

U. S. ARMY

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MILESTONES:

A DIRECTORY OF HUMAN ENGINEERING

LABORATORIES PUBLICATIONS, 1953-1968

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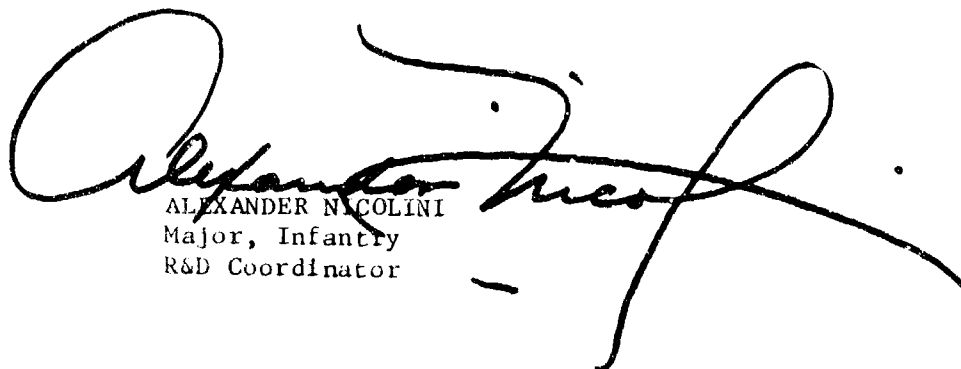
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FOR THE CHIEF:

A large, stylized handwritten signature in black ink, which appears to read "Alexander Nicolini", is written over the typed name and title.

ALEXANDER NICOLINI
Major, Infantry
R&D Coordinator

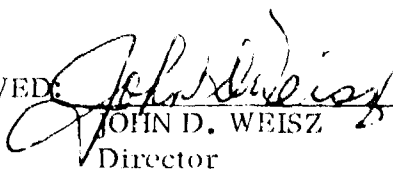
MILESTONES

A DIRECTORY OF HUMAN ENGINEERING
LABORATORIES PUBLICATIONS, 1953-1968

Technical Reports Office

April 1969

APPROVED:


JOHN D. WEISZ

Director

U. S. Army Human Engineering Laboratories

U. S. ARMY HUMAN ENGINEERING LABORATORIES
Aberdeen Proving Ground, Maryland

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How to Use

MILESTONES

✓ MILESTONES is a cross-referenced directory of reports that the U. S. Army Human Engineering Laboratories have published since their founding in 1953. It is compiled and re-issued each year to provide an up-to-date index for the convenience of other people and organizations working in the human factors engineering field.

To allow most effective access to a rather extensive body of knowledge in many specific areas, MILESTONES comprises three volumes or sections. These sections are coded through printing them on colored paper. ↗

Volume I: Subject-Matter Areas. The first, and most detailed, listing is arranged by the kind of information each report contains. Thus readers can quickly locate the data which have been published about any given topic. There are two main sub-categories of subject matter:

General Information, often called basic research, which provides facts that can usefully be applied to many particular situations. For example, Technical Memorandum 7-60, Detection of random low-altitude jet aircraft by ground observers, presents information that can be used meaningfully in many situations where personnel must look for aircraft without special equipment to aid them.

Systems Evaluations, frequently described as applied research, which are studies of the adequacy of specific pieces of equipment developed for a special use. This category includes analyses of missiles, vehicles, atomic reactors, and many other sorts of systems. One example of a systems evaluation is Technical Memorandum 2-58-1, A human engineering evaluation of the Redstone missile system: the azimuth-laying system. While the systems evaluation studies have all been directed toward answering a rather specific question, readers should realize that many of them have more general applicability as well.

In Volume I, a brief abstract of each Technical Memorandum is reprinted here to give readers a more adequate understanding of each study's aims and its findings. Thus readers can decide intelligently whether a report is apt to contain the information they need, and they will be able to order copies of the reports which answer their questions best. It is suggested that, after readers have located reports in Volume II by number or in Volume III by author's name, it will generally be helpful to refer back to Volume I and read the abstract of the report.

Volume II: Numerical Listing, in order of publication. This second section of the directory shows the same list of reports, re-arranged by their numbers, to allow identification of a report when only its number is known. Because reports are numbered sequentially, this list is also in chronological order. Since titles written with telegraphic brevity frequently leave a reader wondering just what was done, it will be helpful to consult the abstract in Volume I; numbers shown in parentheses indicate the page of Volume I where this abstract will be found.

Volume III: Listing of Reports, by author. In this third section, each report is cross-indexed by the senior author. This section will prove valuable in identifying reports which are known best by who wrote them.

VOLUME I - SUBJECT-MATTER LISTING

Technical Memoranda

Part I. GENERAL INFORMATION

A. General References: Standards, Guidelines, Recommended Practice

Color Banding

- **A Guide to Color Banding for Indicators (Meters)**

TM 2-59, Uncl.

W. Wokoun, G. Chaikin

This report presents a rationale for color-coded banding of meters. The principles set forth are illustrated, and swatches of the four colors which are considered maximally discriminable are given.

Colors - Classification

- **Handbook of Color Notation Systems**

TM 10-61, Uncl.

C. Fried, R. S. Gibson

This handbook provides the CIE Chromaticity Coordinates for five systems of designating colors. The five systems are the Munsell, Ostwald, Textile Color Card Association, and U. S. Army Color Card, Federal Specification TT-C-595, and Commercial Standard CS 1947-47.

A sixth system, the Inter-Society Color Council - National Bureau of Standards color name blocks, is included along with equivalent Munsell renotations.

In addition, a single table has been compiled of the five systems for which CIE coordinates have been determined, in terms of ascending values of the chromaticity coordinates, to aid in cross referencing between systems.

This handbook will provide a means to specify exactly colors which have been designated in the past in terms of samples or chips in color notations systems.

Colors - Van Interiors

- **Recommended Paint Characteristics for Van Interiors: Hue, Brightness, and Saturation**

TM 8-63, Uncl.

W. Wokoun

It has long been alleged that the paint used in workspaces -- and especially the color of paint -- affects human performance. This report briefly summarizes the general conclusions of a rather extensive literature survey. It recommends that pleasing colors should be used, even though no one seems to have proved that colors do or do not affect performance. The report also considers brightness and saturation briefly, and it suggests sets of colors which would be appropriate for high-level and for low-level illuminations.

GENERAL
General References

Vehicles

- Human Factors Engineering Design Standard for Wheeled Vehicles
HEL Standard S-6-66, Uncl.
R. F. Chaillet, A. R. Honigfeld

Human factors engineering recommendations for military vehicles in the areas of operability, maintainability, and safety are listed. These recommendations are oriented toward use by human factors specialists.

- Human Factors Engineering Design Standard for Vehicle Fighting Compartments
HEL Standard S-2-64, Uncl.
R. E. Hedgecock, R. F. Chaillet

Provides guidance for the inclusion of human factors engineering requirements in research and development or procurement contractual documents.

B. Sensory and Perceptual Performance

Audition

- A Preliminary Study of Some Variables Affecting Pulsed-Tone Bekesy Thresholds
TM 14-67, Uncl.
R. B. McCommons, D. C. Hodge

This study was performed to determine the effects of varying the period and duty cycle of a pulsed tone on the sensitivity and variability of Bekesy thresholds at several test frequencies. Ten subjects were tested using 36 combinations of these variables. It was determined that threshold sensitivity improves both with longer periods and with higher duty cycles, and that lengthening the period adversely affects intratest variability. Frequency was ruled out as a significant variable. The effects of temporal auditory summation and repetition rate of the pulse as determinants of the results are discussed.

Audition - Localization

- See TM 4-65 and TM 4-66, Page I-35.

Displays - Coding - Flash

- Effectiveness of Warning Lights as a Function of Flash Rate
TM 23, Uncl.
L. T. Katchmar, N. H. Azrin

An investigation of the extent to which variations in flash frequency change a warning light's effectiveness in eliciting a reaction. Ten subjects judged which flashing light they would turn off first. It was found that a warning light's effectiveness increased as a direct function of flash rate, up to a maximum of approximately 10 cps. Further increases in frequency produced a decrease in effectiveness. There is some evidence to indicate that effectiveness, apparent fluctuations, and annoyance all vary in the same way as a function of flash rate.

Displays - Check-Reading

- See TM 2-59, Page I-1.
- A Method for Increasing Efficiency of Dial Check-Reading
TM 6-63, Uncl.
S. G. Dashevsky, S. Glucksberg

The conventional check-reading display, using dials in rows and columns with pointers aligned at the 12-o'clock position, was compared to a similar display with pointers connected by straight lines, i.e., with the pointers in normal position they are seen as segments of straight lines. In this latter display, called the extended-line display, the subjects' task was merely to detect a break in a line, rather than to detect a deviant pointer. Detection of deviant dials was consistently superior with the extended-line display; the displays did not differ with respect to the observers' ability to localize deviant dials in the display array.

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Sensory and Perceptual

- Combining Check-Reading Accuracy and Quantitative Information in a Space-Saving Display
TM 17-63, Uncl.
S. G. Dashevsky, L. C. Oatman

Four dial displays were compared in a check-reading task. Circular and semicircular dials were structured to yield either qualitative or quantitative information. The circular-qualitative dial display was compared with the circular-quantitative dial display. The semicircular-qualitative dial display was compared with the semicircular-quantitative display. The results indicate that dial displays can be structured to yield qualitative and quantitative information in a space-saving display while maintaining efficient subject performance.

- Check-Reading Accuracy as a Function of An Extended-Pointer Dial Display
TM 10-64, Uncl.
L. C. Oatman

Three simulated dial displays were compared in a check-reading task. An extended-pointer dial display was compared with an aligned and an extended-line dial display. The three dial displays were presented to 34 subjects who were asked to indicate whether or not the display contained a deviant pointer, and, if so, to locate the deviant pointer. The data indicate that subjects performed significantly better with the extended-pointer display than with either the aligned or the extended-line display. Location within a display was found to be an important determinant of the number of deviant pointers detected.

- Check-Reading Accuracy as a Function of Dial Alignment in an Extended-Pointer Dial Display
TM 2-65, Uncl.
L. C. Oatman

Two simulated dial displays were compared in a check-reading task. The pointers were aligned at 12 o'clock in one display and at 9 o'clock in the other.

The dial displays were presented to 30 subjects who were asked to indicate whether the display contained a deviant pointer, and, if so, to locate it.

The data indicate that subjects performed about equally well with the two pointer alignments. Locations of the deviant dials within the displays were an important determinant of the number of deviant pointers detected.

- Check-Reading Accuracy: Aligned Dials vs. Extended-Pointer Dials
TM 6-65, Uncl.
L. C. Oatman

Two simulated dial displays were compared in a check-reading task. An extended-pointer dial display was compared with an aligned dial display.

The two dial displays were presented to 30 subjects who were asked to indicate whether or not the display contained a deviant pointer, and, if so, to locate the deviant pointer.

The data indicated that subjects performed about equally well with the extended-pointer dial display and the aligned dial display. However, the location of the deviant dial within the display was an important determinant of the number of deviant pointers detected.

Displays - Coding - Radar

- An Evaluation of Three Proposed Sets of Radar Symbols
TM 8-57, Uncl.
W. C. Blair

Evaluation of three sets of symbols proposed for use in identifying targets on radar scopes.

- An Investigation of Symbol Meaning Combinations for use in Radar Displays
TM 1-58, Uncl.
J. P. Torre, Jr., L. A. Sanders

Covers the attempts to derive a set of symbol forms which could be used to designate enemy, friendly, unknown targets on a radar scope. Two hundred enlisted men were individually tested in two experiments. A free-association-type technique was utilized in experiment 1, whereby subjects were required to draw a symbol for each of the three meanings -- enemy, friendly, and unknown. The second experiment was conducted to ascertain the three most representative symbols from those which occurred most frequently in experiment 1. Specific symbols were obtained along with particular form characteristics for each of the three meanings investigated.

- Evaluation of Radar Symbols for Target Identification
TM 2-58, Uncl.
J. F. Dardano, R. Donley

Five geometric forms considered for use as radar symbols were compared for discriminability. Frequency of symbols on the screen and proportion of the discriminated symbol to other symbols on the display were included as independent variables. Twenty subjects were tested using an optical simulation of a radar scope. Omission of symbols to be discriminated in a limited screen exposure time as a criterion resulted in the cross-within-circle and a cross as most discriminable. The circle and half-circle were less discriminable and three-quarters circle least discriminable. Confusion between symbols was negligible and primarily due to the three-quarter circle as a background symbol interfering with the circle and half-circle.

- Discriminability of AAOC Symbols
TM 4-58, Uncl.
J. F. Dardano, J. A. Stephens

Relative discriminability of four geometric shapes considered for use as radar symbols (cross, cross within circle, circle, and half-circle) were examined at size levels ranging from 1/8" to 1/2" at intervals of 1/16". The shapes were electronically generated by apparatus designed for installation in the Antiaircraft Fire Control System M-33 PPI. The cross and circle were more discriminable than the half-circle and cross within circle; these differences were independent of size level. Minimum size at which discriminability was not impaired lay between 3/16" and 5/16". At the 2/16" size there were extreme increases in scanning time and omissions for all symbols. Subjects did not agree in their ratings of ease of discriminating each shape. Some possible determinants of symbol discriminability are discussed.

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Sensory and Perceptual

- Radar Symbolology: A Literature Review
TM 14-64, Uncl.
A. R. Honigfeld

This literature review was undertaken to summarize the state of the art of symbolology in radar display systems. It reviews the various techniques for coding, extracts general principles for use in designing radar systems, and recommends areas for further research.

