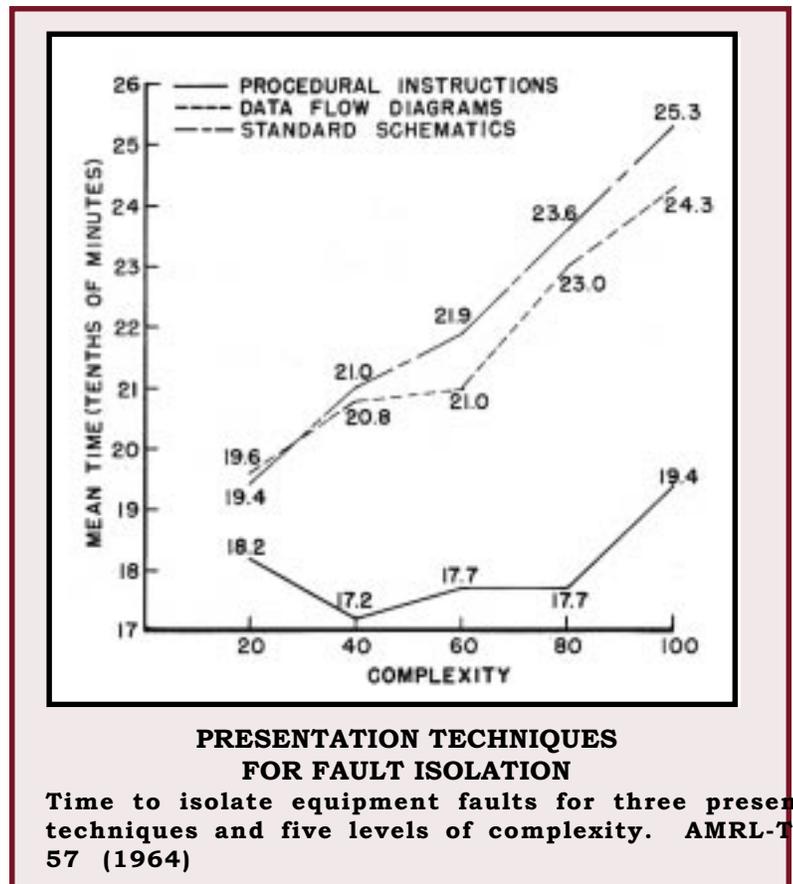
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**"I was lucky enough to be on the selection committee for the original seven Project Mercury astronauts. I had done the anthropometry on all of the candidates, as well as stereo photographs. The photos were to be used to provide accurate body shape information, which would then enable us to make customized pressure suits . . . It was an interesting time in the lab for a few weeks, having all the astronaut candidates around taking tests, meeting, and discussing the results. All the candidates were very impressive, but John Glenn was in the 99th percentile on everything. He was amazing."**

**— Charles Clauser, Anthropologist  
Human Engineering Division**

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**By the 1950s, progress had been made at the lab that expanded work to include space research. Human engineering scientists studied the effects of weightlessness as well as the psychological problems peculiar to the spacecraft. They developed techniques to protect and enhance man's performance on supersonic rocket flights in new, high-altitude environments. Astronauts practiced working with new space tools during weightlessness missions while wearing bulky space suits and 160-pound backpacks which propelled them through space. They also learned how to assemble a space station and how to repair and retrieve satellites while in orbit.**

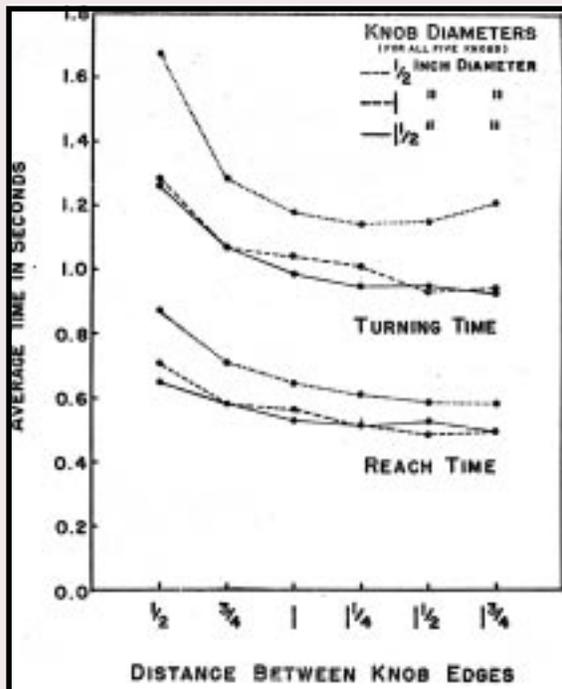
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**"I was in the original Applications Branch, along with Charlie Bates, Dave Greek, and Austin Kibler. We were involved with the preparation of MIL-H-26-207, which was the first human factors data for guided missile systems. We drafted and finally got acceptance from the Air Force for that first human factors specification. The new spec could then be incorporated in the system development programs, which legitimized a lot of the human factors people who were in the aerospace industry at that time. It forced management to have human factors people in the loop in the design approval process. Human factors personnel had sign-off responsibility on all top-line drawings during the design process. This was a real "first;" it had considerable impact on the field."**

**— Donald Topmiller, Chief  
Systems Research Branch  
Human Engineering Division**

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#### EFFECTS ON PERFORMANCE OF KNOB SIZE AND SPACING

Turning and reach times for knobs of different sizes as functions of distance between knob edges. From a study of minimum allowable knob crowding carried out by James Bradley and Norman E. Stump under Research and Development Task No. 71514 on control design and arrangement. WADC-TR-55-455 (1955)

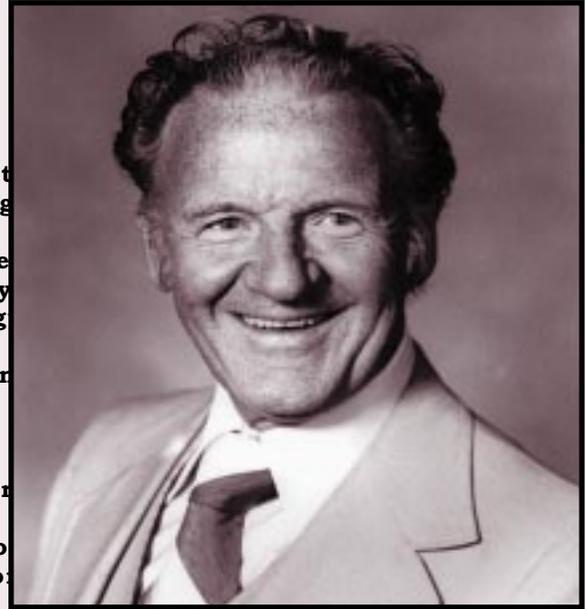
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**Julien M. Christensen, PhD**  
**Chief, Human Engineering Division**

**1956 to 1974**

Julien M. Christensen was assigned as a first lieutenant, US Army Air Force, to the Psychology Branch, Aero Medical Laboratory in October 1945. When he separated from military service as a captain in 1946, he was hired immediately by Lt Col (Dr.) Paul Fitts, Chief of the Psychology Branch. Prior to that time, Chris had been a personnel technician in the Trade Test Division of the US Army's Adjutant General's Office (1941) and in the US Army Air Force's Aviation Psychology program conducting research on navigator selection. He went through Navigator Cadet training and later radar/bombardier training and was assigned to the Army's Aviation Psychology program doing research on navigator training.



He became Chief of the (renamed) Human Engineering Division in 1956, a position he held until retirement from civil service in 1974. Chris supervised an interdisciplinary team of over 60 engineers, scientists, and technicians programs for the United States Air Force. These programs included visual perception, displays, controls, control dynamics, environmental factors, performance modeling, maintainability, human reliability, information processing, decision making, safety, and physical anthropology. He was particularly honored by being elected to the International Explorers and Pole Vaulters Club, being the first civilian scientist to fly with the Air Force over the North Pole (1957). He chaired the Human Performance Advisory Committee, Manned Orbiting Laboratory, and contributed heavily to various bioastronautical and other long-term programs. He was twice President of the international Human Factors and Ergonomics Society (1964-65 and 1986-87) and was awarded an honorary Doctor of Science degree (1989) by the University of Dayton. Subsequent to his retirement from civil service, he became Chairman (1974-1978) of the Department of Industrial Engineering, Wayne State University. Following that, he became Chief Scientist, General Physics Corporation from 1980 to 1984 and later a consultant and Senior Human Factors Scientist at Universal Energy Systems in Dayton, Ohio.