- Radar Symbolology Studies Leading to Standardization
TM 5-68, Uncl.
C. J. Davis

This report covers initial studies directed toward standardization of basic symbols representing "enemy," "friendly," and "unknown" targets on a radar scope. College students of both sexes and enlisted military men served as subjects.

In Experiment I, subjects assigned and ranked 68 geometric designs within the three meaning categories. Experiment II studied retention values after a short exposure to these same forms. Experiment III required all subjects to design a code differentiating the three meaning categories.

All significant findings on meaning were highly dependent on pictorials. Perceptual differentiation and ease of learning are recommended as the major dimensions of code design.

Displays - Coding - Vehicle Controls

- Design of a Picture Language to Identify Vehicle Controls --
I. General Method - II. Investigation of Population Stereotypes
TM 22-61, Uncl.
S. A. Mudd, R. Karsh

I. General Method: A general approach to the problem of developing a picture language or set of picture-symbols, as labels for equipment controls, is discussed. Negative and positive arguments for such a system of symbols and possible research strategies are considered.

II. Investigation of Population Stereotypes: The results of the first of a series of studies are reported. United States and foreign military personnel were asked to make line drawings that might convey the meaning of various wheeled-vehicle controls. These drawings were subjected to a qualitative analysis to extract common design elements. A preliminary set of 34 symbols, based on the resultant design elements, is presented. Recommendations for further research are included.

- Design of a Picture Language to Identify Vehicle Controls --
III. A Comparative Evaluation of Selected Picture-Symbol Designs
TM 15-62, Uncl.
R. Karsh, S. A. Mudd

This study investigated the accuracy of identification of each of 90 picture-symbol designs with each of 34 vehicle control names. Two sets of designs were evaluated. The set which had been empirically derived in a preceding study was found to be more effective than the set which had not been empirically derived. Effective symbols were found for 24 out of 34 vehicle control names. Ten new symbols have been developed. They will be presented subsequent to further evaluative tests.

Displays - Digital

- Indicating (Read-Out) Tube; Human Engineering Applications for Informational Displays
TM 9-58, Incl.
C. S. Cruse

The purpose of this report is to point out some of the advantages that might be gained by the incorporation of "read-out" tubes in weapons systems. While such devices have been used in the past, the increased complexity of modern equipment, together with the associated human factors problems, justifies new emphasis on the use of such tubes.

Those applications discussed constitute only a small fraction of the many possibilities but may be considered representative of such uses.

- A Human Factors Evaluation of Seven Digital Read-Out Indicators
TM 5-60, Incl.
C. Fried

A human factors product evaluation was made on seven representative types of digital read-out indicators. These digital read-outs were compared on the basis of reading speed and increase in errors as the time permitted to read the displays was reduced from 2.0 seconds to .05 second.

Displays - Panel - Cockpit

- Panel Layout for Rectilinear Instruments
TM 4-68, Incl.
R. W. Bauer, R. K. Cassatt, B. M. Corona, F. Warhurst, Jr.

Rectilinear dials on a typical cockpit display were arranged in parallel, both horizontally and vertically, and also in a mixed, orthogonal arrangement. Although, intuitively, the parallel layouts appeared advantageous, the mixed layout yielded the best detection accuracy and the shortest detection times. Increasing the spacing between groups within a parallel, vertical array did not significantly improve performances. Uniform scales in any arrangement proved superior to non-uniform scales in readout accuracy. Thirty-six pilots and sixteen technical and scientific laboratory personnel participated in the study. Performances of pilots and non-pilots were very similar.

Displays - Sights

- The Effects of Modified M1 Rifle Sights on Marksmanship
at Low Levels of Illumination
TM 25, Incl.
D. C. Hodge

This laboratory experiment attempted to determine whether any of the experimental sights would prove to be optimal under both high and low illumination. Seven experimental sights -- representing those previously tested and those currently used on rifles -- and the standard sight were tested under two levels of illumination.

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Sensory and Perceptual

- An Evaluation of Selected Rifle Sights under Two Levels of Illumination
TM 7-57, Uncl.
H. F. Pohlmann, L. T. Katchmar

This study was an investigation of rifle-sight accuracy under live firing conditions under high (50-foot candles) and low (one-foot candle) levels of illumination. It investigated a standard M1 sight, as well as two experimental sights which reportedly permit highly accurate sighting in both high and low illumination under laboratory conditions. The results indicate that the standard M1 sight gave the smallest mean shot-group under both levels of illumination.

- Evaluation of Sighting Devices for a Small Hand-Held Rocket Launcher
TM 6-59, Uncl.
H. T. Curran, Jr., R. T. Gschwind

This study investigated the degree of difference in accuracy due to aiming error between three types of experimental sighting devices: an iron sight with a 20-inch sight radius utilizing a plexiglass plate upon which a reticle was etched for the front post; a unity-power optic using singlet lenses; and a unity-power optic using doublet lenses. Determinants of qualitative disparity between the sights and possible effects of low-illumination sighting are discussed.

Driving - Television-Guided

- Closed Circuit Television Vehicle Driving: 1. A Preliminary Investigation
TM 10-60, Uncl.
C. G. Moler, G. L. Brown

This report is the result of a driving study using television as a sole means of observation. The purpose of the study was to determine the feasibility of such a driving technique.

Television affords adequate protection from radiation and has certain other advantages over the optical systems presently used on Armor vehicles. The intention of the study was to obtain indications of the problem areas using existing television equipment and to determine the need for future studies of this nature.

The results were favorable in demonstrating the feasibility of driving with closed circuit television. Additional studies will be conducted.

Jamming - Radar

- Study of the Effects of Continuous Wave Jamming on the Detection of Antiaircraft Operations Center Symbols
TM 9-59, Uncl.
C. Fried

Detection time was studied for four geometric shapes, considered for adoption as Antiaircraft Operations Center Symbols, that were exposed to three degrees of simulated continuous wave jamming. The shapes studied were the circle, cross, half-circle, and cross-within-circle. Their diameters remained constant at 5/16". The shapes were generated electronically on a plan position indicator display.

Detection time increased for all four symbols as the intensity of continuous wave jamming increased, but the increase was not significant for the increase from the no-noise to the mild-noise level. All symbols, except the cross, had approximately the same detection time

for each of the three noise levels. Any differences were not significant. The number of errors made by the subject was small and did not show any trend. The significantly lower detection time for the cross at all noise levels is discussed.

Jamming - Radar - Counter Measures

- Synthetic Video as an Electronics Counter-Counter Measure:
A Study of Pulsated and Steady State Symbology
TM 11-60, Uncl.
C. Fried

A study was conducted to determine the effectiveness of pulsing a suggested Antiaircraft Operations Center (AAOC) symbol in overcoming the concealment effects of white noise jamming. Pulsing resulted in a flickering symbol on a Plan Position Indicator. Four degrees of jamming intensity were studied along with four flicker rates -- 0, 2, 4, and 8 cycles per second.

The psychophysical technique of method of limits was used to determine if flicker improved detection with a background of jamming. The results indicate that no advantage is gained in pulsing a synthetic symbol in overcoming the effects of jamming. A discussion of this result with a review of procedures is included.

Legibility - Cast Characters

- The Legibility of Letter and Number Castings
TM 16, Uncl.
M. I. Kurke

This report summarizes a literature survey about letter and number legibility, especially as affected by the casting process. The author concludes that: (1) there is no information specifically about cast lettering; (2) readability of printed material depends on the viewing angle, with maximum legibility at 90°; (3) legibility is enhanced by simple type faces that emphasize the characteristics which distinguish one letter from another; (4) the Mackworth lettering and Antique type face are very legible, when compared to other selected styles; (5) optimal stroke width for daytime reading is 18 - 20 percent of the letter height, but for night reading, stroke width should be less; (6) other factors affecting legibility are size, figure-ground contrast, illumination, observation time, and color contrast.

Motion Perception - Kinetic Depth Effect

- Studies on the Kinetic Depth Effect as a Mean for Presenting Three Dimensional Information - I. Methodology and Selection of Forms for Study
TM 2-60, Uncl.
C. Fried

In an introductory study of the Kinetic Depth Effect, 12 stationary shadow projections of each of nine forms were presented to 10 subjects to determine which forms appeared flat or two-dimensional, and which appeared three-dimensional. This study was done to select from the nine forms a smaller group, all of whose shadow projections would appear as two-dimensional.

The only forms that appeared two-dimensional to all subjects in each of their 12 shadow

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Sensory and Perceptual

projections were the wire rod and the helix. The helix on examination was revealed to undergo substantially the same changes as the wire rod.

A historical account of the Kinetic Depth Effect illusion and its pertinence for three-dimensional displays is presented.

- Studies on the Kinetic Depth Effect as a Means for Presenting Three Dimensional Information - II. Effects of Varying Angle and Length of a Two-Dimensional Form
TM 18-60, Uncl.
C. Fried

An attempt was made to correlate the amount of length and angle changes of shadow projections of rotating wire rods with the ease with which the depth impression of the Kinetic Depth Effect is elicited. This attempt was based on earlier findings of Wallach and O'Connell, that the stimuli for the Kinetic Depth Effect are length and angle changes of lines making up a moving form.

The attempt was not successful as all shadow transformations presented to the subjects in this study produced the impression of a figure rotating in space. Suggestion is offered that further thought be given to determining the stimuli for the Kinetic Depth Effect illusion.

Motion Perception - Threshold

- Studies on the Perceived Threshold for Motion - I. Effects of Aperture Dimension on Threshold Velocity
TM 6-62, Uncl.
C. Fried

The influence of aperture dimension on the lower threshold of motion was investigated by comparing the effects of five differently sized aperture squares on motion threshold. The effect of aperture dimension was apparent for the smaller dimensions employed. The theoretical implications of these results were further explored in two additional experiments intended to determine if threshold values are a function of frame of reference dimensions or distance to a reference line. It was concluded that motion threshold value is a function of the latter, if a well-defined referent is provided.

- Studies on the Perceptual Threshold for Motion - II. Effects of Induced Motion on Threshold Velocity
TM 18-62, Uncl.
C. Fried

A proposed means for reducing threshold for perceived motion, by adding the force of induced movement to true movement, was explored. Induced movement was evidenced by (1) subjects reporting movement when no actual movement occurred, and (2) the increase in threshold when the direction of its influence was opposed to actual movement. The predicted threshold reduction, when the direction of actual and induced movement were identical, did not occur, because, presumably, the subjects attempted to compensate for the influence of induced movement.

Pattern Recognition

- Pattern Identification by Man and Machine
TM 17-68, Uncl.
Proceedings of a Planning Conference

The Institute for the Study of Cognitive Systems at Texas Christian University is conducting a research program titled "Parameters of Human Pattern Perception" with Project THEMIS funding. This program's goals include development of a formal mathematical model of human pattern recognition behavior and subsequent computer simulation of the model.

Research on human pattern recognition has become increasingly more sophisticated during the past decade. At the same time substantial progress has been made in duplicating certain aspects of human pattern recognition capability in machines. Cross-fertilization between these two areas is a much-desired goal and the Texas Christian University research program is specifically planned to foster such mutual facilitation. The Institute, under the sponsorship of the U. S. Army Human Engineering Laboratories, is planning a symposium which will bring together leading workers in both fields.

To maximize the benefits of such a symposium to the Department of Defense, a planning conference was held in Fort Worth, Texas, 12-13 December 1968. This report summarizes presentations given at the planning conference.

Sights - Night

- Night Sights (U)
TM 17-67, Confidential Report
R. R. Kramer

(U) A series of tests was conducted to determine if illuminated modified iron sights would provide increased hit probability. The illumination consisted of low power point sources on either the front or rear sight of the rifle, or both. Tests were conducted indoors under controlled light levels using CO₂-powered repeating-pellet rifles, and outdoors using .22 cal rim fire rifles, M-16, and M-14 rifles.

Sights - Optical

- Low Power Optical Systems and Aerial Target Detection
TM 5-57, Uncl.
M. I. Kurke, C. N. McCain, Jr.

Several monocular optical systems were investigated at Aberdeen Proving Ground, Md., and Yuma Test Station, Ariz., to find minimum visibility thresholds for detecting airborne targets. In general, there was an inverse relationship between threshold and magnification. The Yuma study was conducted to determine the minimum magnification needed to detect aircraft at a range of 10,000 yards. The 3x optics met this criterion. However, when parts of the Yuma study were repeated at Aberdeen Proving Ground, under better controlled conditions, results indicated that 2 1/2 power would be comparable at the required range. Empty-field myopia did not seem to affect target detection under the conditions studied.

GENERAL
Sensory and Perceptual

Spotting Rounds

- A Human Engineering Evaluation of Spotting Rounds
with Respect to Fire Direction Capabilities
TM 4-59, Uncl.
C. Fried, L. F. Ivey

Twelve enlisted men were used as subjects in an exploratory experiment conducted to evaluate spotting rounds with respect to fire direction capabilities. The spotting rounds were randomly placed around the target. Observations were made from four distances -- 500, 1000, 1500, and 2000 yards. The subjects were required to make corrections in yards for azimuth and range from the position where the spotting round appeared to the actual target position.

- An Evaluation of Observer Errors in Spotting Round Fire Control
TM 4-60, Uncl.
R. T. Gschwind

A field investigation was conducted to measure human errors associated with spotting round fire control. Ten mortar observers were used to direct fire of a 60-mm mortar at each of five 8' x 8' vertical targets randomly positioned within the range of the weapon. They were allowed five rounds to adjust and were instructed to call on target when they thought a round fell within 25 yards of the target.

Nearly all the subjects thought they had determined the range after five rounds, however, the distribution of range error when calling on target had an average deviation from the target of seven percent of the range of the target.

- The Effectiveness of Various Spotting Techniques in Fire Control: A Pilot Study
TM 9-61, Uncl.
S. Glucksberg, H. L. Klein

Spotlights were used to simulate spotting bursts in an investigation of several spotting techniques.

Thirty-two subjects estimated distances from specified lights to a target. Comparisons of accuracy under the following conditions were made: (1) one light vs. two lights, (2) simultaneous vs. serial presentation of lights, (3) reference distance between lights given vs. no given reference.

No reliable differences were obtained between any conditions. Distance estimation was found to be extremely poor under the conditions used. It was concluded that the spotlights could not be used as burst simulators because of their visibility when OFF.

Target Detection

- See Vigilance, TM 1-66, Page I-16.

Target Detection - Limited Visibility

- Human Limitations of Line of Sight Missiles During Limited Visibility
TM 3-68, Uncl.
A. J. Eckles, III, T. A. Garry, W. C. Mullen

This paper examines the effects of several intervening light sources on a viewer's optical image of an illuminated target presented during periods of limited visibility. Quantitative measures of resulting target obscuration as affected by target brightness, light-source intensity and light-source range were obtained.

Target Detection - TV

- Target Detection Using Black-and-White Television
Study I: The Effects of Resolution Degradation on Target Detection
TM 9-65, Uncl.
L. C. Oatman

The probability of detecting an M-48 tank at four different levels of television (TV) resolution (800, 600, 400, and 300 lines) was investigated on a black-and-white closed-circuit TV system.

The four levels of TV resolution were presented to 16 subjects, who were asked to indicate in which one of nine areas the tank appeared on the TV screen.

The data indicated that subjects performed about equally well at the 800, 600, and 400 levels of resolution; however, their performance was significantly poorer at the 300 level of resolution. The tank's location on the TV screen was an important factor in the probability of target detection, but was confounded with other variables.

- Target Detection Using Black-and-White Television
Study II: Degraded Resolution and Target-Detection Probability
TM 10-65, Uncl.
L. C. Oatman

This study used a black-and-white closed-circuit television (TV) system to investigate the effects of two levels of TV resolution (800 and 450 lines) on the probability that subjects would detect an M-48 tank. While a previous study used horizontal degradation only, this one degraded the TV image in both horizontal and vertical dimensions.

The tank was shown in each of nine areas of the TV screen, under both levels of resolution. Thirty subjects observing the TV monitor were asked to indicate in which of the nine areas the tank appeared.

With changes in the horizontal resolution only, in the previous study, changing resolution from 800 to 450 lines did not affect target-detection probabilities significantly. But with both horizontal and vertical changes, subjects performed significantly better at the 800 level of resolution than at the 450 level. The tank's location on the TV screen, although confounded with other variables, appeared to have an important effect on target-detection probability.

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- Target Detection Using Black-and-White Television
Study III: Target Detection as a Function of Display Degradation
TM 12-65, Unc1.
L. C. Oatman

Two previous studies have examined the probability of detecting an M-48 tank on a black-and-white closed-circuit television (TV) system, with apparently conflicting results. When only horizontal resolution was reduced to get resolutions of 300, 400, 600, and 800 lines, detection performance was essentially the same for the three highest resolutions, though significantly poorer for the 300-line resolution. Yet when resolution was reduced in both horizontal and vertical dimensions, 800-line resolution gave better detection performance than 450-line resolution did. Extraneous variables that could not be controlled -- such as uneven brightness and resolution on the TV monitors themselves -- made it difficult to interpret these results. Thus it was not clear whether the first result was an unlikely chance event or whether resolution's effect depends on the number of dimensions reduced. The present study replicated the first one to test its verifiability.

Displays at all four levels of resolution were presented to 20 subjects, who were asked to indicate in which one of nine areas the tank appeared on the TV screen. The results verified those of the first study: the subjects detected targets about equally well with the 800-, 600-, and 400-line resolutions, but their performance was significantly poorer with 300-line resolution. This finding suggests that, if resolutions are equal, reducing both horizontal and vertical dimensions will impair detection performance more than reducing just horizontal resolution (i.e., reducing bandwidth). The effects of the tank's location on the TV screen, although probably an important determinant of target-detection probability, again proved impossible to isolate from various extraneous variables.

Target Detection - Tanks

- ✓ ● Target Detection: A Comparison of Several Vision Systems
Mounted in Stationary and Moving Tanks (U)
TM 7-67, Confidential Report
G. L. Horley, A. J. Eckles, III, R. E. Dax

Two field studies compared detection performance of several tank vision systems: open hatch, closed hatch, periscope, telescope and television. The studies involved observations against defending (stationary) and attacking (moving) targets and observations from both stationary and moving tanks. Experienced tank commanders and gunners served as observer-subjects. The combined results rank the detection performance of the five vision systems tested; in addition, the Study II results compare stationary versus moving observations. Further research is recommended with a wider variety of surveillance tasks to obtain more complete measures of overall surveillance performance.

Vigilance - Aircraft Detection

- Detection of Random Low-Altitude Jet Aircraft by Ground Observers
TM 7-60, Uncl.
W. Wokoun

This study investigated the efficiency of the human ground observer in detecting and identifying jet fighter aircraft, as a function of size of sector, observer and aircraft altitude, when targets appeared essentially at random. Particular emphasis was placed on allowing the subjects minimal information about when and where aircraft might appear. The evaluation included four search-sector sizes (360° , 180° , 90° , and 45°). Three types of jet aircraft (T-33, F-86, and F-100) approached along six courses at two altitudes (500 and 1500 feet).

Results include cumulative probability curves indicating the likelihood that aircraft will be detected or identified at any given distance for the various combinations of search-sector size and altitude, as well as supplementary analyses of day-to-day variations in detection efficiency, the effect of intertrial interval, variation due to aircraft course and terrain, variation due to cross-over range, and accuracy of identification.

- Subjective Reports from Subjects in an Aircraft Detection Study: A Questionnaire Analysis
TM 22-62, Uncl.
W. Wokoun

Questionnaires were administered to 22 subjects who had served as ground observers in an aircraft detection study conducted by another agency at White Sands Missile Range, New Mexico. This report summarizes the subjects' responses to questions about how they tried to detect aircraft and the variables which they felt had affected their efficiency in doing so.

Vigilance - Auditory Fatigue

- Role of Tonal Relevance in Auditory Fatigue
TM 7-68, Uncl.
L. C. Oatman, G. R. Price

A new rationale concerning the subject's attitude toward a tone during exposure was tested in an attempt to find evidence for a central factor in auditory fatigue. The subjects were instructed, in one instance, to attend to the intensity of a 40-dB SL, 4.0-kHz tone. The amount of auditory fatigue that resulted was insignificantly different from conditions in which the subjects had been engaged in mental arithmetic or reverie during similar exposures.

Vigilance - Auditory Localization of Helicopters

- Auditory Localization of a Helicopter -- From Ground Position
TM 15-63, Uncl.
R. W. Bauer

Three studies of unaided auditory localization of a helicopter are summarized. In each, a UH-1B helicopter in flight was the sound source and was localized by subjects on the ground. Absolute mean angular errors of different groups and under different conditions ranged from 8° to 24° and more, with smaller errors found under quieter conditions and at greater target ranges. Error size was not significantly affected by: flight direction, altitude changes from

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low nap-of-the-earth (20-60 feet) to low contour (100-110 feet); interfering noises from 90-mm gunfire; or wearing a combat helmet. There were significant differences associated with interfering noise from passing vehicles and with subjects' auditory acuity.

Vigilance - Ground Target Detection

- Helicopter Armament Program Air-to-Ground Target Detection and Identification
TM 1-62, Uncl.
C. G. Moler

This study was conducted to gather baseline data on the ability of observers to detect, identify, and estimate slant range to typical stationary ground targets from low-flying helicopters.

All subjects were rated pilots with training and/or experience in aerial observation. Targets consisted of five types varying in size from the M-48 tank to a single machine gun on antiaircraft mount.

Rank order of target types as determined by frequency of detection was tank, jeep with recoilless rifle, support platoon, Scorpion, and machine gun. Tables of probabilities of detection, probabilities of correct identification, and the ranges at which each target type was most often detected are presented in this report.

- Helicopter Armament Program Air-to-Ground Range Estimation
TM 2-62, Uncl.
G. Goldstone, L. C. Oatman

This study was conducted to investigate the ability of an observer to estimate slant range from altitudes of 50, 100, and 150 feet, utilizing both "pop-up" and "running" modes of flight over various terrain types.

Twenty percent of the range estimates had overcalls of no greater than nine percent error and undercalls of no greater than six percent error.

The results of the course and altitude variables did not yield a statistically significant difference under either the "running" or "pop-up" mode of flight.

- A Field Survey of Air-to-Ground Target-Detection Problems
TM 1-66, Uncl.
S. A. Hicks, C. G. Moler

Twenty enlisted men were tested on a target-detection task at Fort Ord, Calif. Each subject was required to detect ten targets appearing at ranges of 1000 meters to 2100 meters. Forty trials were run. The results indicate that detection and identification depend on more than mere distance between target and observer. Not only did a target's size and form affect its detectability, but it appeared that the main cause of misidentifications was differing targets with similar sizes and forms. These results are related to current literature, and their implications for the course of the program are examined.

- Acquiring and Relocating Targets from a Helicopter: A Preliminary Investigation
TM 2-66, Uncl.
R. A. Monty, S. A. Hicks, C. G. Moler

This preliminary investigation was conducted to help resolve the controversy over whether or not a helicopter in combat can increase its safety by performing an evasive maneuver after detecting a target but before firing on it. The result showed that, at least in one situation, the evasive maneuver can give the helicopter some advantage, but not for the reasons hypothesized. It was concluded that the problem is sufficiently complex to warrant additional research.

Vigilance - Speed and Accuracy

- Absolute Judgments in Speeded Tasks: Quantification of the
Trade-Off Between Speed and Accuracy
TM 11-68, Uncl.
R. G. Pachella, D. F. Fisher, R. Karsh

The subjects engaged in making absolute judgments were gradually forced to increase the speed of their responses. Information transmission decreased linearly as criterion time was decreased from 1.0 second to 0.4 second.

C. Motor Performance

Controls - Arrangement

- An Evaluation of Mode Selector Switch Arrangements
TM 10-59, Uncl.
G. B. Wattles, E. C. Weiss, D. E. Holzen

A study was initiated to determine the optimum switching arrangement in terms of operator performance for the selection of track, acquisition, and search modes for a proposed AA weapon system. Five switching arrangements were evaluated, and these constituted the independent variable conditions.

The dependent variables were: (1) errors of omission, (2) errors of commission, (3) breakdown rate, and (4) subjective statements of preference.

One hundred subjects were examined in terms of their performance on the various switching arrangements using time as a stressor. An arrangement which employed a push button and two bar switches, all hand-operated, was found to be optimum.

Controls - Population Stereotypes

- Investigation of Natural Movements in Azimuth and Elevation
Lever Control Adjustments for Horizontal and Vertical Positions
TM 3-59, Uncl.
R. G. Lazar, J. R. Williams

This study was designed to: (1) determine population stereotypes or "natural" movements involved in the operation of levers designed to control elevation and azimuth movements; (2) determine in which plane levers should be placed to better effect control, i.e., the horizontal or vertical plane.

Results indicated that there is a consistent relationship between right and left control movements and right and left movements of a display in both the horizontal and vertical positions. However, the major finding was that there is no such consistency or "natural" movement or population stereotype with vertically positioned lever controls which move forward and backward when these controls are associated with an up and down display movement.

Controls - Rotary

- Manual Rotary Performance
TM 7, Uncl.
J. D. Weisz

This report discusses manual rotary performance -- a type of repetitive movement people use in cranking an automobile, sighting a mortar, laying an artillery gun in azimuth, etc. The author distinguishes between two types of rotary controls -- cranking wheels and handwheels -- and discusses how their operational factors differ.

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Motor Performance

- Physical Force Problems: I. Hand-Crank Performance
for Various Crank Radii and Torque-Load Combinations
TM 3-57, Uncl.
L. T. Katchmar

Investigation of the normal work output of 75 military subjects who turned handcranks of various sizes against varying torque-load resistances. Three handcrank radii (4, 5, and 7 inches) and five torque loads (10, 30, 50, 70, and 90 inch-pounds) were used.

Learning - Effect of Experimenter

- The Influence of Military Rank of Experimenter on the
Conditioning of a Verbal Response
RM 10-62, Uncl.
S. Glucksberg

The relative effectiveness of experimenters of different military ranks as sources of reinforcement was investigated in a verbal conditioning task. With all experimenter variables, other than perceived formal rank, held constant, no effects of rank were obtained. Only those subjects who were aware of the contingency between their responses and the experimenter's behavior increased their use of the reinforced response. Implications for psychological research in a military setting are discussed.

Learning - Verbal

- Indicators of Response Strength Hierarchies in Continued Word Association
TM 1-67, Uncl.
B. G. Andreas

One minute of continued word association was shown to yield both the Noble (1952) and Noble and Parker (1960) indicant of meaningfulness, m , and the Bilodeau and Howell (1965) indicant of probability of response occurrence. The probability values (proportion of Ss giving particular responses) were determined over the entire period of response production as well as for the initial group of three responses. The median ordinal position of response occurrence was also calculated. The probability values of the present study correlated positively with those obtained by Bilodeau and Howell. Over the restricted range studied, these p values did not correlate significantly with median ordinal position.