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**A SUBJECT USING BIMODAL CONTROLS TO OBTAIN DATA FOR DESIGN CRITERIA**

A subject being tested on simultaneous activation of bimodal controls in a study done under Project 7184, "Human Performance in Advanced Systems," Task 718404, Advanced Systems Human Engineering Design Criteria. The work was performed by Melvin J. Warrick and Lester Turner. AMRL TDR-63-6 (1963)

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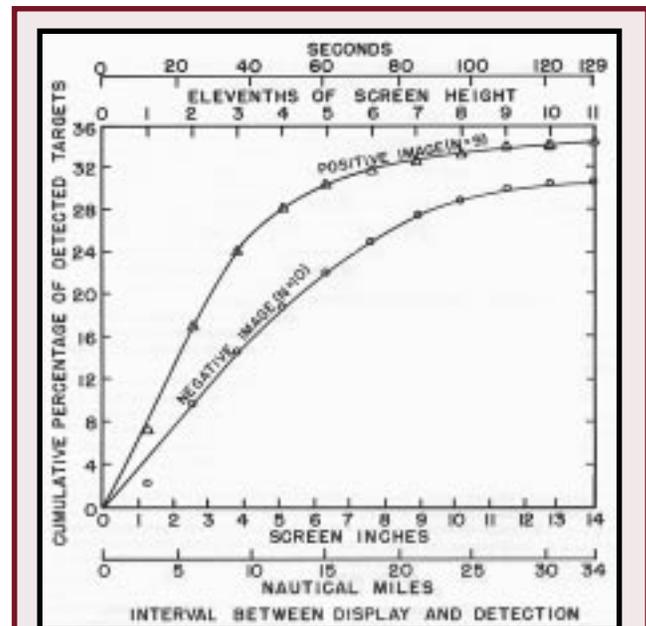
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#### TARGET DETECTION AS A FUNCTION OF IMAGE POLARITY

Data comparing detection of targets with positive and negative image polarity on a side-looking radar display. The work was performed jointly under Program 665A, "Precision Strike," and Task 718404, "Advanced Systems Human Engineering Design Criteria." The work was performed by Barbara A. Van Ausdall and Dr. Herschel C. Self. AMRL-TR-64-82 (1964)

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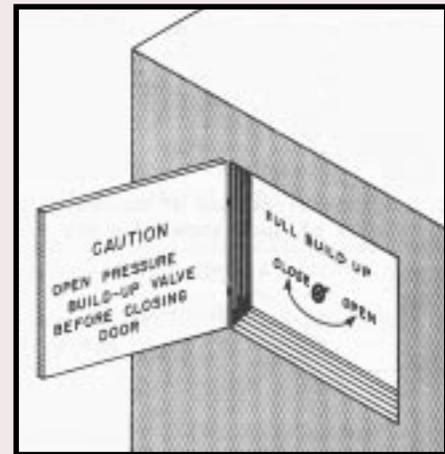
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#### DESIGNING FOR MAINTAINABILITY

An example of labeling instructions for hazardous tasks; taken from a guide for designing mechanical equipment for maintainability. This work examined design factors for accesses, connectors, fasteners, labels, instructions, etc. and made recommendations for maintenance of support equipment. The work was done under Task 71586, "Design for Maintainability," by James W. Altman, Angeline C. Marchese, and Barbara W. Marchiando of the American Institute for Research. ASD TR-61-381 (AD 269 332)(1961)

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**TESTING AN EARLY MODEL OF AN  
EXTRA-VEHICULAR PROPULSION UNIT**

Sgt Bill Sears in a C-131B aircraft wearing a jet-propelled, manual-control extra-vehicular propulsion unit called a locomotion belt while assessing a human's ability to rotate his body in a zero-gravity environment. After considerable experimentation and design effort, these propulsion units were developed into the equipment used by the American astronauts for extra-vehicular excursions. The aircraft was flying in a parabolic flight path or orbit to produce the free-fall condition of zero gravity such as occurs in an earth-orbiting space vehicle. This picture was taken during an experiment in 1961.

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#### DISPLAYS AND CONTROLS FOR MANNED SPACE FLIGHT

Cockpit mockup used in a study of display and control requirements for manned space flight. This work was done under Project No. 7184, "Human Performance in Advanced Systems," and Project No. 7185, "Design Criteria for Crew Stations in Advanced Systems." The work was done by Charles O. Hopkins, Donald K. Bauerschmidt and M.J. Anderson of the Hughes Aircraft Company. WADD-TR-60-197 (1960)

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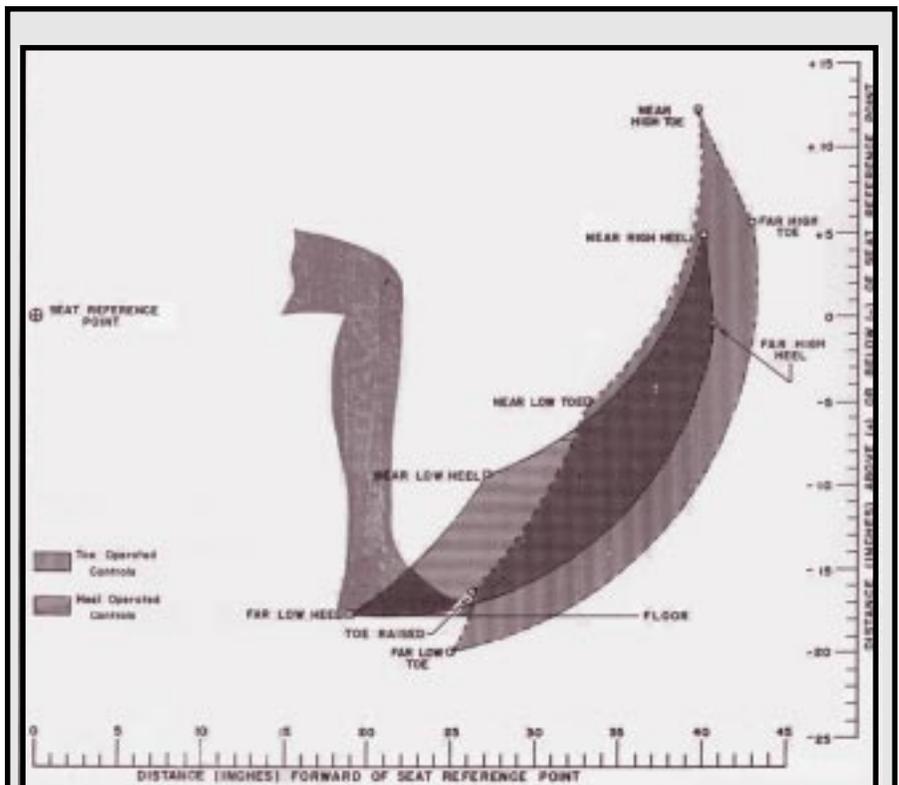
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#### ANTHROPOMETRY OF WORKPLACE LAYOUT

A chart for foot-pedal activation by a seated operator. The chart is from a compilation of human engineering recommendations on various aspects of the layout of workplaces including general considerations, workplace dimensions, location of controls and displays, and direction of motion relationships. This report was prepared under Research and Development Project 7180, "Human Engineering Applications to Equipment Design" by Jerome H. Ely, Robert M. Thomson, and Jesse Orlansky. WADC-TR-56-171 (1956)

## The Human Has Limitations

Engineering psychology began with the intellectual discovery that the human was not a perfectly adaptable organism. Of course, no one had ever formally asserted that the man was perfectly adaptable, but up until a few years ago the applied psychologist acted as if the human's flexibility were sufficient to make possible all important adjustments between man and his environment. We now know that this is not so. All of us are aware of how, during World War II, the approach of designing the task to fit the operator was added to the more traditional psychological procedures of selecting and training operators to fit their jobs. This was necessitated by the variety and complexity of military equipment. Machinery had finally outrun the man's ability to adapt. And the recognition of this fact was the first important insight in the development of engineering psychology.

— Franklin V. Taylor, 1960, "Four Basic Ideas in Engineering Psychology," *The American Psychologist*

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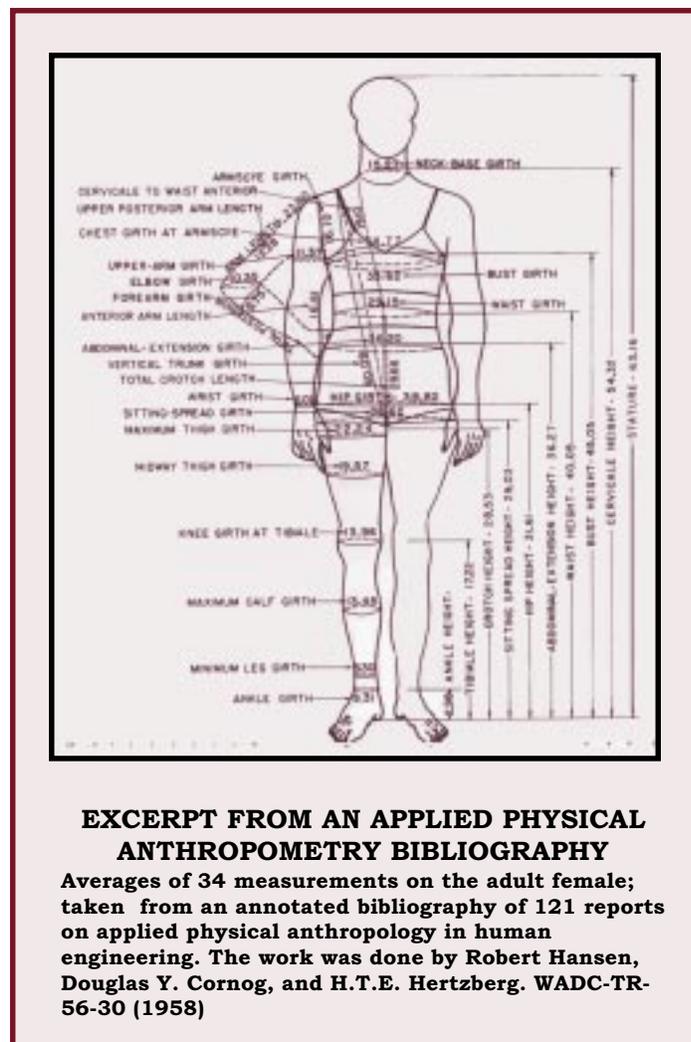
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#### VISUAL TRAINING PROCEDURES

Julien M. Christensen testing a subject with a tachistoscope which presented brief exposures of a display in an examination of visual training procedures to expand the visual field of trainees. WADC-TR-54-239

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**Most of the efforts of the Behavioral Sciences Laboratory are classified as applied research, i.e., research directed toward the solution of problems anticipated in future Air Force systems. Unless the research is aimed from 3 to 10 years into the future, it is likely to be too late by the time research is completed. Although identified as applied research, much of our research is planned so that it has general scientific value beyond the application to a particular Air Force problem.**

— March 1965, "Human Engineering and Training Research Division,"  
*Behavioral Sciences Laboratory*

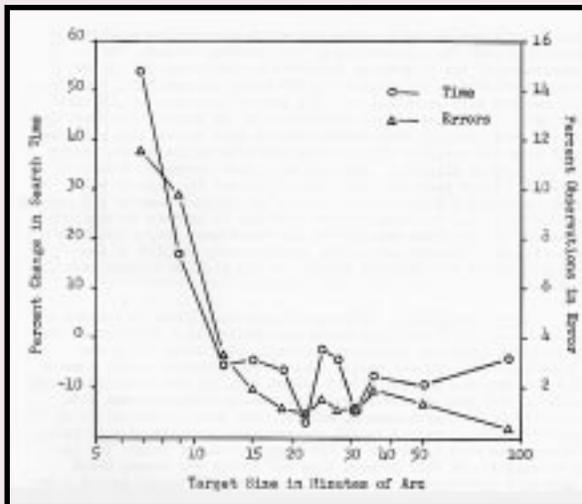
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**As a student of Professor Fitts, I well remember his emphasis on rigor in research, on exhaustive inquiry, on plain hard work, his impatience with those who did not share his regard for these qualities, and his complete willingness to give unstintingly and unreservedly of his own ideas, assistance and time to any student who did. He was a firm but gentle and inspiring adviser.**

— Julien Christensen, June 1965,  
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#### TARGET DETECTION AS A FUNCTION OF TARGET ANGULAR SIZE

A graph of search time and errors as functions of angular target size in minutes of arc. This work was done under Task 71580, "Criteria for the Design and Arrangement of Displays," by William C. Steedman and Charles A. Baker. WADD-TR-60-93 (1960)

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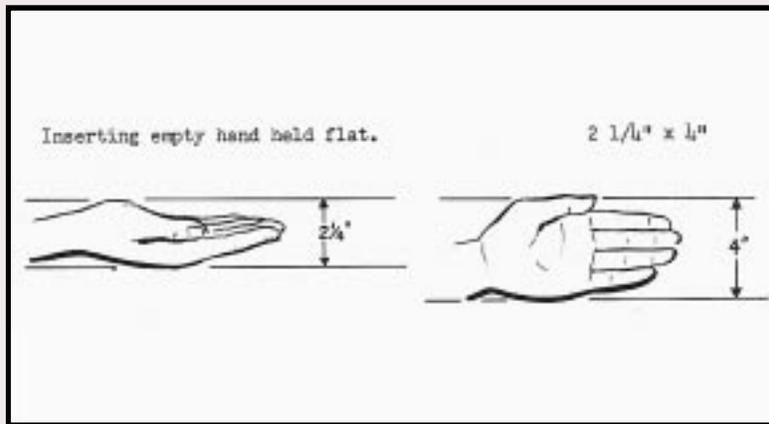
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**EXCERPT FROM A GUIDE FOR DESIGN AND MAINTAINABILITY**  
**Required size of an access opening for one-hand tasks from a design guide for maintainability containing recommendations on design practices for maximizing the ease with which electronic equipment can be maintained.**  
 The work was done by John D. Folley, Jr. and James W. Altman of the American Institute for Research. WADC-TR-56-218 (1956)

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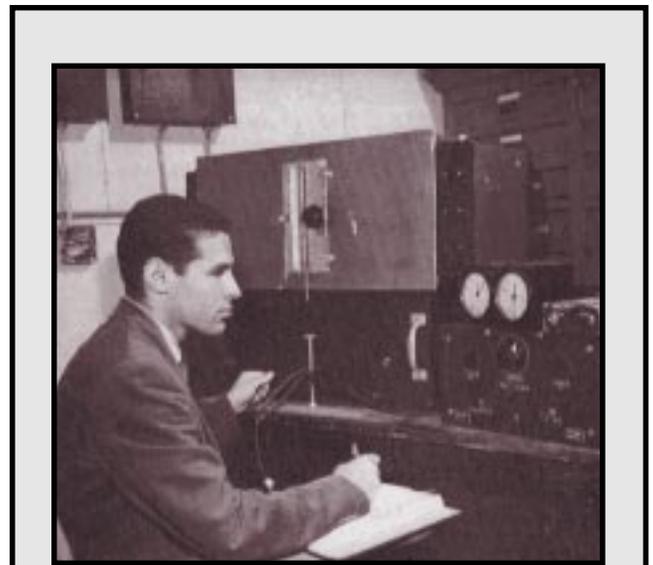
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#### SELECTING INSTRUMENT SCALES FOR READING EFFICIENCY

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### SUBJECTS IN ZERO GRAVITY IN AN AIRCRAFT

Test subjects floating in zero gravity in an aircraft in a flight path that produces zero gravity. These flights were designed to test the effects of weightlessness on the crew members of future vehicles in orbit around the earth. These tests, conducted by the Human Engineering Branch, were later continued and extended by NASA.



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#### KNEE BENDS IN A PARTIAL PRESSURE SUIT

A subject performing deep knee bends in a full-pressure suit in a study to obtain data for designing pressure suits that could provide natural mobility and minimal ballooning. The work was done under Task 718408, "Anthropology for Design" by Author S. Iberall of the Rand Development Corporation. AMRL-TR-64-118 (1964)

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**“The most important and satisfying work I was involved with was the development and implementation of the Human Engineering System Simulator. It was based on an IBM 360-40 and was the first system that allowed us to do multi-operator simulation research. At that time we had a requirement to do command and control studies involving systems like the AWACS. The facility was constantly threatened by the base Computer Center, who felt that a laboratory should not have such a large computer facility. I spent a lot of time convincing them that it was a research facility rather than a data processing facility. There was no other facility like it at that time. We did a lot of good research during those years.”**

— Don Topmiller, Chief  
Systems Engineering Branch  
Human Engineering Division

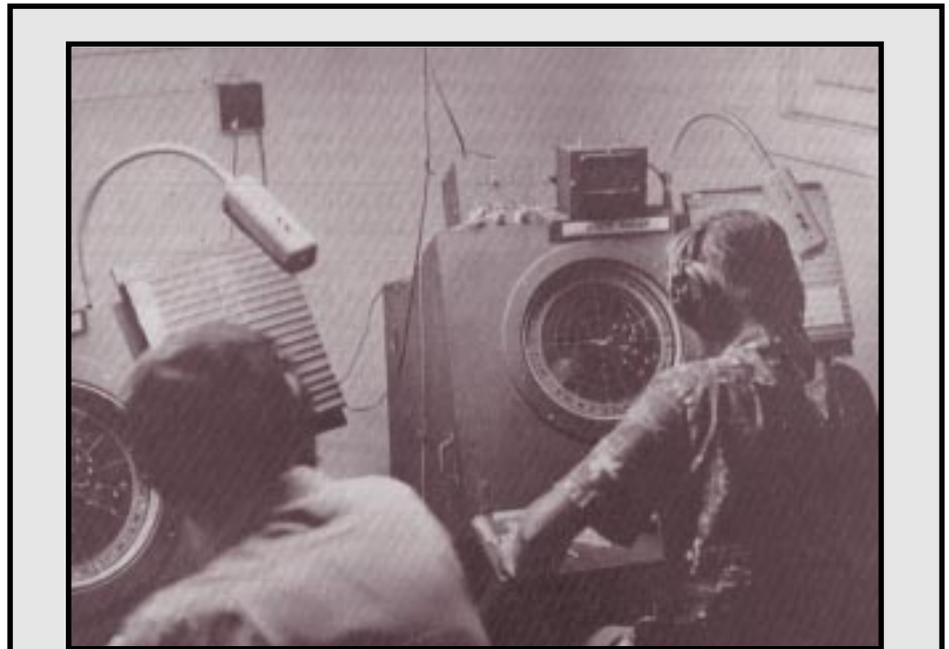
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**“I got interested in the study of models used to estimate the total body moments of inertia and body part moments of inertia. We did not have computer models back then. I developed a wooden model that represented—at least mathematically—those parameters. That led to further development in the area of mass distribution characteristics of the human body. This information was important for predicting how the body would respond when in motion, or to changes in motion. NASA, of course, had a tremendous interest in this, so they funded a project I had proposed to expand and improve the data. We collected the measurements from cadavers, using the facilities at FAA Civil Aeromedical Institute in Oklahoma City—probably the best anatomy lab outside of the universities. Measurements of volume, mass, and center of mass for various body parts were collected. We then prepared regression equations from the data. A lot of those equations are still being used today.”**

— Charles Clauser, Anthropologist  
Human Engineering Division

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#### **BROAD-BAND BLUE LIGHTING FOR CONTROL ROOMS**

**Evaluating a broad-band blue lighting system for radar approach control centers (RAPCON) to assist in developing such a system as part of the research on human engineering problems of air traffic control. This work was carried out by Conrad L. Kraft of The Ohio State University. WADC-TR-56-71 (1956)**

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**Colonel John C. Simons**  
*Researcher*  
*Human Engineering Division*

**1956 to 1966**  
**1968 to 1971**

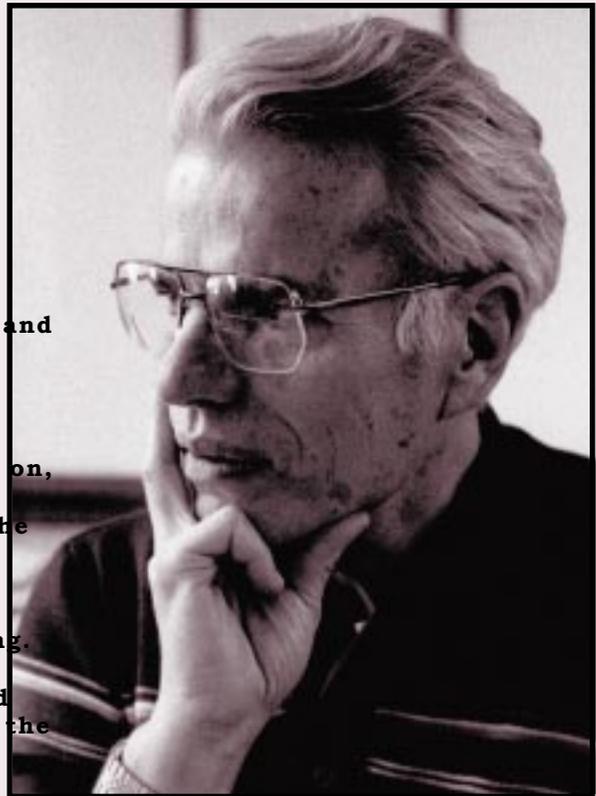
John Simons was one of the most prolific and creative minds ever assigned to the Human Engineering Division of the Aero Medical Laboratory (now Armstrong Laboratory).