- Stability of Response Strength Hierarchies in Continued Word Association
TM 4-67, Uncl.
B. G. Andreas, M. Mills

Selected stimulus items were repeated in a booklet testing continued word associations. Subjects had been instructed to treat any such recurrence as a new encounter, neither trying consciously to repeat nor to avoid repeating their earlier responses. Slightly fewer than half of the original responses were repeated by individuals, although total production was about the same. Correlations indicated high stability of common response probabilities and low to moderate stability of ordinal positions of responses.

Loading - Heavy Ammunition

- Some Human Factors Considerations in Loading Heavy Ammunition (U)
TM 8-67, Confidential Report
N. F. Dickinson, Jr., G. P. Ganem, J. P. Torre, Jr.

(U) The results of two related ammunition-handling studies are incorporated here into a single report.

(U) The first study investigated the effects of round weight, tray height, and tray elevation on the loading of 155mm projectiles. All three variables were found to affect loading performance significantly.

(U) The second study used the same test projectiles, the same test apparatus and similar test procedures to see if right or left-hand loading made any difference in performance. No significant difference was discovered.

Loading - Missile Dimensions

- The Effects of Missile Lengths and Weight on Loading Time
TM 9-60, Uncl.
F. M. McIntyre

The purpose of this study was to determine if length or weight or an interaction between the two within selected limits affected most significantly the criterion of loading time for a given number of rounds.

Portability - Principles

- An Investigation of Portability Principles for Two-Man Loads
as Applied to T201 Mortar
TM 16-61, Uncl.
L. V. Clark

A study was conducted to investigate the effects of human engineering principles upon portability of two-man loads ranging from 100 to 170 lbs. in weight. Components of a T201 mortar were equipped with portability kits in the form of detachable stretcher and satchel-type handles. The components were transported for about 1/2 mile over varying types of terrain. Distance, rate of carry, plus time and frequency of rest were used as measures of portability.

It was found that stretcher-type handles make a significant improvement in portability and that, by using these handles and relieving the strain upon the porters' hands, optimum portability can be achieved.

It is recommended that portability be considered in the development of heavy infantry weapons as efficient, tactical usage may be dependent upon portability.

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- An Evaluation of 50 and 80 lb. Ammunition Containers and Recommendations for Improved Package Design
TM 5-58, Uncl.
S. A. Hicks

This study compared the efficiency with which two different weights of ammunition containers (50 and 80 lb.) could be man-carried across a one hundred and fifty yard course of irregular terrain. It was concluded that under test or assumed normal conditions two 50 lb. containers were an optimal load for a single ammunition bearer. An ammunition package design concept was formulated embodying a combination folding top handle and lock actuating lever, and a detachable side handle.

Reaction Time - Galvanic Skin Resistance

- Relationship Between Galvanic Skin Resistance and Reaction Time on a Vigilance Task
TM 8-61, Uncl.
R. Karsh

Relationships between five indices of galvanic skin resistance (GSR) and three indices of reaction time obtained during a visual monitoring task were investigated.

Thirty-nine untrained enlisted men monitored a cathode ray tube screen for a one-hour period in an isolated environment. Observers were required to detect 25 critical signals which differed from a periodically blinking background signal only by a larger amplitude. Performance was measured by reaction time. Continuous measures of GSR were obtained.

Interrelationships among GSR indices as well as mean reaction time changes over time were consistent with earlier reports on these variables. No significant relationships were found between indices of GSR and reaction time, between or within observers. Extreme individual variation of both variables was observed.

Short Term Memory

- Paced Rehearsal in Sequential Short-Term Memory
TM 12-66, Uncl.
R. A. Monty, R. Karsh, H. A. Taub

Subjects were required to mentally keep track of the number of occurrences of each of four different symbols presented sequentially. It was found that a green light introduced into the sequence just prior to the presentation of each successive symbol tended to enhance performance. It was suggested that the light served to cue the subjects to complete rehearsal of the current state of the information in preparation for the next stimulus in the sequence.

● Stimulus Characteristics and Spatial Encoding in Sequential Short-Term Memory

TM 3-67, Uncl.

R. A. Monty, D. F. Fisher, R. Karsh

Performance of the keeping-track task described by Monty, Taub, and Laughery was examined as a function of the class of stimuli employed. It was found that a stimulus class possessing a natural or built-in order led to better performance than did a stimulus class lacking such order. It was suggested that the differences stem from the speed with which subjects complete encoding of the information to be remembered rather than from the time available for rehearsal between successive stimuli.

● Keeping Track of Sequential Events: Irrelevant Information and Paced Rehearsal

TM 5-67, Uncl.

R. A. Monty, R. Karsh, H. A. Taub

The effects of irrelevant information on subjects' ability to keep track of a changing situation mentally were examined. It appears that, when relevant stimuli are presented at an irregular rate of presentation, irrelevant stimuli interspersed with the relevant stimuli may enable subjects to pace rehearsal of the current state of the changing situation in a fashion that reduces the interference effects of the irregular rate of presentation.

● Keeping Track of Sequential Events: Effects of Stimulus On-Time and Interstimulus Off-Time

TM 6-67, Uncl.

H. A. Taub, R. A. Monty, K. R. Laughery

Subjects were required to keep track of the number of occurrences of each of four different letters (categories) presented sequentially as a function of the total number of letters presented (trial length), the rate of presentation, and the two components which, when combined, constitute the rate, namely, stimulus on-time and the interstimulus interval or off-time. In general, performance varied inversely with trial length and rate of presentation. Of greater importance, however, was the complex interaction between the rate of presentation and the components of that rate. At the fastest rate, performance was relatively invariant as a function of these components; at intermediate rates the shortest on-time led to the best performance, while at the slowest rate the shortest on-time led to the poorest performance. The observed results are explained primarily in terms of the time available for rehearsal.

● Sequential Memory: Keeping Track Performance as a Function of Information Exposure Time and Interstimulus Noise

TM 11-67, Uncl.

S. Glucksberg, R. Karsh, R. A. Monty

Subjects were required to keep track of the number of occurrences of each of three pure tones presented at a constant rate in sequences (trials) of various lengths. With trial lengths of 8 and 12 tones, as practice progressed the shorter the stimulus exposure duration, the better the performance. This effect was not obtained with trial lengths of 16 and 20 tones. White noise presented during interstimulus intervals did not affect performance. Implications for a model of keeping-track behavior are examined.

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- Pacing of Rehearsal in Sequential Short-Term Memory
TM 15-67, Uncl.
R. A. Monty, R. Karsh, H. A. Taub

The subjects were required to keep track mentally of the number of occurrences of each of four different symbols presented sequentially. It was found that a light introduced into the sequence just prior to the presentation of each successive symbol tended to enhance performance. It was suggested that the light served to cue the subjects to complete rehearsal of the current state of the information in preparation for the next stimulus in the sequence.

- Brief Visual Memory as a Function of Visual and Acoustic Confusability
TM 16-67, Uncl.
S. Glucksberg, D. F. Fisher, R. A. Monty

Sperling's technique of partial report was used to examine the effects of visual and acoustic confusability on brief visual memory. The data suggested that insofar as interference effects are concerned, short-term memory and brief visual memory are dissimilar in at least two respects: (a) visual rather than acoustic confusability affects brief visual memory, and (b) as the recall interval is increased, interference effects in brief visual memory decrease -- an observation opposite to that generally noted for short-term memory.

- Spatial Encoding Strategies in Sequential Short-Term Memory
TM 14-68, Uncl.
R. A. Monty

Keeping-track performance was examined as a function of cues designed to control the spatial encoding strategies adopted by subjects. Spatial organization of the material to be remembered significantly affected short-term retention and interacted with the characteristics of the type of stimulus materials employed, demonstrating that visual encoding can play an important role in short-term memory.

- Order of Recall in Short-Term Memory
TM 16-68, Uncl.
H. A. Taub, R. A. Monty

Short-term recall of letter sequences, color-coded into two halves, was measured as a function of color presented first, alphabet half presented first, order of report, and blocks of trials. Analysis of the first half of subjects' reports suggested that reports which reversed the colored halves were superior to an ordered report of the colors except in trial block one when the letters presented first in a sequence were from the first half of the alphabet. Trends from the second half of a report were in the direction of more accurate recall with reversed as compared to ordered reports.

Tracking - Control Systems

- Literature Review: Tracking Control Mechanisms and Displays
(Light Antiaircraft System Oriented)
TM 9-57, Uncl.
S. A. Hicks

A review of the literature dealing with tracking in general, control systems, display systems, compensatory vs. pursuit tracking, and auditory vs. visual displays. It is particularly relevant to designing fire-control systems for low-altitude antiaircraft weapons.

- Gunner Tracking Behavior as a Function of Three Different Control Systems
TM 2-63, Uncl.
R. T. Gschwind

An investigation was conducted to determine the magnitude and character of tracking errors occurring after firing a rocket at a moving target from a lightweight mount. Six professional gunners with varying degrees of experience fired 3.5-inch rockets from each of three distinct types of tracking devices, viz., a two-hand wheel system, an electrical rate system, and a viscously damped, integrated position control system (Free Mount).

There was no significant difference in magnitude of tracking error between the Free Mount and the rate system, with both achieving 0.5-mil RMS error across all conditions of angular rate. The two-hand wheel system was significantly worse with 1.0-mil error at low rates and 2.0-mils error at high rates.

Tracking - Error Measurement

- A Technique of Investigating Tank Gunner Tracking Error
TM 20-62, Uncl.
F. M. McIntyre

This study is a report of the ability of tank gunners to track continuously over a period of time, to evaluate the role of experience in reducing error, and to provide a basic measurement technique for future tracking studies. The study was conducted with experienced and novice subjects tracking a target tank through various evasive maneuvers around a rectangular course, at various ranges. The results of the study indicate that the instrumentation and procedure designed for this study provide a satisfactory technique of measuring tracking error, that the experience of the subject did not affect tracking performance in this problem, and that the measuring technique may be used to evaluate target evasive techniques as well as tracking error.

Tracking - Gun Turret

- An Investigation Comparing the Relative Effects of Two Modes of Gun Turret Operation on Tracking Performance: Study I
TM 4-62, Uncl.
H. C. Wallach, H. L. Klein

Two modes of gun turret operation were compared for their relative effects on tracking performance.

One mode of turret operation was termed fully articulated; the manned turret moved both in azimuth and elevation in response to operator hand-control movements. The second mode of turret operation was termed partially articulated; in response to the hand controls of the operator who manned the turret, the turret moved in azimuth, but only the sight moved in elevation, rather than the complete turret.

The results of the data analysis, based on 20 test target runs per subject, following 52 practice target runs, indicated that there were no significant differences in tracking performance attributable to the dissimilarities between the two modes of turret operation.

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Motor Performance

- An Investigation Comparing the Relative Effects of Two Modes of Gun Turret Operation on Tracking Performance: Study II
TM 5-62, Uncl.
H. L. Snyder, L. C. Oatman, H. C. Wallach

The objective of this experiment was to investigate how two modes of gun turret operation compare in facilitating tracking performance.

One mode of turret operation was termed fully articulated; the manned turret moved both in azimuth and elevation in response to operator hand-control movements. The second mode of turret operation was termed partially articulated; the manned turret moved in azimuth, but the sight alone moved in elevation.

The results of the data analysis indicated that, over the 56 target runs each subject tracked, there were no significant differences in tracking performance between the two modes of turret operation, however, the interaction between mode and trials was significant.

Tracking - Pursuit - Delay Times

- Performance of a Pursuit Tracking Task with Different Delay Times Inserted Between the Control Mechanism and the Display Cursor
TM 12-61, Uncl.
H. C. Wallach

The object of this investigation is to estimate the extent of deterioration of performance on a pursuit tracking task when various time delays are inserted between the control corrections and the corresponding display movements.

The results indicate that performance on this particular pursuit tracking task tended to deteriorate as the delay time was increased. It should be emphasized, though, that after as little as 1/2 hour of practice on the task, the performance of 11 of the subjects was at a level much superior to a "chance" level of control. However, the relationship between the amount of delay time and the degree of adequacy of control performance was not very clear-cut, in that the group variability of tracking scores was roughly proportional to the group mean values.

Tracking - Rotary Pursuit - with Extraneous Tasks

- Rotary Pursuit Tracking with Divided Attention to Cutaneous, Visual, and Auditory Signals
TM 5-63, Uncl.
S. Glucksberg

Cutaneous communication has been suggested for use in several types of military tasks. This investigation was designed to compare the disruptive effects of visual, auditory, and cutaneous (electrical) stimulation upon pursuit rotor tracking performance. Subjects were required to respond to a specified signal (light, sound, or electric current) while engaged in tracking. Only one modality was employed at any one time. Three distractive signal detection tasks were used: (1) simple reaction time (RT), (2) disjunctive RT requiring a spatial discrimination and (3) disjunctive RT requiring an intensity discrimination. In all three cases attention to visual signals significantly impaired tracking accuracy. Neither auditory nor cutaneous stimulation disrupted tracking performance.

D. Environmental Factors

Anthropometrics

- Minimum Cubic Dimensions for Operators of an Integrated Fire-Control System
TM 22, Uncl.
H. W. Nelson, J. E. Leopardo

Compilation of data concerning minimum dimensions for an integrated fire-control system.

- See H&L Standards S-2-64 and S-6-66, Page I-2.

Arctic

- A Literature Survey of Human Performance under Arctic Environment
TM 6, Uncl.
S. L. Reevesman, J. R. Hollis, J. B. Mattson, Jr.

The authors review troop operational factors in the arctic by surveying the literature and interviewing organizations that do such research. They conclude that: (1) arctic conditions seem to affect troop performance and should be considered in designing machines for arctic use; (2) the information needed to adequately modify man-machine systems for arctic use is not yet available; (3) the effects of arctic conditions on troop operational factors need more detailed, specific study.

- Human Engineering Arctic Field Liaison Study
TM 19, Uncl.
E. Charney, L. T. Lee, A. J. Rose

This report gives human engineering information about specific items of Ordnance equipment used in the Alaskan Command. A field liaison team observed Exercise MOOSEHORN and visited the Arctic Test Branch, CONARC, at Ft. Greely, Alaska, during January and February 1956. It also investigated some items further at Ft. Richardson, Alaska. This survey had three objectives: (1) to answer specific questions about Ordnance equipment in the arctic; (2) to determine the important human engineering problems that occur under arctic conditions; and (3) to find out what field expedients the users had adopted, and how they suggested solving these human engineering problems.

The liaison team interviewed both officer and enlisted personnel, and it observed the firing and tactical handling of equipment items used in Exercise MOOSEHORN.

- A Study of Cold Weather Organizational Maintenance Problems (M29, M59, M76)
TM 6-57, Uncl.
D. K. Andrew, A. S. Bacon, A. J. Rose

This study investigated maintenance problems of the Cargo Carrier M29, Amphibious Cargo Carrier M76, and the Armored Infantry Vehicle M59 under cold-weather conditions by surveying drivers and organizational maintenance men assigned to the Yukon Command, Alaska. Although this study was originally focussed only on human engineering maintenance problems, its scope was enlarged as it uncovered information and problems in other areas.

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Environmental

Blast - Rhesus Monkeys

- An Exploratory Study into the Effects of Low Blast Pressure on Behavior in Rhesus Monkeys
TM 11-59, Uncl.
J. J. Romba, P. Martin

Four psychological-test-sophisticated Rhesus monkeys were exposed to 90 shots of 5 - 7 pounds per square inch blast peak overpressures, and changes in behavioral phenomena were noted.

Interference with performance improvement on learning tests was apparent. Selective decrements in motor coordination were also noted. No locomotor activity changes were observed.

Blast - Transmission - Monkey Model

- The Propagation of Air Shock Waves on a Biophysical Model
TM 17-61, Uncl.
J. J. Romba, P. Martin

Shock wave characteristics were studied in the field about and within the Rhesus monkey body form. Measurements were obtained in free air, top of the animal's head, the mid-brain, and the lower thorax, with distance and position of the explosive varied in relation to the animal's body. The study of shock wave transmission from one body level to another was accomplished, and the problem complexity of shock wave energy distribution in the field of the organism was emphasized. Shock wave forms were observed to be uniquely characteristic of the medium through which shock wave transmission occurred. In addition, body tissue was found to greatly attenuate the shock wave. The study of shock wave characteristics in and about biophysical media is believed to be relatively unexplored.

Confinement

- The Effects of Four Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: A Pilot Study
TM 3-60, Uncl.
S. A. Hicks

This study was undertaken to determine changes in general combat relevant performance as a result of four hours confinement in a maneuvering armored personnel carrier. Fifty enlisted men were tested both before and after confinement on tests designed to measure stamina, response time, gross motor coordination, arm steadiness, equilibrium, and eye-arm coordination. The four-hour confinement period resulted in losses in all areas. The losses were statistically significant in three areas.

- The Effects of Eight Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: Study II
TM 17-60, Uncl.
S. A. Hicks

Second study in a series designed to determine changes in general combat relevant performance as a result of sustained confinement in a maneuvering armored personnel carrier. The purpose of this investigation was to determine the effects of eight hours confinement. Forty enlisted men were tested both before and after confinement on tests designed to measure stamina, eye-arm coordination, gross motor coordination, arm steadiness, and rifle accuracy. The eight-hour confinement period resulted in losses in three areas. The losses were statistically significant in two areas.

- The Effects of Twelve Hours Confinement in Static Armored Personnel Carriers on Selected Combat Relevant Skills: Study III
TM 1-61, Uncl.
S. A. Hicks

Third study in a series designed to determine changes in general combat relevant performance as a result of sustained confinement in armored personnel carriers. The purpose of this investigation was to determine changes in performance as a result of 12 hours confinement in static (stationary) armored personnel carriers. Secondly, it was intended to determine the extent to which subjects' activity level contributes to the observed decrements. Forty enlisted men were tested both before and after confinement on tests designed to measure stamina, eye-arm coordination, gross motor coordination, and rifle accuracy. The 12-hour confinement period resulted in statistically significant losses in three areas.

- The Effects of Twelve Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: Study IV
TM 2-61, Uncl.
S. A. Hicks

Fourth study in a series designed to determine changes in general combat relevant performance as a result of sustained confinement in armored personnel carriers. The purpose of this investigation was to determine changes in performance as a result of 12 hours confinement in mobile armored personnel carriers. Forty enlisted men were tested before and after confinement on tests designed to measure stamina, eye-arm coordination, locomotor coordination, equilibrium, and hand-arm steadiness. The 12-hour confinement period resulted in statistically significant losses in stamina and locomotor coordination.

- The Effects of Twenty-Four Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: Study V
TM 23-61, Uncl.
S. A. Hicks

Fifth study in a series designed to determine changes in general combat relevant performance as a result of sustained confinement in armored personnel carriers. The purpose was to determine changes in performance as a result of 24 hours confinement in mobile armored personnel carriers. Forty-four enlisted men were tested before and after confinement on tests designed to measure stamina, eye-arm coordination, locomotor coordination, equilibrium, and hand-arm steadiness. The 24-hour confinement period resulted in a statistically significant loss in eye-arm coordination and hand-arm steadiness.

GENERAL
Environmental

- The Effects of Twenty-Four Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: A Follow Up
TM 7-62, Uncl.
S. A. Hicks

Sixth study in a series designed to determine changes in general combat relevant performance as a result of sustained confinement in armored personnel carriers. The purpose of this investigation was to determine changes in performance as a result of a confinement period of 24 hours duration. Forty-four enlisted men were tested before and after confinement on tests designed to measure stamina, eye-arm coordination, locomotor coordination, equilibrium, and hand-arm steadiness. The 24-hour confinement period resulted in statistically significant losses in all areas excluding eye-arm coordination.

- The Effects of Repeated Confinement on the Performance of Men in a Hot-Wet Climate
TM 7-63, Uncl.
S. A. Hicks

This investigation is the seventh in a series designed to determine changes in general combat-relevant performance as a result of sustained confinement in armored personnel carriers. The present study examined how a hot-humid environment modified the performance of men confined to an armored personnel carrier. Eleven enlisted men took tests of choice reaction time, hand-steadiness, equilibrium, and running speed both before and after confinement. In the hot-wet environment, confinement produced statistically significant losses in hand steadiness, equilibrium, and running speed. Recommendations for future research are included.

- The Effects of Repeated Confinement on the Performance of Men in a Temperate Environment
TM 11-64, Uncl.
S. A. Hicks

This investigation is the eighth in a series designed to determine changes in performance as a result of sustained confinement in armored personnel carriers. The present study examined the effects of confining a single group of subjects for a 12-hour period on each of five successive days. Ninety enlisted men took tests measuring equilibrium, stamina, gross motor coordination, and marksmanship. There were statistically significant losses in all areas after the initial confinement period. Subsequent trials showed progressively smaller decrements until, at the end of the final session, the subjects performed at the pre-confinement level. It was concluded that repeated exposure to confinement produces an adaptation phenomenon which voids the obviously transient effects that accompany intermittent exposure.

- The Effects of Confinement on the Performance of Combat Relevant Skills. Summary Report
TM 16-64, Uncl.
S. A. Hicks

This report summarizes the results of the U. S. Army Human Engineering Laboratories program on confinement in armored personnel carriers. The results are reported as they relate to the goals of the overall program and as individual studies relate to one another. Vehicle design deficiencies are cited and discussed.

- Group Behavior in Prolonged Confinement: Review and Annotated Bibliography
TM 14-65, Uncl.
A. R. Honigfeld

Field and laboratory confinement studies were reviewed to evaluate existing information and to identify areas where future research will be needed.

The studies reviewed deal with confinement of two or more people in a restricted space for a prolonged period of time, and they devote particular attention to how performance degrades under such conditions.

Few of the studies yield data pertinent to the Army's chief interest in confinement: how men will perform during prolonged confinement in armored vehicles.

The review concludes with recommendations for studies designed to yield confinement information more directly relevant to the Army's interest.

Desert

- Report on Preliminary Observations of Human Engineering Problems under Desert Conditions
TM 11, Uncl.
S. L. Reevesman

Most Ordnance equipment is designed for use in extreme environments. While the equipment is tested to assure it will operate in extreme environments, little attention is given to how these environments affect the people who use it. This report gives subjective comments about how desert conditions affect the man-machine system, and how much they affect it.

- Measurement of Temperatures in Various Ordnance
Equipment under the Desert Environment
TM 14, Uncl.
S. L. Reevesman, F. W. Schulze

The temperatures encountered by personnel operating equipment at Yuma Test Station, Yuma, Ariz., were surveyed to define the range of temperatures that would be encountered in the desert, as a basis for simulation in laboratory tests.

- Visual Efficiency under Desert Conditions
TM 20, Uncl.
L. T. Katchmar, R. E. Jelinek, D. C. Hodge

This study attempted to find out how some environmental conditions that are typical in hot deserts affect visual acuity, depth perception, and retinal sensitivity to critical flicker frequency.

GENERAL Environmental

Lighting

- Lighting Small-Shelter Interiors: Criteria and an Example
TM 13-65, Uncl.
G. L. Kurtz

This report gives lighting criteria and lighting-system design methods for illuminating small-shelter interiors effectively. It summarizes the amounts of light (quantity) currently recommended for representative visual tasks, as well as the practices for controlling light (quality).

Then, to show how these lighting-design methods are actually applied, it describes a lighting system designed for the proposed control cab of a mobile low-power nuclear power plant. This lighting system was evaluated by making a lighting survey in a control-cab mock-up. The results showed the system satisfied the lighting criteria established for the shelter.

Music and Vigilance

- Vigilance with Background Music
TM 16-63, Uncl.
W. Wokoun

This study draws together two sorts of work -- attempts to improve vigilance performance and use of background music in industrial settings -- to explore how background music affects performance on a vigilance task. Fourteen subjects were tested on a simple disjunctive reaction time task, which gave eight stimuli in an hour's session. The independent variable was music (a specially programmed Muzak tape recording) vs. continuous noise (a small fan in the experimental room). The performance of subjects who worked while hearing noise did not change significantly during the hour. However, the subjects who heard background music responded significantly better (faster) during the latter two-thirds of the hour than they had at first. Also, the music group performed significantly better in the middle third of the hour than during the last third. Other tests, comparing the groups with each other, rather than with themselves, did not demonstrate significant differences with the number of subjects used.

- Effects of Music on Work Performance
TM 1-68, Uncl.
W. Wokoun

Sixty-three subjects worked at a vigilance task for an hour while listening to one of three musical programs. While all three programs included the same 23 selections, the Ascending Program grew steadily more lively, and the Descending Program grew steadily less lively, while the Increasingly Variable Program progressively increased the contrast between adjacent selections. Results showed that changing the sequence of the 23 selections profoundly affected reaction times and variabilities, as well as individual consistency. Subjects performed the vigilance task better with the Ascending Program than with the other two programs.

- Work Performance with Music: Instrumentation and Frequency Response
TM 9-68, Uncl.
W. Wokoun

This experiment tested whether music's instrumentation affects response times on a vigilance task. Instrumentation was varied by restricting the frequency range, thus eliminating many of the overtones that determine timbre. Forty-one subjects worked at the task for one hour while listening to a program of 23 selections, alternately Wide-Range and Filtered. The subjects showed significantly better alertness during the Wide-Range condition throughout the hour. The Filtered condition gave slower response, greater variability, and inferior individual consistency. Hence the music's instrumentation had several significant effects on alertness. In addition, the more-stimulating musical program here appeared responsible for faster responses and lower variability than in the preceding experiment.

Night Flight Vision

- Night Flight Vision: I. Research Problems and Methods
TM 12-68, Uncl.
R. W. Bauer

Review of the literature in aviation and in vision, and consideration of photometric methods available, raise a number of fundamental questions about cockpit lighting. Dark adaptation and acuity must be examined in relation to the total cockpit light flux, the ambient illumination outside the cockpit, and the spectral composition of the light flux. Furthermore, the aircraft mission requirements must be incorporated into design decisions. The program of research recommended has a character consistent with that proposed by Bartelt, Twist, and Lazo (1966). Photopic and scotopic luminance, photometric and radiometric methods, color coding and contrast, and acuity at low luminances are reviewed. Analytic methods are described, and areas requiring fundamental human factors research are indicated.

- Night Flight Vision: II. Psychophysical Comparisons
of Three Colors of Cockpit Lighting
TM 13-68, Uncl.
R. W. Bauer

Three different spectral distributions of cockpit display lighting were investigated as to their effects on dark adaptation and visual acuity during night flight. These distributions were instrument and panel lighting red, tungsten (clear) white, and Air Force (lunar) blue-white. Cockpit-lighting brightness (photopic luminance), color and color combinations with the addition of indicator lights were controlled, and effects on dark adaptation and distant visual acuity outside the cockpit were measured. Interactions among lighting colors, photopic and scotopic visual acuities, and luminance thresholds for objects of different sizes were shown. Results were discussed in relation to the literature on dark adaptation and night vision in flight.