His contributions span four decades as a soldier, scientist, engineer and leader. Early on, Capt Simons was an important contributor to the Aero Medical Laboratory's partial role in the Mercury Space Program. He was one of the principals responsible for development of the parabolic flight trajectory used to simulate "zero-G" for engineering and astronaut training. Zero-G testing included such things as hydraulics, space locomotion, and human and animal physiological response. Variations of the parabolic flight profile are still used today by NASA in their C-135 zero-G aircraft.

Another notable achievement by Capt Simons was the development of the Long Lines personnel extraction system. It had long been understood that an aircraft flying a coordinated "pylon" turn could lower a cable which at the pylon turn point would hang stationary. This quirk of physics was exploited to recover personnel from behind enemy lines. The Long Lines system was tested with both mannequins and human volunteers and was operationally deployed. Although later supplanted by the Fulton extraction system, the Long Lines system pioneered the concept of rescue by fixed-wing aircraft.

As a major, Simons flew combat in his third war, Vietnam, with the famous 1st Air Commando Unit. Wounded in combat, he convinced the doctors to let him convalesce in Dayton. His first day back in the country, he appeared on crutches in the laboratory and eagerly passed his new combat experience to fellow scientists and engineers.

The most important idea to emerge was the lateral firing gun. Again employing the pylon turn, lateral firing ordnance could be aimed with extraordinary accuracy. Upon his reassignment to the laboratory as a branch chief, Simons doggedly pursued the idea and eventually wangled a briefing to the Chief of Staff, then



General Curtis LeMay. Gen LeMay was convinced and ordered that the prototype for what would become the AC-47 be built and tested at the Eglin AFB range. The tests were so successful that the aircraft was flown directly to Vietnam and immediately deployed in combat. John Simons is credited as co-inventor of the "gunship" which has served so successfully in Vietnam, Grenada, Panama, Iraq and Somalia.

John Simons continued to make creative contributions to the Human Engineering Division as a contractor after his retirement. His last contribution, one of the original 1968 combat-born ideas, was the Sensor Platform Imagery (SPI). SPI is a real-time reconnaissance drone which allows strike air crews to review the target minutes before they attack. His laboratory simulation completed in 1993 confirmed the effectiveness of SPI more than 20 years after the original Simons idea.

The creative genius of John Simons is a tribute to the soldier-scientist. The unique combination of master's degree, flying knowledge, combat experience, and a dedicated Air Force laboratory environment turned his creativity into exceptional productivity.

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**TESTING FINGER DEXTERITY  
WHILE WEARING A PRESSURE SUIT**

A pressure-suited subject being tested with the Purdue Pegboard Dexterity Test for finger dexterity in a study to establish an objective baseline for evaluating the functional mobility of pressure gloves. This study was done under Task 718408, *Anthropometry for Design* by Dieter E. Walk. AMRL-TR-64-41 (1964)

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#### ASTRONAUTS, AIRCREW MEMBERS, AND EXPERIMENTERS

Participation in zero gravity flights conducted to determine effects on humans and their performance in space.

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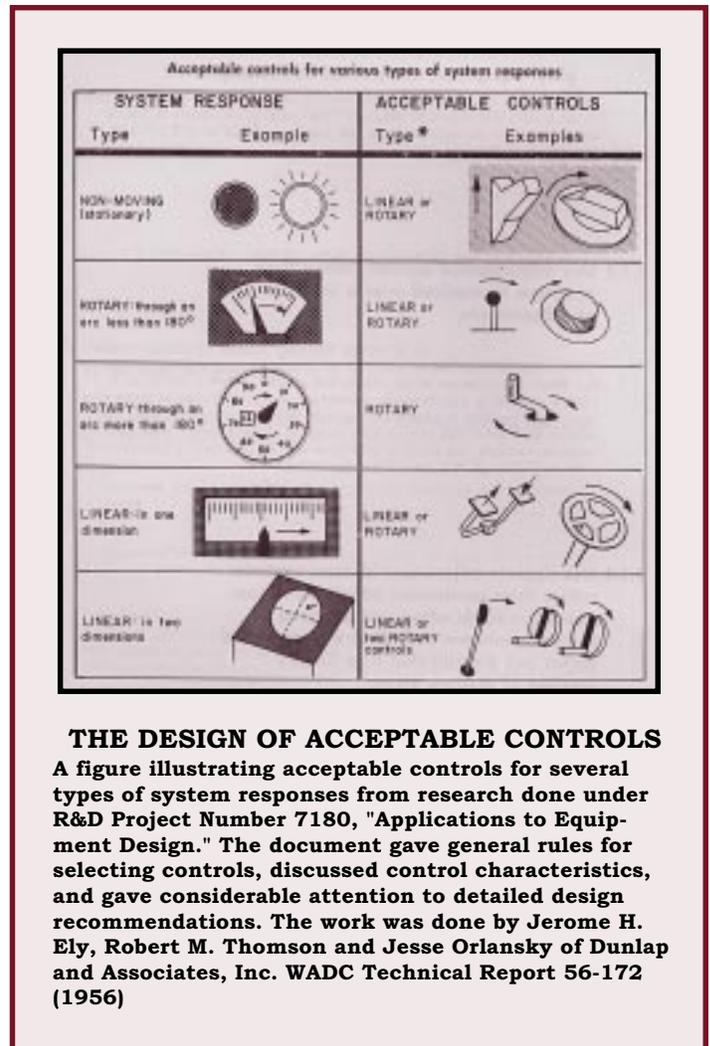
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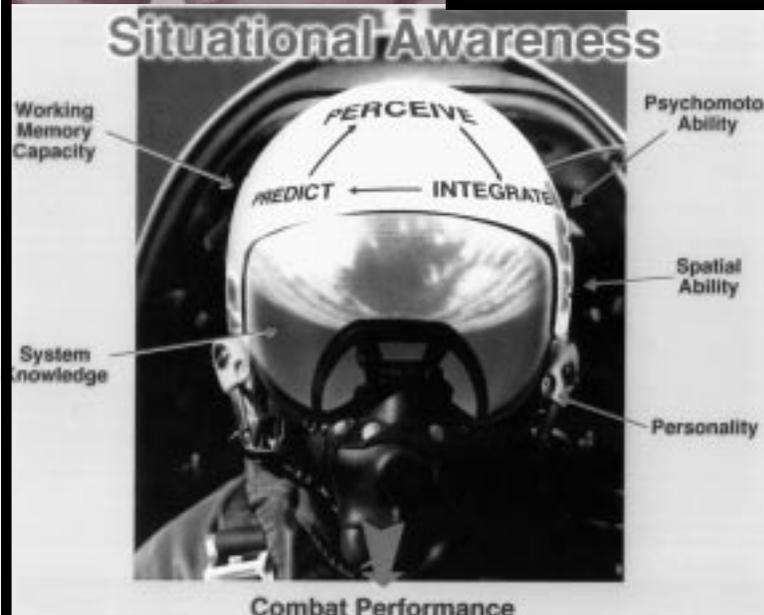
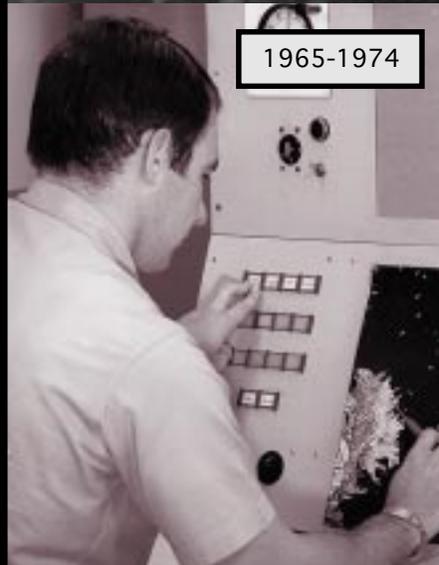
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## The Vietnam War Years