GENERAL
Environmental

Noise - Auditory Acuity Measurement - Monkeys

- A Method for Study of Hearing Loss and Recovery in Rhesus Monkeys
TM 11-62, Uncl.
P. Martin, J. J. Romba

A method is described for the rapid and reliable measurement of the Rhesus monkey's auditory acuity. This method proved suitable for determining the animal's hearing loss and subsequent recovery. Two important factors of the method were: (1) the controlled presentation of the pure tone stimulus through earphones which are affixed to the animal by means of a newly developed phone-holding device, and (2) the provision for obtaining a clearly defined indicator response. The method was evaluated in terms of the exposure of a monkey to one gun-generated noise impulse. Post-exposure audiograms were obtained rapidly and without difficulty.

- Hearing Loss in the Rhesus Monkey After Repeated Exposures to Identical Noises
TM 3-64, Uncl.
J. J. Romba, H. W. Gates

This experiment is the first in a series studying hearing loss in monkeys. Five animals were exposed to repeated single-pulse noises alternately at 72- and 96-hour intervals, to observe inter-subject and intra-subject variations in hearing behavior under similar physical-noise conditions. Audiograms were taken periodically, from two minutes after exposure to 72 hours later, for 2 and 4 kc test tones. There were distinctive differences in individual animal patterns of hearing loss and recovery. Two animals clearly showed smaller hearing losses during the later exposure sessions, and that loss phenomenon is discussed.

Noise - Auditory Fatigue

- Experiments on Central Factors in Auditory Fatigue
TM 9-66, Uncl.
G. R. Price, L. C. Oatman

The central factors affecting pure-tone auditory fatigue, already noted by Wernick and Tobias, were explored further in three experiments. The first experiment, replicating Wernick and Tobias' study, verified their results. However, observations made during Experiment I suggested several changes in procedure, which were used in Experiments II and III.

Results of Experiments II and III indicate that, when subjects can resume threshold tracking after the exposure without having to do anything else at the same time (such as writing an answer to a problem), the differences between the experimental groups disappear. Thus the effect that had been ascribed to central factors actually seems to be a procedural artifact. This interpretation is consistent with the procedures and findings of previous experiments.

Noise - Auditory Detection and Localization

- Auditory Localization of Noises
TM 4-65, Uncl.
R. W. Bauer, R. F. Blackmer

This report summarizes three studies of unaided auditory localization of fixed noise sources. Pointing was as accurate as aiming at auditory targets in darkness. Elevation errors were not significantly larger than azimuth errors. Subjects with hearing deviations (defects) performed as well as non-deviant subjects (normals) in auditory localization.

- Noise Localization After Unilateral Attenuation
TM 4-66, Uncl.
R. W. Bauer, J. L. Matuzsa, R. F. Blackmer, S. Glucksberg

Partial hearing loss was simulated by insertion of V51-R plastic ear plugs. Subjects wore plugs continuously for periods ranging from six hours to three days. Predictable shifts in localization errors were observed when the stimulus was a broad-band noise made up of frequencies above 3000 cycles per second. Reorientation in azimuth localization with ear plugs inserted required three days or more unless accelerated by specific training.

- Acoustical Considerations for a Silent Weapon System: An Exploratory Study (U)
TM 10-66, Confidential Report
G. R. Garinther, J. B. Moreland

(U) This report describes several detection studies for different types of impulse and steady-state noises associated with a silent weapon system. Both the effect of attentiveness on a listener's ability to hear these noises and the different types of information acquired by people listening to either subsonic or supersonic projectiles were investigated.

Noise - Continuous - Effects on Behavior

- Some Effects of Noise on Human Behavior
TM 6-58, Uncl.
N. H. Azrin

Military personnel were conditioned according to a fixed-interval schedule of target presentation and exposed to various conditions of noise. It was found that the effect of noise on behavior was largely a function of whether the noise had any differential relation to the target or to the responses. When noise, or its absence, was used as a discriminative stimulus for the target, responding came under the control of the noise, or its absence. Similarly, when intense noise, or its absence, was made contingent upon responses, the pattern and frequency of responding were found to vary as a function of the conditions of noise presentation. When the noise was not presented in some differential relation to the target or the responses, its major effects were transient and largely predictable on the basis of stimulus change.

GENERAL Environmental

- The Effect of Attention on Auditory Evoked Potentials
TM 15-68, Uncl.
L. C. Oatman

Click-evoked potentials were recorded from unanesthetized cats with electrodes chronically implanted in the auditory cortex, cochlear nucleus, and round window. The clicks (irrelevant stimuli) were presented continuously as background before, during, and after the presentation of a visual discrimination task (relevant stimuli) which attempted to alter the attentive state of the animals. The mean peak-to-peak amplitudes of averaged click-evoked responses from six adult female cats were significantly smaller during attention to the visual discrimination stimuli when compared with the pre-discrimination and control periods. This relationship was present at all electrode placements for five experimental animals with middle ear muscles cut as well as one control animal with middle ear muscles intact. The results suggest that during attention, a central inhibitory mechanism, independent of middle ear muscles, modifies click-evoked responses possibly via the olivo-cochlear bundle which terminates on the hair cells in the cochlea.

Noise - Continuous - Vigilance

- Relationships of Intermittent Noise, Inter-Signal Interval and Skin Conductance to Vigilance Behavior
TM 7-59, Uncl.
J. F. Dardano, I. Mower

Relationships of intermittent, low-intensity, ambient, white noise, inter-signal interval variability, and basal skin conductance to prolonged observation were investigated. Enlisted men monitored a cathode ray tube screen for a continuous three-hour period in an isolated environment. Observers were required to differentiate a total of 180 critical signals which differed from periodically blinking background signal only by a larger amplitude. Performance was measured by reaction time.

Monitoring performance did not deteriorate with low-variability of inter-signal intervals, 50 to 70 seconds. Intermittent noise impaired performance with this schedule by slightly increasing reaction times during the entire session. With a greater variability of inter-signal intervals, performance deteriorated continuously during the vigil and was unaffected by intermittent noise.

A minimum inter-stimulus interval of 30 seconds resulted in an inverse relationship between reaction time and length of inter-stimulus interval, at least up to the mean interval. Basal skin conductance was negatively correlated with logarithm of reaction time when performance deteriorated under a signal schedule requiring continuous observation.

Noise - Impulse

- Psychological and Physiological Effects of Muzzle and Breech Blast
TM 17-1, Uncl.
W. C. Blair, F. W. Schulze

A report on a literature search to guide future investigations of psychological and physiological effects of muzzle and breech blast.

- First Interim Report - Psychological and Physiological Effects of Muzzle and Breech Blast
TM 17-2, Uncl.
W. C. Blair

A report on design, methodology, results, and evaluation of the physiological and psychological effects of muzzle and breech blast.

- A Pilot Study of Temporary Threshold Shifts Resulting from Exposure to High-Intensity Impulse Noise
TM 19-61, Uncl.
M. G. Smith, G. Goldstone

This investigation was a pilot study to determine the temporary threshold shifts resulting from exposure to high-intensity impulse noise. The threshold shifts induced were of a temporary nature, i.e., there were no instances of permanent hearing losses among any of the experimental subjects. The purpose was to explore various physical parameters of a sound source and relate them to any decrements they may have on auditory acuity. Thirty enlisted men received audiometric tests both before and after exposure to a high-intensity impulse noise generated by an M14 rifle. Rate and number of impulses were varied separately and examined at three test frequencies.

- Preliminary Studies of the Impulse-Noise Effects on Human Hearing (Project HUMIN)
TM 15-64, Uncl.
D. C. Hodge, H. W. Gates, R. B. Soderholm, C. P. Helm, R. F. Blackmer

This report summarizes the accomplishments of the U. S. Army Human Engineering Laboratories impulse-noise program (Project HUMIN). After reviewing past research and stating the rationale for studying how impulse noise affects human subjects, it gives detailed descriptions of the apparatus and procedures which have been developed for the program. The results of four preliminary impulse-noise experiments with human subjects are presented and discussed, together with certain special problems which have arisen during the conduct of the program. Finally, the projected future course of the project is outlined.

- Reliability of Temporary Threshold Shifts Caused by Repeated Impulse-Noise Exposures
TM 3-65, Uncl.
D. C. Hodge, R. B. McCommons, R. F. Blackmer

Twenty-two subjects were exposed to the same gunfire-noise condition nine times. Their auditory thresholds were measured at six frequencies from 500 to 6000 cycles per second before and after exposure, and all temporary threshold shifts (TTSs) were converted to TTS_2 for ease of comparison. Fluctuations in mean TTS_2 were five dB or less for all frequencies across the nine exposures, but individual differences were large and the reliability coefficients were small. It was concluded that, while repeated-measurement experimental designs appear appropriate for impulse-noise studies, group data are more meaningful than data for individual subjects. Very small samples of subjects should not be used for such studies, because it is important to be able to generalize the results to the Army as a whole.

GENERAL
Environmental

- Further Studies of the Reliability of Temporary Threshold Shift from Impulse-Noise Exposure
TM 3-66, Uncl.
D. C. Hodge, R. B. McCommons

Three studies were conducted to determine the reliability, under various exposure conditions, of temporary threshold shift (TTS) produced by impulse noise. The subjects, who were representative of the Army population, were tested at frequencies throughout the range of human hearing. Individual subjects' TTSs were not consistent enough to permit any meaningful generalizations. However, group-mean TTS was a reliable measure of impulse-noise effects for subjects with both normal and subnormal hearing, and throughout the range of audible frequencies. Basing interpretations on these types of data should insure that results from various tests will be comparable.

- Reliability of Temporary Threshold Shift from Impulse-Noise Exposure
TM 2-67, Uncl.
D. C. Hodge, R. B. McCommons

A comprehensive damage-risk criterion (DRC) for impulse-noise exposure is needed, and it is desirable to state the DRC in terms of allowable TTS (temporary threshold shift), since TTS is both a valid and convenient measure of noise effects on hearing. This is possible only if TTS is also a reliable measure. Four TTS-reliability studies are reported. The following conclusions are reached. (1) Individual subject's TTSs are not sufficiently reliable to permit generalization of impulse-noise effects. (2) Group mean TTS varies only slightly across a series of exposures and is considered to be a reliable (consistent, repeatable) measure. This is true for the exposure of normal-hearing subjects to different impulse-noise conditions, for the TTSs of subnormal-hearing subjects, and for frequencies representative of the whole range of human hearing. (3) The formulation of an impulse-noise DRC should be based on group data (means, quartiles, etc.). Samples should be as large as possible and should be representative of the population to which generalization of results is desired.

- Growth of Temporary Threshold Shift from Impulse Noise:
A Methodological Study
TM 10-67, Uncl.
D. C. Hodge, R. B. McCommons

An experiment was performed (a) to validate a procedure for determining the growth rate of temporary threshold shift (TTS) from impulse-noise exposure and examine the range of TTS growth rates occurring in a sample representative of the Army population; and (b) to see how binaural and monaural impulse-noise exposures differ in their effects on TTS growth rate. Thirty-nine subjects were exposed to 155 dB peak-level gunfire impulses until they demonstrated 15 dB TTS₂ at 2, 4, or 6 kHz. The results showed that (a) fewer impulses should be administered at the beginning of a test session to better estimate the shape of the TTS growth function; and (b) binaural exposure to impulse noise, under the conditions employed in this study, did not result in consistently faster or slower rates of TTS growth than monaural noise exposure.

- A Behavioral Study of the Sound-Shadow Effect in Impulse Noise
TM 12-67, Uncl.
D. C. Hodge, R. B. McCommons

The sound-shadow effect of the human head in an impulse-noise field was studied by exposing 27 subjects to gunfire so their left ears were normal to the oncoming shock wave (near ear) and their right ears were protected by the shadow of the head (far ear). Noise exposure was continued until the subject's near ear demonstrated 15 dB temporary threshold shift (TTS) and the post-exposure TTS in near and far ears was compared. Peak pressure level at the entrance of the far ear canal was less than one-half that found at the near ear (153 vs. 161 dB re 0.0002 microbar). Mean TTS was significantly smaller in the far ears than it was in the near ears. The mean "protection" afforded the far ear by the head's shadow ranged from three dB at 1 kHz to 12 dB at 6 kHz. The implications of the findings for the protection of weapon crewmen are discussed.

- Criteria for Assessing Hearing Damage Risk from Impulse-Noise Exposure
TM 13-67, Uncl.
R. R. A. Coles, G. R. Garinther, D. C. Hodge, C. G. Rice

This paper presents criteria for assessing damage risk from impulse-noise exposure. The criteria are based on conclusions of independent British and American studies and on the work of other research workers in this field. Most of the studies which led to these criteria were performed with noise from small arms, but the criteria are general enough to permit assessment of most other types of impulse noise. The variables which must be considered in determining the potential hearing hazard and in making practical application of the criteria are presented, and the parameters which must be measured are defined. The measurement technique and type of transducers to be used are discussed.

Noise - Intensity's Effect on Latency

- Response Latencies in the Rhesus Monkey as a Function of Tone Intensity
TM 3-63, Uncl.
H. W. Gates, J. J. Romba, P. Martin

An analysis was made of response latencies of four young-adult, audiometric-test-sophisticated Rhesus monkeys to near-threshold two-kilocycle stimulus tones. The animals were restrained during the test, and headphones were used to deliver the tone. Equal log unit decreases in stimulus intensity produced a positively accelerated response latency curve for the group. Variances tended to increase logarithmically with a decrease in stimulus intensity, though variability was consistent throughout the ten days of testing within each intensity level. Latency measurements provide an objective indication of "goodness of performance" during sensory threshold testing of animals.