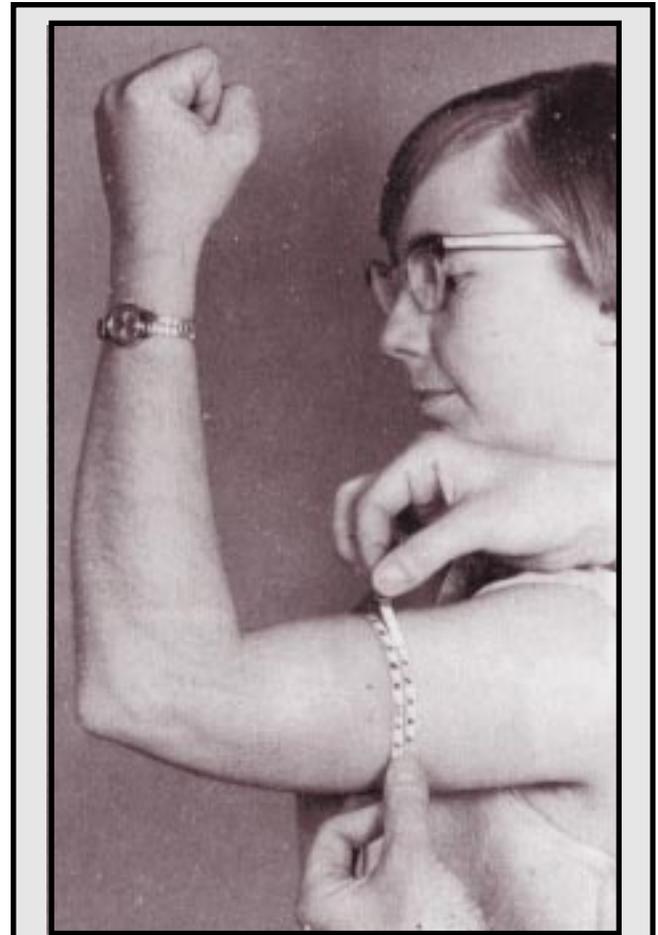
1965-1974

A seemingly small war in a far-off land will teach the nation painful lessons about fighting limited wars with limited military objectives and limited success. As in all wartime eras, pressure on the military and its laboratories to expedite better weapons to the battlefield is intense. A famous laterally firing gun-ship concept is co-founded in the Human Engineering Division and used effectively in Vietnam. The strong scientific and technical leadership of Drs. Christensen and Warrick continues.



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#### **DESIGN DATA FOR FEMALE CLOTHING**

Measuring the biceps of the flexed left arm of a female Air Force member during data collection for an anthropometric survey. The data were used in the design, sizing, and procurement of clothing and the intelligent design of equipment and layout of functional workspaces for women in the military. This work was done by Charles E. Clauser and Lt Col Pearl E. Tucker of AMRL and John T. McConville, E. Churchill, Lloyd L. Laubach and J.A. Reardon of Webb Associates, Inc. AMRL-TR-70-5 (1972).

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— May 1985, "Human Engineering, Yesterday and Today," *Civilian Employees Reporter*

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**VILLAGE USED IN AN AIRBORNE STUDY OF THE EFFECT OF OBSERVER FIELD OF VIEW**

A simulated Viet Cong village used in an airborne study of visual reconnaissance with two fields of view. This study was in support of Advanced Development Program 665A, "Reconnaissance Strike," and Task 718404, "Advanced Systems Human Engineering Design Criteria." The work was done by Charles Bates, Jr., Steve A. Heckart, Herschel C. Self, D.F. McKechnie, and E.P. Hanavan. AMRL-TR-68-43 (1968)



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#### **MEASURING ARM REACH CAPABILITY**

**A subject in a test apparatus for measuring the arm reach capability of lightly clothed and pressure-suited air crewmen. The data attained were used for the placement of aircraft controls. The work was done under Workunit 71840808, "Layout of Workplaces" by John W. Garrett, Milton Alexander, and Chester W. Matthews. AMRL-TR-70-33 (1970)**

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**TESTING DETECTION OF  
BRIEFED TARGETS AS A  
FUNCTION OF AIRCRAFT SPEED**

Example of some of the side-looking radar imagery used in a study on the effects of prior target briefing on identifying targets on a display from aircraft moving with different simulated velocities. The work was performed jointly under Program 665A, "Reconnaissance/Strike Systems," and Task 718404, "Advanced Systems Human Engineering Design Criteria" by Don F. McKechnie. AMRL-TR-66-149 (1967)

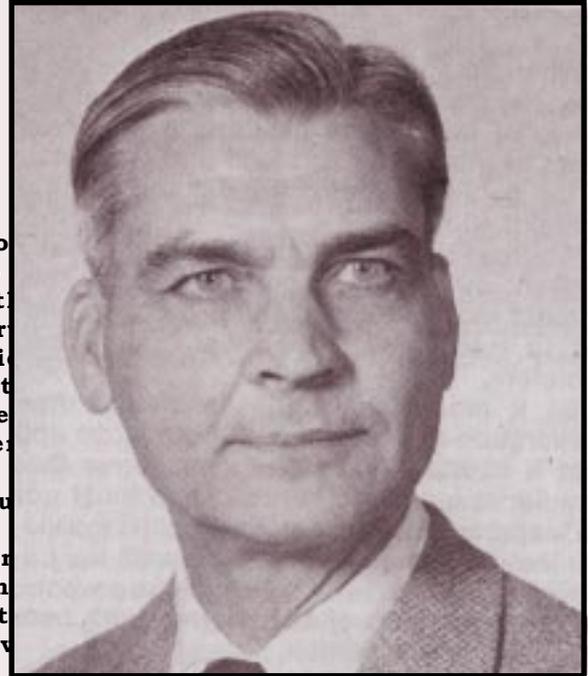


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**H.T.E. Hertzberg**  
**Chief**  
**Anthropometry Section and Branch**

**1961 to 1972**

H. T. E. Hertzberg was assigned to the Aero Medical Laboratory in 1946 and later moved to Human Engineering Division in 1961. He was the prime impetus for stimulating the military service to acknowledge the important need for defining the human body size (anthropometric) variability of our military populations. His influence spanned the globe. The research facility, the Universite Re Descartes in Paris, named its anthropometry laboratory in his honor. His anthropometric survey of 4000 flying personnel in 1950 became the "standard" for large-scale surveying, not only in the United States but internationally as well. Perhaps his greatest contribution was the anthropometric survey of NATO countries in 1960-61. This survey required incredible planning, organizing, and coordinating. Subjects were measured in three countries by a team with representatives from two services and three universities. The team, led by Mr. Hertzberg in the lead, was in the field collecting data for a year.



As chief of the Anthropometry Section and then the Anthropometry Branch, he led his team in some of the most forward looking research of his time, including the first investigations of stereophotography as an anthropometric tool, the first developments of form-fitting liners for helmets, and the classic studies of dynamics and kinematics used in human body modeling. His work improved the fit, safety, and performance of all types of equipment systems including aircraft seats, oxygen masks, flight/space suits, high-altitude gloves, and automobiles. Many technological changes occurring since the Hertzberg era had their beginnings in his original research.

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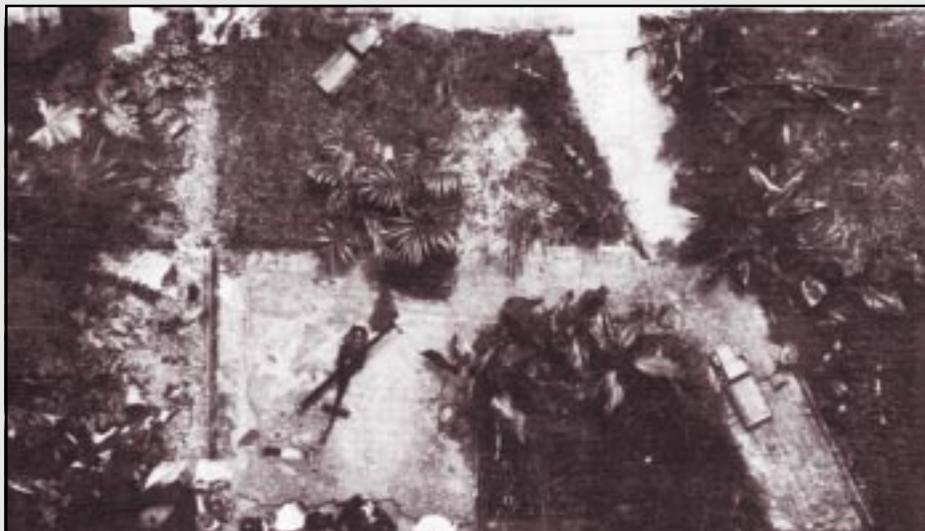
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**"I got my start in the applications area of human engineering. It always impressed me that there were these guys out in the field using poorly-designed equipment—from a human engineering point of view. I felt our mission was to do something about this situation; I always thought we should have equipment designed so that at least its basic operation would be intuitively obvious . . . The one effort that I got great satisfaction out of — and that had the most benefit to the taxpayer and the flying Air Force—was the specifications and standards program. The problem is that, given the choice, most contractors will not spend the time and energy to design for the human operator, unless they have some incentive. Putting the specification and standard on the contract gives them incentive that gets them to do it. There was a lot of frustration and aggravation involved, but I still feel that this work was the most meaningful of all I have done while with the division."**

— Steve Heckart  
Applications Human Engineer  
Human Engineering Division

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**TARGET DETECTION COMPARED WITH DIFFERENT SENSORS**  
 Military targets in a study comparing laser line-scan images with strip photography for ease of finding tactical targets. The work was performed under Project 7184, "Human Performance in Advanced Systems," Task 718404, "Advanced Systems Human Engineering Design Criteria" in support of the Reconnaissance Division of the USAF Avionics Laboratory, by Herschel C. Self and William S. Myers. AMRL-TR-69-115 (1970)

### TESTING TARGET DETECTION WITH SIDE- LOOKING RADAR

Measuring the effects of the number of allowed target choices on the target detection behavior of observers using a moving-image display from a side-looking radar sensor. The man at the console is Dean Kocian. The work was performed jointly under Advanced Development Program 665A "Reconnaissance/Strike" and Task 718404, "Human Engineering Design Criteria for Reconnaissance and Reconnaissance/Strike Systems." The research was conducted by Herschel C. Self and Almon J. Bate. AMRL-TR-69-96 (1969)



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**A HELMET-MOUNTED DISPLAY USED  
IN OPTIMIZING HELMET COUPLING**

One of the helmet-mounted displays used in a program to develop an optimized optical link for a helmet-coupled system. The work was done by Mr. Eric R. Fehr of the Hughes Aircraft Company. AMRL-TR 73-20 (1973)

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**"The person at the lab who had probably the greatest influence on my career was my first section chief, Ed Hertzberg. He was meticulous; he constantly tried to get us to write with some clarity of thought. He did his utmost to see that the job was done right. He was very, very thorough. I admired him for that . . . Another person was Mel Warrick. He was the acting chief when I came on board. He was a great person to talk to and a fantastic editor. I always felt we were so lucky to have him."**

**— Charles Clauser, Anthropologist  
Human Engineering Division**

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**ONE OF MANY MEASUREMENTS ON PRESSURE-SUITED SUBJECTS TO OBTAIN DESIGN DATA**

Milton Alexander measuring the mid-torso circumference of a seated subject wearing a pressure suit inflated to a pressure of 3.7 pounds per square inch. In this study, 138 measurements for standing, sitting, and supine positions were taken on each subject to formulate criteria for the design of workplaces. The work was done under Workunit 71840808 by Milton Alexander and John W. Garrett of the Human Engineering Division and Sgt Michael P. Flannery of the Air Defense Command. AMRL-TR-69-6 (AD 697 022)(1969)

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# ORGANIZATION\*

(As of 1965)

**AIR FORCE SYSTEMS COMMAND**

**AEROSPACE MEDICAL DIVISION**

**6570th AEROSPACE MEDICAL  
RESEARCH LABORATORIES**

**BEHAVIORAL SCIENCES  
LABORATORY**

Lt Col W.H. Stobie, Chief  
W.F. Grether, Technical Director

**HUMAN ENGINEERING  
DIVISION**

J.M. Christensen  
M.J. Warrick

**ANTHROPOLOGY BRANCH**

H.T.E. Hertzberg

**CREW STATIONS BRANCH**

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**PRESENTATION OF  
INFORMATION BRANCH**

D.E. Erlick, PhD

**PERFORMANCE  
REQUIREMENTS BRANCH**

C. Bates

**SYSTEMS RESEARCH BRANCH**

Capt K.L. Wiegand, PhD

**Harshbarger, J. H.** (1965). *Test and evaluation of electronic image generation and projection devices, Volume I. Evaluation techniques* (AMRL Technical Report 65-116(I)). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 623 908)

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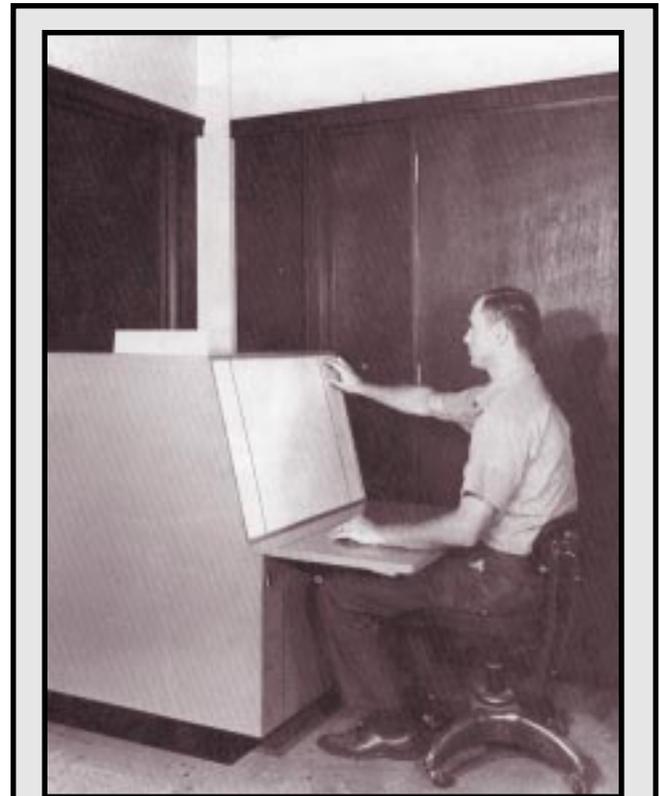
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**Hilgendorf, R. L.** (1968). *Visual search and detection under simulated flare light* (AMRL Technical Report 68-112). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 681 129)



#### **OBTAINING DATA FOR GROUND SUPPORT CONSOLE DESIGN**

**A user being tested during research intended to develop design standards for missile ground support consoles. The work was done under Project 7184, "Human Performance in Advanced Systems," Task 718404, "Human Engineering Design Criteria," and Task 718408, "Anthropometry for Design." The work was conducted by K.W. Kennedy and Charles Bates, Jr. AMRL-TR-65-163 (1965)**

**Hilgendorf, R. L.** (1969). *Arousal level theory and aerospace medical research* (AMRL Technical Report 69-27). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory.

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"My first assignment in the Human Engineering Division (August 1967) was to Don Topmiller's Systems Effectiveness Branch. Don was trying to establish a maintainability research program; and I, having had several years of aircraft maintenance experience, was most enthused about the prospects of solving some of the problems I had encountered throughout the years. The first opportunity for research came with a request from the Aero Propulsion Laboratory at WPAFB to evaluate quick-release panel fasteners for space applications. A zero-gravity simulation facility had already been completed in Building 21 in Area B (see figures at right and below); the facility provided a gimbaled support cradle, in which a person could be securely harnessed, riding on air-bearing pads over a poured epoxy floor, while tethered to a vertical work surface. With air applied, the air bearing pads rode approximately 0.002 inches above the epoxy floor, which was level to within 0.0005 inches over a 26-by-30 foot area. Work effort was measured in terms of forces and torques applied to the work panel (measured by strain gauges) as panels having various types of hand-operated fasteners were removed and installed. The data indicated that there were significant variances across the eleven very differently designed and operated fasteners, as well as interactions between fastener design and gravity conditions. The effort was documented in the Proceedings of the Second National Conference on Space Maintenance and Extravehicular Activities, Las Vegas, Nevada, August 1968. (AMRL TR-68-117)

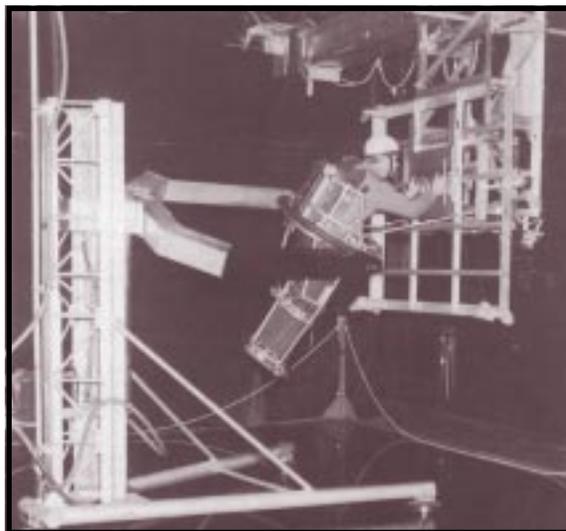
We were about to explore the effect of deflated and inflated space suit encumbrances upon performance requirements for operation of some of the better fastener designs when we were directed to stop related research in deference to NASA."

-- Wayne L. Martin  
Chief, Visual Display Systems Branch  
Human Engineering Division



#### **JULIEN M. CHRISTENSEN INVERTED IN ZERO-GRAVITY SIMULATION FACILITY**

This device, riding on air bearing pads on a poured epoxy floor that was level to within 0.0005 inches over its 26 by 30 foot area, was used in the evaluation of forces and torques required for panel fastener operation under simulated zero-gravity conditions. Bernie DeWinter, one of several instrumentation technicians provided by the Aero Propulsion Laboratory, is on the left. Wayne L. Martin is on the right. (1968)



#### **MEASURING FORCES AND TORQUES WHILE IN A ZERO-GRAVITY SIMULATOR**

Work in conjunction with the Aero Propulsion Laboratory to determine human performance requirements for hand-operated fasteners for space applications. The support cradle, coupled with air bearings on the poured epoxy floor provided tethered movement with six degrees of freedom under near-frictionless conditions. Forces and torques required to remove and install fasteners under normal gravity and simulated zero gravity, as measured by strain gauges on the work panel, identified significant differences across fastener design and gravity conditions. The research was done by Wayne L. Martin, Billy M. Crawford, William N. Kama and J. Herman. AMRL-TR-68-117 (1968)

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**During the 1960s . . . (members of the Human Engineering Division) were also busy making modifications for B-52 crew stations which, in turn, led to the development of new simulation techniques. Man-in-the-loop simulation put a person in a certain job scenario while he was still on the ground. This helped reduce the need for flight tests, and helped researchers measure the performance of both the person and the equipment. This system continues to be used in the Air Force. Future plans call for a similar program to be used with future strategic crew systems.**

— May 1985, "Human Engineering, Yesterday and Today," *Civilian Employees Reporter*