GENERAL
Environmental

Noise - Measurement

- Transducer Techniques for Measuring the Effect of Small-Arms' Noise on Hearing
TM 11-65, Uncl.
G. R. Garinther, J. B. Moreland

This study investigated several types of transducers which might be considered for use when evaluating the hearing hazard of pressure waves that small arms produce. In measuring the small arms' peak sound-pressure level, error was directly proportional to the measured rise times and inversely proportional to the positive pressure duration of the wave. The most accurate results were obtained by positioning the transducers vertically, with the pressure wave grazing the sensing surface at 90° incidence. Moreover, there was good agreement between measurements made with a wide-band piezoelectric transducer and those made with a wide-band condenser microphone. Finally, pistonphone calibrations at low levels (127 dB) compare favorably with shock-tube calibrations at high levels (170 to 180 dB).

Noise - Middle-Ear Attenuation

- Middle-Ear Muscle Effects on Low-Intensity Sounds
TM 16-65, Uncl.
G. R. Price

Experiments in which loudness judgments have been made for a tone in one ear while another tone has been present in the opposite ear have questioned the role played by the middle-ear muscles. Loudness judgments probably involve both central and peripheral factors. In order to evaluate the peripheral factors, cochlear potentials were measured on 12 lightly anesthetized cats. There were changes in the cochlear potential to pure tones in one ear (ranging in frequency from 0.2 to 10 kilocycles) from middle-ear muscle activity elicited by contralateral two-second pure-tone bursts (ranging from 0.65 to 5 kilocycles) as the tones producing the cochlear potentials were varied in intensity. As the intensity of the measured tone was varied, the size of the effect (in dB) remained constant.

Noise Protection

- Effectiveness of the V-51R Ear Plug with Impulse Pressures up to 8 psi
TM 1-63, Uncl.
B. Jacobson, E. M. Dyer, R. J. Marone

The protection that the V-51R ear plug provides against high-intensity impulse noise was determined for simulated rapid-fire field conditions. Twenty enlisted men were exposed to 2, 4, and 6 pounds per square inch peak overpressures generated by a 105mm howitzer. Their temporary threshold shifts were then measured at 2000 and 4000 cycles per second. The results indicated that inserting the V-51R ear plug without checking its fit does not give adequate protection to all personnel. It was also found that a protection-checked ear (ear plug inserted to minimize the level of a reference sound) gave adequate protection with impulse pressures up to 8 psi.

- Attenuation Provided by Fingers, Palms, Tragi, and V-51R Ear Plugs
TM 2-68, Uncl.
H. H. Holland, Jr.

Measurements of the attenuation of noise provided by use of the fingers, palms, tragi, and V-51R ear plugs are presented for nine test tones. The results of the study show that the tragi provide the best attenuation, the palms and fingers slightly less attenuation, and the ear plugs the least attenuation.

Noise - Systems

- Studies done with specific systems:

<u>Technical Memoranda</u>				<u>Standard</u>
7-58	14-61	4-63	3-64	S-1-63B, Maximum Noise Level for Army Materiel Command Equipment
10-58	20-61	10-63	15-64	
8-60	12-62	12-63	1-65	
12-60	23-62	14-63	5-65	

Padding - Vehicles

- Personnel Protection Padding for Military Vehicles
TM 1, Uncl.
W. W. Snyder, C. L. Reno

This report points out certain factors -- softness and energy absorption -- which should be considered in selecting padding materials to protect personnel in military vehicles. However, the writers question whether specific criteria should be developed for these factors.

Rest Periods

- The Motivational Effects of Rest Periods on Performance
TM 8-59, Uncl.
S. A. Hicks

This study investigated the effects of different rest schedules on the performance of a heavy rotary task. The schedules used were: (1) fixed interval -- rest after a given amount of time; (2) fixed ratio -- rest after a given number of responses. The results indicate that, for the type of task under consideration here, the fixed-ratio schedule elicits greater total output than does the fixed-interval schedule. There are indications that this effect may be a direct result of the work load or physical strength of the operator. Variables requiring further investigation are cited in this report.

GENERAL
Environmental

Stress

- The Effects of Stress on the Performance of Riflemen (U)
TM 5-66, Confidential Report
J. P. Torre, Jr., R. R. Kramer

(U) Two studies report how riflemen performed under stress. In both studies the stressor was a BB gun, which shot at the riflemen unless he shot at and hit a man-silhouette target in a predetermined time.

(U) Two techniques of firing -- aiming and pointing -- and two types of weapons -- M14 and M16 -- were compared with and without stress.

- Chronic Free Operant Avoidance as a Psychological Stress: A Re-Evaluation
TM 10-68, Uncl.
M. D. Levine, T. P. Gordon, W. J. Johnson, R. M. Rose

Rhesus monkeys were maintained for 30 days on a modified free operant avoidance schedule in order to evaluate this paradigm as a chronic stress. Subjects were run in four groups to assess the separate contributions of human contact, intersubject interaction and chair restraint. Urinary 17-hydroxycorticosteroid (17-OHCS) levels and gastrointestinal ulcers were used as stress measures. Chronic exposure to this paradigm did not necessarily produce a stressed organism or gastrointestinal pathology. The adrenal corticosteroids did, however, provide a sensitive, objective index of emotionality. For all four experimental conditions, most subjects had lower 17-OHCS levels during the 30 days of shock avoidance (stress period) than during either adaptation or training and were free of pathology at autopsy. One animal, however, demonstrated elevated 17-OHCS levels throughout the study (45 days) and upon autopsy was shown to have a frank gastric ulcer. The data suggest that the individual difference variable is much more important than the stress situation itself.

Tropical

- The Human Thermal Environment in a Wet Tropical Area (Operation SWAMP FOX II)
TM 1-64, Uncl.
A. A. Woodward, Jr.

During Operation SWAMP FOX II observations were made on the human thermal environment during the tropical rainy season in Panama. This report gives hourly measurements, for 43 consecutive days, for air temperature, humidity, air movement, solar radiation, and WBGT Index.

The results show the importance of knowing hourly variations in environmental variables in assessing the severity of the thermal environment to men. Conditions severe enough to affect human performance adversely occurred only during the four middle hours of the day. The results indicate the primary importance of solar radiation in determining whether the thermal environment will become stressful to humans. The inadequacies of standard meteorological data for estimation of human thermal stress are discussed.

- Physiological Responses of Men to Wet Tropical Environmental Conditions
(Operation SWAMP FOX II)
TM 2-64, Uncl.
A. A. Woodward, Jr.

During Operation SWAMP FOX II in Panama, men under heat stress were observed while walking up and down a 12.5° slope and while confined (as a squad) for up to six hours in an armored personnel carrier at an unforested tropical site. Measurements of bodily temperatures, pulse rates, and sweat production were used as indices of heat strain in the men.

Subjects walking in the sun, unloaded, did not suffer excessive heat strain under midday tropical conditions. About two-thirds of the sweat produced was evaporated for body cooling. Data on confined men showed there was little risk they would become heat casualties when exposed to Effective Temperatures up to 33.3° C. (92.0° F.) for as long as four hours. The men showed physiological adjustments to changes in environmental stress in less than 10 minutes.

Vehicles - Rear-View Mirrors

- Human Factors Analysis of Rear-View Mirrors for Motor Vehicles
TM 11-65, Uncl.
G. D. Pettit

This study's purpose was to examine, from a human engineering point of view, the basic requirements for rear-view mirrors used on large cargo trucks and buses: why a rear-view mirror is needed, when and where the driver needs it most, where it should be located, and what physical and optical characteristics it should have for the driver to make the necessary judgments. The study included a literary review of literature concerned with rear-view requirements, highway problems and rear-view mirror design, as well as a graphical analysis of rear-vision requirements for large cargo vehicles traveling on multilane highways in heavy traffic.

Vehicles - Physiological Pathology

- A Partial Review of the Literature on Physiological Disorders
Resulting from the Operation of Motor Vehicles
TM 17-62, Uncl.
J. W. Lewis

A review of available literature on physiological difficulties arising from riding and driving automotive vehicles is presented. Findings indicate that a number of physical complaints show causes arising from the shocks and vibrations transmitted to the operator as a result of inadequate consideration of seating and suspension.

GENERAL Environmental

Vehicles - Prone Posture

- A Discussion of the Concept of the Prone Arrangement for Track-Laying Combat Vehicles
TM 4, Uncl.
J. A. Stephens

Designers have already considered using the prone position, rather than the usual seated position, for aircraft pilots. Prone driving could pave the way for lower-silhouette tanks by reducing the height needed for the driver's compartment. But design criteria for prone arrangement in an airplane are not directly applicable to tanks, and the prone beds developed so far do not reduce vertical space requirements much. The author discusses specific requirements for developing a prone arrangement for tanks.

- Driver's Position in Tanks
TM 13, Uncl.
J. A. Stephens, J. D. Weisz, D. C. Hodge

This study evaluated how a prone position, as compared with a seated position, affects psychomotor performance. A group of military personnel manipulated steering-type controls in both positions.

The authors conclude that: (1) psychomotor performance, as measured in this study, seems essentially the same in both positions; (2) there was a learning effect: the position tested second always gave better performance than the first one; (3) because the subjects were tested for limited times only, there is no way to tell how continuing performance in a position -- as in driving a track-laying vehicle -- would affect efficiency.

- Driver's Position in Tanks: A Field Evaluation of the Prone Position
TM 27, Uncl.
H. F. Pohlmann, Jr., J. E. Leopardo

An evaluation of a driver's ability to operate a tracked vehicle (modified M41 tank) from the fully prone position.

Vehicles - Rating Scale

- Evaluation of Vehicle Rating Scale
TM 8, Uncl.
J. R. Hollis

Several experimental rating scales were designed before a trial form was accepted. Items were selected after examination of the various types of wheeled vehicles and driving them on all types of terrain under various conditions, to try to simulate the vehicles' tactical use. The initial scale items were tested with small samples of test drivers, then the items were reworded and tried out again, until an acceptable list of items had been developed. To check the scale's usability, it was administered to a group of Transportation Corps drivers at Fort Eustis. Reliabilities were calculated separately for men who had driven less than a year, and for those who had driven more than a year. The scale's validity was not checked, since the items had been selected for their "face validity."

Vehicles - Turret Position for Driver

- Human Factors Evaluation of Tank Driving from a Turret Position (U)
TM 6-66, Confidential Report
G. L. Horley, A. J. Eckles, III, R. V. Krogh

(U) This report gives the results of a tank-driving test conducted at Landsburg, Germany, for the US/FRG MBT program. Two separate driver's positions were evaluated: a driver's position in the hull and a driver's position in the turret. The subjects were five tank drivers and two tank commanders from the Federal Republic of Germany and U. S. forces stationed in Germany. The test measured driver-vehicle performance and driver-commander-vehicle performance under selected tactical-terrain conditions. The driver's "g" environment was also measured for the two driver's stations with the test vehicle traversing a straight cross-country course at its maximum speed. Human engineering recommendations are made for improving the design of a tank-turret driver's station.

Part 2. SYSTEMS EVALUATIONS

Aircraft - Crew Composition

- An Analytical Methodology for Estimating Crew Composition of a Two-Man Army Aerial Vehicle
TM 7-66, Uncl.
M. A. Famiglietti, S. Moreland, J. H. Sullivan

This report describes a method for making coarse quantitative estimates of crew composition for a two-man Army aerial vehicle. It assumes that crew composition depends predominantly on the tasks men are assigned to perform.

For illustration the method is applied to an aerial-vehicle concept for high-speed, low-altitude surveillance and target acquisition.

Aircraft - Voice-Warning System

- Army Aircraft Voice-Warning System Study
TM 6-68, Uncl.
J. E. Brown, C. M. Bertone, R. W. Obermayer

This report describes an analytical study that was intended to serve as a basis for the application of voice-warning systems (VWS) for the UH-1B and UH-1D (Huey), AH-1G (Cobra), CH-47 (Chinook), CH-54 (Skycrane), and OV-1 (Mohawk). The following problems of installing a VWS in these Army aircraft were studied: (1) the identification and selection of messages for maximum effectiveness; (2) the determination of priority sequences; and (3) the integration of the VWS into existing cockpits. The study involved the collection of basic data and the conduct and validation of mission analyses, operational sequence diagrams, task analyses, aircraft configuration analyses, pilot opinion surveys, and Army aircraft accident analyses. In this report, priority sequences are derived for all major emergencies for the six vehicles; further analytical effort is described which reduced the list to 20 messages for inclusion in the VWS. For each aircraft, two lists of 20 messages are proposed; one list assumes additional sensors, while the second assumes the current sensor system. Recommendations are made for message structure and content, priority sequences, integration of the VWS with the current visual-warning system, general sensor requirements, interlocking between VWS messages, and other related considerations.

Antiaircraft Mounts

- Report on Conference Reviewing Project DA 502-08-032, Weapon, Short Range, Antiaircraft, Including Mount
TM 5, Uncl.
W. W. Snyder

This report gives a human factor engineering evaluation of three mounts -- gun, anti-aircraft short range T176; Oerlikon type 6, J1A, Ser. No. 4; and gun, anti-aircraft short range T175.