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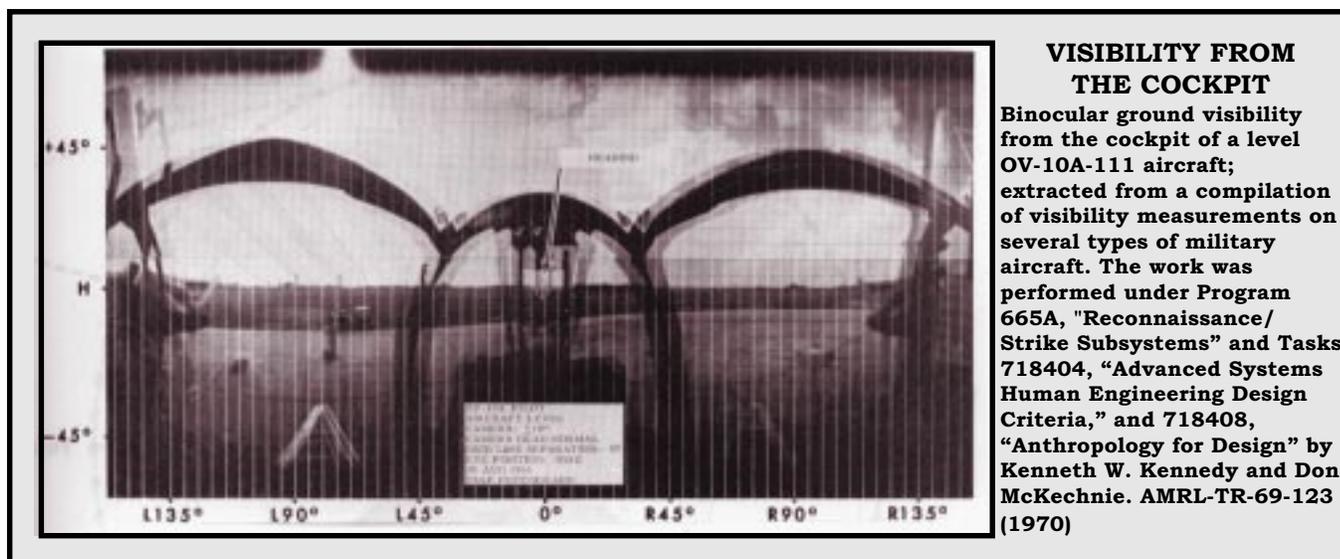
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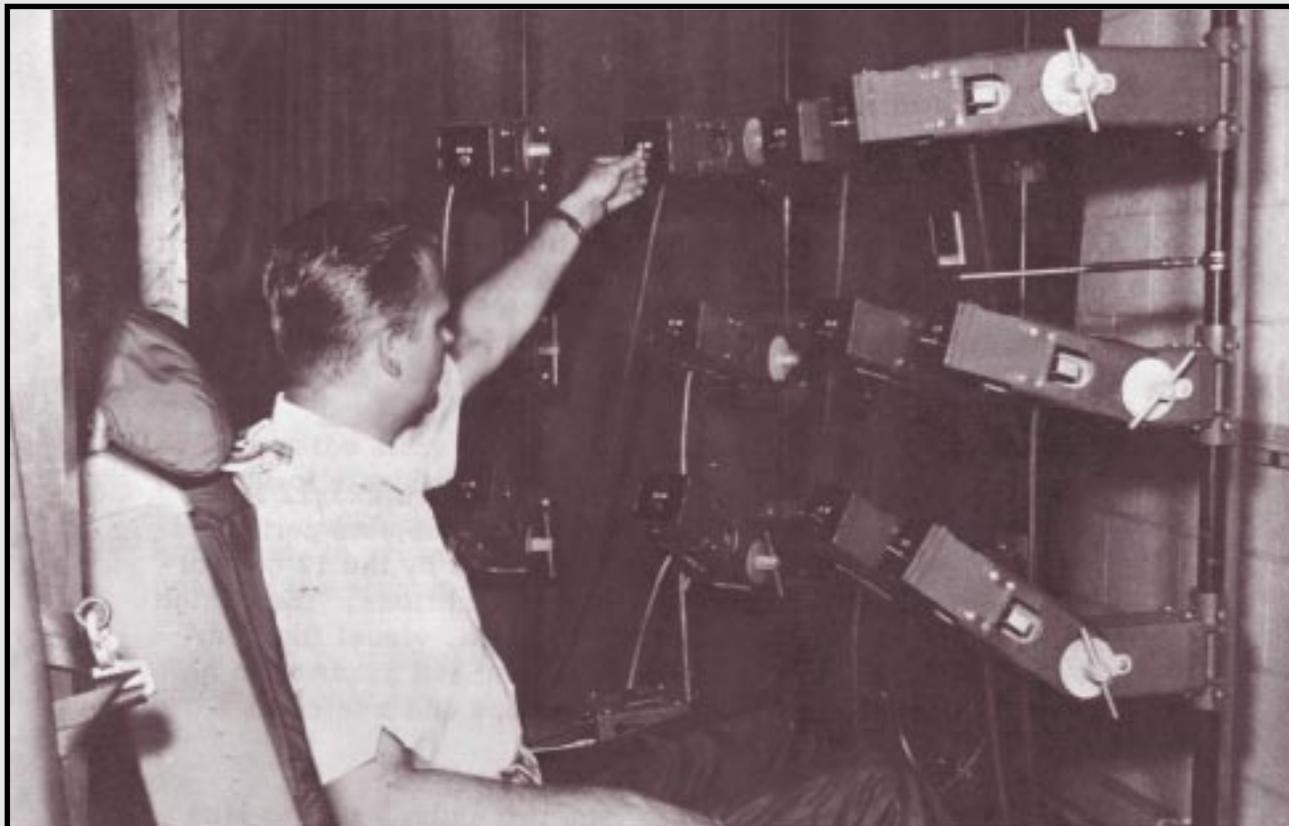


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**SETUP FOR MEASURING THE EFFECTS OF SYSTEM CHARACTERISTICS ON TARGET RECOGNITION**

Terrain model and gantry-mounted, closed-circuit TV camera used to simulate aircraft flight at low-light levels. The system features a TV viewfinder for measuring the effects on target recognition of system characteristics. The work was done on contract to North American Rockwell Corporation in support of the Directorate of Reconnaissance Engineering and sponsored by the 665A Program Office. The work was done by J.M. Humes and D.K. Bauerschmidt. AFAL-TR-68-271 (1968)



**TESTING THE EFFECT OF PANEL LAYOUT ON VISUAL FIXATION AND UNCERTAINTY**

Testing in a workplace efficiency evaluator for the effects of panel layout on visual fixation and uncertainty. The work was conducted under Task 718402, "Criteria for the Design and Arrangement of Controls and Control Systems." The research was done by Donald A. Topmiller and Earl D. Sharp. AMRL TR-65-149 (1965)

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**"I had been a machinist before I began to get interested in human factors; so, when it came time to start rebuilding and modifying the simulators to suit our needs, I was able to go to the base machine shop and tell the machinists exactly what we needed, in their language. This way I was able to get the facility set up extremely quickly."**

— Earl Sharp, Program Engineer  
Human Engineering Division

**"My first task was the zero-G project. I replaced Bob Kellogg, who had been developing a machine which would spin the subject around the axis of the eyes in a zero-G environment, to study whether the tendency for the eyes to counter-rotate was a vestibular function or some kind of reflex. That's how I got into the program. After that, I did a lot of work in the areas of vestibular and visual functions as well as performance—all in zero-G."**

— Robert O'Donnell, Chief  
Workload and Ergonomics Branch  
Human Engineering Division

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**The Human Engineering Division includes most of the work areas of the original Psychology Branch, which ultimately grew into the Behavioral Sciences Laboratory. In this branch the primary concern is with research on human performance that could lead to improvements in the design of operating procedures for Air Force systems. The ultimate objective, of course, is to maximize the effectiveness of our weapon systems by properly matching human and machine capabilities and functions.**

— March 1965, "Human Engineering and Training Research Division," Behavioral Sciences Laboratory

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Laubach, L. L., & Alexander, M. (1966). Measurements of muscle strength. *Integrated life support system study (20-day evaluation program)* (AMRL Technical Report 66-185, pp. 34-47). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 656 311)

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**Melvin J. Warrick, PhD**  
**Associate Chief**  
**Human Engineering Division**

**1958 to 1973**

Mel Warrick was hired into the Psychology Branch, Aero Medical Laboratory, in March 1946 by Lt Col Paul Fitts, then its Chief. Prior to that time he had been in military service undergoing gunnery, bombardier, and radar operator/navigator training and doing research on bombardier training in the Army Air Force's Psychology Program. Before that, Mel had been trained as a private pilot, had taught high school science and mathematics, and had done research from 1941 through 1943 on bombardier selection for the US Army Adjutant General's Office and the USAF Psychology Program.

As technical advisor and associate chief, he monitored the division's exploratory development and basic research programs in the various fields of human engineering as applied to ground, air, and space equipment and systems. Under the tutelage of Dr. Fitts, Mel did his direction-of-motion stereotype (stimulus-response compatibility) studies, certain of which results have been distilled, by others, into what is now known as "Warrick's Law." Mel was the principal technical editor of the division's publications, carrying on the Fitts' tradition of clarity and parsimony in writing. He was the first of the civilian scientists to fly at "zero G" untethered and the first to provide human factors input to the Atomic Energy Commission.

He retired as a civil servant in 1975 and as a lieutenant colonel in the USAF Reserves in 1976. He has continued to this date (1995) as a "volunteer" within the Armstrong Laboratory.

Leuba, H. R., & Rhodes, K. (1968). *Information transmission in operator reports of equipment malfunction: Methodology* (AMRL Technical Report 68-20). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 838 161)

Lindemuth, R. W., & Tieber, J. A. (1965). *An analysis of the inertial properties and performance of the astronaut maneuvering system* (AMRL Technical Report 65-216). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 622 443)

Lyons, J. P., & Gillio, A. (1972). *The human engineering electronic countermeasures simulator* (AMRL Technical Report 72-59). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 781 093)

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Martin, W. L., & Chubb, G. P. (1970). *Human engineering considerations in designing interactive graphic displays for logistics management* (AMRL Technical Report 70-106). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory.

In 1969, Earl Sharp stumbled on to an old friend looking at some video tapes of the defensive workstation of the B-52. This fortuitous encounter led Earl to take an interest in the Electronic Warfare Officer's (EWO) workstation, which has led to a 20-year commitment to improving the design of EWO crewstations in the latest Air Force high tech bombers, including the B-52, B-1, and currently the B-2.

Earl has been the driving force behind the development of some of the most realistic bomber simulation and testing facilities in the world. Having persuaded the powers-that-be in Strategic Air Command to give him \$270,000 and a B-52 training device in 1971, Earl set about putting together a high-fidelity simulation facility with the capability to collect performance data from every thrown switch, twisted knob, and CRT display. This facility has since produced valuable data which has provided the impetus for many workstation and display design changes for the B-52, as well as being the template for a similar B-1 facility, and Earl's legacy, a B-2 test and evaluation facility.

— Klein Associates,  
Interview with Earl Sharp

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**McCoy, W. K., Jr., & Frost, G. G.** (1966). *Predictor display techniques for on-board trajectory optimization of rendezvous maneuvers* (AMRL Technical Report 66-60). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 635 918)

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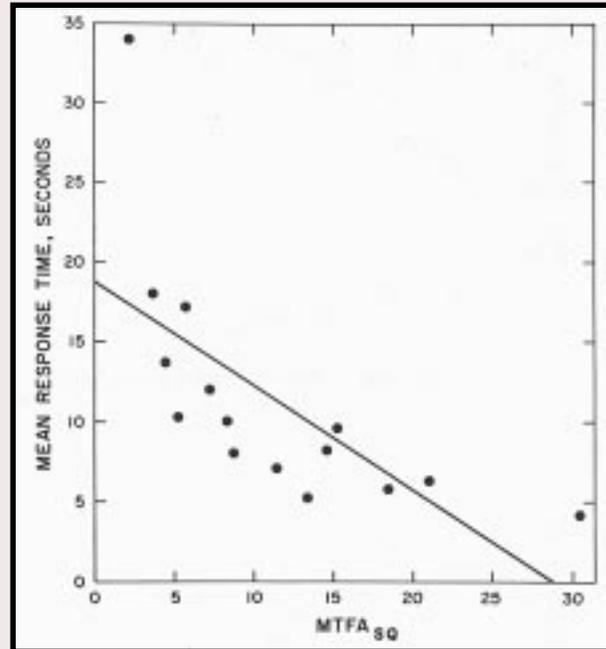
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**McKechnie, D. F.** (1970). *Comparison of a moving map display and two graphics with handheld maps* (AMRL Technical Report 69-110). Wright-Patterson AFB, OH: Aerospace Medical Research Laboratory. (DTIC No. 714 061)

**McKechnie, D. F., & Griffin, L. L.** (1966). Experimental use of several briefing methods as aids to target detection with high resolution reconnaissance data. *Proceedings of Symposium on Aeronautical Charts and Map Displays*.

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#### IMAGE QUALITY AND RECOGNITION TIME

Mean recognition time for human faces in a study of the effect of image quality on visual search. The work was done on a contract with the Virginia Polytechnic Institute and State University by Dr. Harry L. Snyder, Ms. Robin Keesee, Mr. William S. Beamon, and Mr. James R. Aschenbach. AMRL-TR-73-114 (1974)

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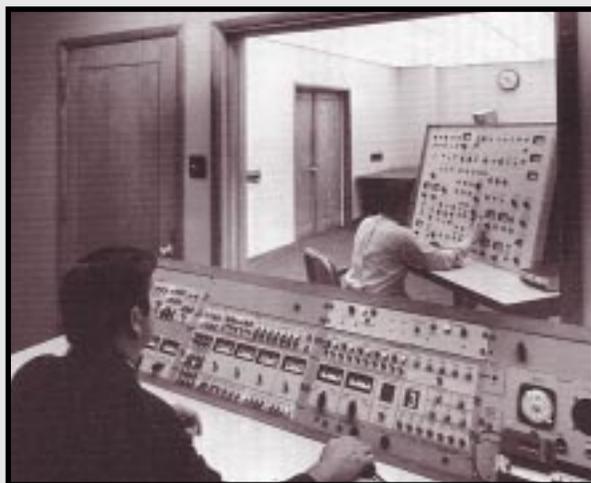
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**TESTING THE EFFECTS OF PANEL LAYOUT**  
Testing operator performance in a study of the effects of panel layout on performance in discontinuous tasks. The work was done on contract to the Philco-Ford Corporation under Task 718404 "Human Engineering for Real-Time Reconnaissance and Weapon Delivery" by R.A. Goldbeck, K.A. Wright and R.L. Fowler. AMRL-TR-70-137 (1971)

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#### OBTAINING DATA FOR DESIGNING INFORMATION RETRIEVAL CONSOLES

A subject using an information retrieval console in a study of control panel design methodology. The work was done on contract by the Bunker-Ramo Corporation under Task 718404, "Advanced Systems Human Engineering Design Criteria." The work was performed by David Meister and D.E. Farr. AMRL-TR-66-28 (1966)

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**OBSERVER STATION USED IN TESTING THE EFFECT OF ILLUMINATION LEVEL ON TARGET DETECTION**

Observer in the nose bubble of a WB-50D aircraft in an airborne study done in Panama on the effect of illumination level on visual target detection. This work, in support of Advanced Development Project 665A, was completed under Task 718404, "Human Engineering for Real-Time Reconnaissance and Weapon Delivery." The work was done by Dr. James L. Porterfield, Dr. Herschel C. Self, Mr. Steve A. Heckart, Maj E.P. Hanavan, and Mr. Don F. McKechnie. AMRL-TR-71-9 (1971)

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**MEASURING FEMALE HANDS FOR DESIGN**  
Milton Alexander measuring wrist breadth in research on the anthropometry of the Air Force female hand. The work was done in support of Project 7184, "Human Performance in Advanced Systems" by John W. Garrett. AMRL-TR-69-26 (1970)

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**TARGET RANGE USED IN A  
STUDY OF COLORED SUNGLASSES**

Above is the target range at Wright-Patterson Air Force Base used in a study of the effects of colored sunglasses on visual performance. The study was done on a contract to Multi-Tech Associates under Project 7184, "Human Performance in Advanced Systems." The work was conducted by Robert S. Hart. AMRL-TR-74-38 (1974)

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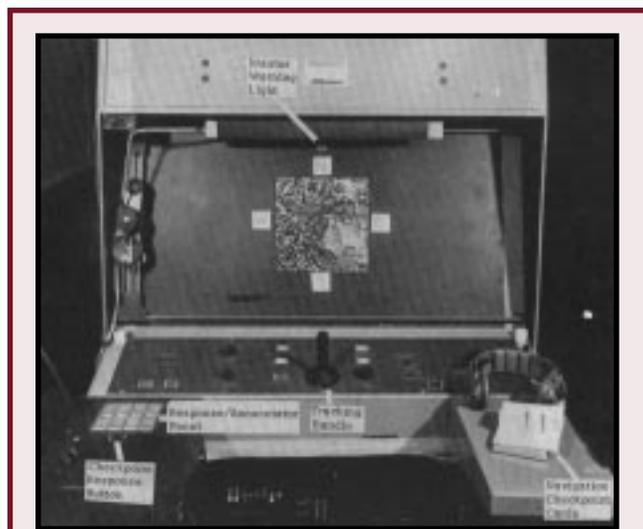
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#### **SIMULATED NAVIGATION TASK USED IN A STUDY OF WARNING SYSTEMS**

**The display of moving, rear-projected strip photography and the associated equipment used in a simulated aircraft navigation task in comparing the merits of malfunction warning systems. This study by Almon J. Bate under Task 718404, "Advanced Systems Human Engineering Design Criteria" supplemented an earlier 1966 study on warning systems. AMRL-TR-68-193 (1968)**

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**TESTING COCKPIT WARNING SYSTEMS ON  
A SUBJECT BUSILY DETECTING TARGETS**

Almon J. Bate testing an observer engaged in a target detection task. The study uses a moving rear-projection display image of strip photography on an information-retrieval console. The study, which compared cockpit warning systems, was done under Task 718404, "Advanced Systems Human Engineering Design Criteria" by Almon J. Bate and Charles Bates, Jr. AMRL-TR-66-180 (1967)

### TOOL USE IN ZERO GRAVITY

An experimental subject floating in an aircraft flying a special flight path that produces a zero gravity condition. The study examines the effect on tool use of zero gravity. Here the subject is using a screwdriver to make instrument adjustments.



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#### TESTING FLARE EFFECTIVENESS WITH A TERRAIN BOARD SIMULATION

An observer, using a terrain board simulation, looking for ground targets in a study that examines the effectiveness of air-dropped flares. The work was part of a joint services program on air-to-ground target acquisition, with the findings to go into the "Joint Munitions Effectiveness Manual." The work was performed by Dr. Sheldon MacLeod AMRL-TR-73-46 (1973)

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#### HELMET-MOUNTED DISPLAY TECHNOLOGY

Thomas Furness of the Human Engineering Division checking out an early helmet display fabricated by industry for the division. Furness, Charles Bates, Jr., and Dean Kocian began pushing the development of the technology of helmet-mounted sights, helmet-mounted displays, and visually-coupled systems in the early 1960s with funds for industrial development and laboratory investigations obtained from several sources, including the Air Force, the US Army, and NASA. Their input of ideas, enthusiasm, and funds greatly hastened the development of the technology, bringing helmet-mounted equipment into operational use by the armed forces years earlier than would have happened without their efforts. This, and related work, is continuing with the leadership of Dean Kocian, Harry Lee Task, Brian Tsou, and other laboratory personnel.

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**“The lab in the sixties was not only smaller, but dramatically different. There was practically no research money. The money we did have went mostly into an OSU (Ohio State University) system research contract. The other big contract was with University of Dayton to provide experimental subjects. Most of the researchers did their own research with limited in-house funds; very little contractor research was being done at that time.”**

— Steve Heckart  
Applications Human Engineer  
Human Engineering Division

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