SYSTEMS

Antitank Guided Missile, SS-11

- D
- A Human Factors Engineering Evaluation of the SS-11 Antitank Guided Missile
TM 16-60, Uncl.
F. M. McIntyre

I-1. Report of specific human factors deficiencies in the SS-11 Antitank Guided Missile System (ATGM) ground equipment, M38A1 1/4-ton, M-59, M-113 Armored Personnel Carrier, and HU-1 helicopter launchers. Report written as a result of ordnance evaluation of SS-11 system. Includes comparison of SS-11 ATGM ground equipment with ENTAC ATGM ground equipment.

Antitank Weapons

- I-1.
- Gunners' Aiming Errors in Antitank Weapons (U)
TM 5-64, Confidential Report
R. T. Gschwind

(U) This report shows the importance of gunners' aiming errors in the use of antitank weapons. It reports on field tests which measured aiming errors of several types of weapons, and it relates these results to present MAW requirements.

- Gunner Aiming Errors with the MAC and DC Medium Antitank Weapon Systems (U)
TM 8-66, Confidential Report
R. T. Gschwind

(U) These tests were conducted to describe the gunner's contribution to total system error with the MAC and DC Medium Antitank Weapons. The configurations, noise, blast, and firing reactions were simulated. Six gunners fired at both stationary and moving targets. The results show aiming error at the moment of trigger pull, the way firing changes aim, and aiming error for several seconds after firing.

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AR15 Rifle

- Ability of Shooters to Gauge Two-Round Bursts from the AR15 Rifle
TM 9-63, Uncl.
J. P. Torre, Jr.

This study examined the ability of ten shooters to fire automatic bursts of two rounds per trigger pull from the AR15 rifle under three different firing conditions. Under these firing conditions shooters can be expected to obtain a two-round burst per trigger pull approximately 75 percent of the time.

Armored Infantry Vehicle

- Human Engineering Survey of Armored Infantry Vehicle, M59
TM 26, Uncl.
E. Charney, A. J. Rose, L. T. Lee

Results given summarize a study conducted among crewmen of the Armored Infantry Vehicle, M59, to examine the human engineering problems it poses for typical line units. The report includes a discussion of specific difficulties and field expedients employed, as well as the suggestions and recommendations that were offered by the more-than-500 men interviewed during the study.

Cargo Truck, XM520E1

- An Evaluation Technique and Feasibility Study of Shock and Vibration Protection for an Experimental Driver's Seat in the 8-ton, 4x4 Cargo Truck, XM520E1
TM 13-63, Uncl.
D. M. King, J. H. Lea

This report discusses a study which was undertaken to determine the feasibility of improving the shock and vibration protection offered by a seat for the driver of the 8-ton, 4x4, Cargo Truck, XM520E1. The major phases of this study were: (1) planning a quantitative method of evaluation and the required instrumentation for determining the effectiveness of shock and vibration protection; (2) applying certain engineering principles from a human factors viewpoint to explore the possibilities of increasing shock and vibration protection for the operator of the XM520E1; (3) a test and subsequent quantitative evaluation of the experimental seat, as compared with the present vehicle seat.

Carrier, Command Post, XM577

- Human Factors Evaluation of the Carrier, Command Post, Light, Tracked XM577: Systems Noise Evaluation
TM 14-63, Uncl.
G. R. Garinther, R. Donley

Noise measurements in the XM577 Command Post Vehicle were made with the vehicle both stationary and moving. Sound power level and directivity indices were obtained for the auxiliary generator.

The noise produced by the moving vehicle presents a hearing hazard to personnel who have no ear protection, and direct voice communications within the vehicle were nearly impossible. The stationary vehicle with teletype and vehicle-mounted auxiliary generator operating presented no hearing hazard; but prolonged conversation will be very difficult in the XM577.

SYSTEMS

Corporal

- Human Engineering Comparison Study of the Ground Guidance Stations of Corporal Missile System Type II and Type III
TM 2-57, Uncl.
A. P. Van Huyck, T. W. Miller, B. L. Sova

A limited human engineering survey of the Corporal II and III ground guidance stations.

Davy Crockett

- Human Engineering Evaluation of the Davy Crockett Graphical Firing Scale (U)
TM 19-60, Confidential Report
Short Range Direct Fire Weapons Staff

(U) An experiment was conducted to determine the type and frequency of errors made when using a graphical firing scale for the Davy Crockett weapons system. Ten subjects worked a total of 120 problems. It was found that human errors in the operation of the graphical firing scale can seriously affect the capabilities of the weapon.

- A Human Factors Engineering Evaluation of the Davy Crockett Graphical Firing Scale (FRE 24776) (U)
TM 11-61, Confidential Report
Short Range Direct Fire Weapons Staff

(U) An experiment was conducted to determine the size, type, and frequency of errors made when using the graphical firing scale (FRE 24776), which was designed for the Davy Crockett XM28 weapon system. Ten subjects worked a total of 100 problems. It was found that the size, type, and frequency of human errors in the operation of the graphical firing scale can seriously affect the capabilities of the weapon.

Grenade Launchers

- Accuracy and Rate of Fire for Single-Shot and Semiautomatic Grenade Launchers (U)
TM 8-68, Confidential Report
R. R. Kramer

(U) A field test measured the accuracy and rates of fire of the M79 and T148 Three-Shot Grenade Launchers. Both stationary and moving targets were used. The firers fired both as rapidly as possible, and slowly with precision, and both with and without the sights.

Gun-Launcher, XM81

- Muzzle Blast Measurements on XM81 Gun-Launcher
TM 20-61, Uncl.
J. D. Waugh, H. H. Holland, Jr.

This study presents an evaluation of the effects of gun-blast upon exposed crew and supporting infantry on and around a tank-mounted XM81 gun-launcher. Measurements were taken using piezoelectric pressure-sensitive gages. Results are compared with known data on the limits of human tolerance. It is recommended that the wearing of the V-51R earplug be mandatory for the gun-launcher crew members and supporting infantry when the weapon is being fired.

Honest John

- Human Engineering Survey of Honest John Weapon System
TM 24, Uncl., 1956
A. P. Van Huyck, G. M. Davidson, A. C. Notary

Report of a field liaison team's survey of the 762-mm. Rocket (Honest John), consisting of a preliminary investigation and a comprehensive survey of its use by units in the Seventh Army Area, USAREUR. This investigation was conducted to identify the significant human engineering problems users encountered with the Honest John weapon system. It also gathered information about how the operators cope with these problems, their field modifications, and their suggestions for design improvements.

- A Human Factor Engineering Evaluation of the Trailer-Mounted
762-mm (Honest John) Rocket Handling Unit XM405A1
TM 5-61, Uncl. (Appendix A - Confidential)
W. J. Doherty, Jr.

This report covers the human factors engineering evaluation of the Trailer-Mounted 762-mm (Honest John) Rocket Handling Unit XM405A1. Comments are included with regard to control evaluation, task and operational analysis, safety, and organizational maintenance.

Howitzer, 105-mm

- Muzzle Blast Measurements on Howitzer, 105-mm, M2A2E2 with Muzzle Brake No. 8
TM 12-60, Uncl.
H. H. Holland, Jr.

Measurements of muzzle blast in the crew area of the 105-mm Howitzer, M2A2E2, with Muzzle Brake No. 8, were made primarily to determine the peak overpressures produced. Measures of positive impulse and duration of positive phase were also made. Some of the overpressures measured were high enough to rupture unprotected human eardrums. It is recommended that attempts be made to lower the peak overpressures below 4 psi. If this criterion is not met, ear protection should be mandatory.

SYSTEMS

- A Loading Rate Evaluation of a Pivot Chamber Breech and an XM102 Howitzer Breech (U)
TM 9-62, Confidential Report
W. D. Norlander, J. P. Torre, Jr.

~~FA-1~~ (U) This study concerns loading 105-mm howitzer breech mock-ups in order to evaluate a Pivot Chamber Breech (PCB) and to determine maximum firing rates. As a comparison to the PCB, the conventional breech of the XM102 105-mm Howitzer was used. Loading was done on three conditions of the breech mock-ups: (1) the PCB, (2) the XM102 at 25° (approximating the most commonly used howitzer elevation), and (3) the XM102 at 70°. Loading studies were conducted for periods of three minutes (rapid loading) and one hour (sustained loading). The resultant loading rates were matched with the mechanical cycle times of the systems in order to determine firing rates.

- Muzzle Blast Measurements on Howitzer, 105-mm, XM103E1
TM 23-62, Uncl.
H. H. Holland, Jr.

~~FA-1~~ Measurements of muzzle-blast in the crew area of the 105-mm Howitzer, XM103, without a muzzle brake and with muzzle brakes WTV-F8241 (high efficiency), 5/K (medium efficiency), and WTV-F8259 (low efficiency), were made to determine the peak overpressures produced. The overpressures produced by the four different brake conditions were one of the most important factors determining which brake would be used on the XM102 Howitzer. The howitzer was fired at elevations of 2, 45, and 62 - 68 degrees.

Howitzer, 155-mm

- Muzzle Blast Measurements on Howitzer, 155-mm, M1A2E3 with Muzzle Brake No. 8
TM 14-61, Uncl.
H. H. Holland, Jr.

~~FA-1~~ Measurements of muzzle blast in the crew area of the 155-mm Howitzer, M1A2E3, with Muzzle Brake No. 8, were made primarily to determine the peak overpressures produced. Measures of positive impulse and duration of positive phase were also made. The howitzer was fired at elevations of 0, 32.5, and 65 degrees with 70° F. and 125° F. propelling charges. Some of the overpressures measured were high enough to cause inner-ear deafness and to rupture unprotected human eardrums. It is recommended that the wearing of the V-51R ear-plug be mandatory for all personnel located in the crew area when the 155-mm Howitzer, M1A2E3, is being fired.

Lacrosse

- Human Engineering Evaluation of the Mock-up Equipment of the Lacrosse B Forward Guidance Station
TM 18, Uncl.
S. L. Reevesman, J. A. Stephens, F. W. Schulze, H. F. Pohlmann

An evaluation of an electronically inert mock-up of the Lacrosse B Forward Guidance Station to pinpoint operations that are susceptible to time delay and operator errors.

- A Human Engineering Evaluation of the Lacrosse Assembly and Launch Area Task III Missile, Launcher Series 3000 (U)
TM 3-58, Confidential Report
L. Estrine, B. L. Sova

(U) This report presents the results of a human engineering evaluation of the Assembly and Launch Areas of the Task III Missile, Launcher Series 3000 (a developmental version), Lacrosse Missile System. A representative sample of the proposed user population was trained and used throughout the evaluation. The results of the evaluation, presented in recommendation form, will reduce human errors and operational time in the handling, checkout, and launching procedures.

- A Human Engineering Evaluation of Sightunit XM43 and its Application to the Lacrosse Lightweight Launcher
TM 1-60, Uncl.
R. G. Lazar, B. L. Sova

This study was conducted to (1) examine display characteristics of Sightunit XM43 from a human factors standpoint, and (2) specific application to the Lacrosse lightweight launcher.

A primary aim within the second objective was to make design recommendations for elevation and azimuth controls to be associated with the employment of Sightunit XM43 on the Lacrosse lightweight launcher.

The major finding of the first phase of the study having general application to field artillery use of Sightunit XM43 was that the elbow telescope of this unit should be employed only in the horizontal position. The second phase of the study incorporated recommendations resulting from phase one. From the onset, special emphasis was devoted to the design of the control panel which consists of the azimuth and elevation controls and their specific use with Sightunit XM43 and the Lacrosse lightweight launcher.

- A Human Factors Engineering Evaluation of the Lacrosse Missile System: Final Report
TM 13-60, Uncl.
T. B. Pomeroy

This report presents the results of a five-year continuous evaluation of the Lacrosse Missile System from the human factors engineering standpoint, and a compilation of recommendations made by HEL. The purpose of this evaluation was to recommend human engineering modifications in the design of the equipment and improved methods of handling and operating the equipment.

Methods used were: (1) discussions with equipment designers, (2) observation of user tests, (3) discussions with the using troops, and (4) conducting formal tests.

LANCE

- Acoustical Evaluation of the LANCE Missile System
TM 5-65, Uncl.
J. B. Moreland

The noise of the LANCE Self-Propelled Launcher was evaluated with the vehicle moving and stationary. The noise of the LANCE Transport Loader was also investigated while the vehicle was stationary. The moving vehicle not only produces more noise than recommended in HEL Standard S-1-63B, but speech intelligibility for conversations in the moving vehicle is

SYSTEMS

far below acceptable limits. Noise levels around the vehicles during missile-transfer operations are high enough to prevent adequate, unaided-voice communications between the Crane Operator and the Section Chief, although the noise level is not hazardous.

Light Assault Weapon (LAW)

- An Analysis of the Infantry Assault Weapon, Light (LAW) TV-1 Prototype Rocket Noise
TM 10-58, Uncl.
R. Donley, H. T. Curran, B. J. King

Measurements were made at the approximate ear position of the operator to determine the maximum sound pressure level, the frequency components, and the rise time of the noise from the LAW System using the TV-1 rocket with M-35 motor. Similar measurements were made on the Launcher, rocket, 3.5 inch M20A131 to provide data for comparison. The maximum sound pressure level of the LAW rocket was 165 dB re 0.0002 dynes per square centimeter at the operator's ear position.

Little John

- Human Factors Engineering Evaluation of the Little John Launchers, XM34 and XM80
TM 6-60, Uncl.
T. B. Pomeroy

This report presents a human factors survey of Little John Launchers XM34 and XM80. This survey consisted of test observations and discussions with using troops. The purpose was to determine what significant human factors problems were being encountered by the users with the Little John Launchers. In addition an attempt was made to gather information about how the operator copes with these problems and to elicit suggestions for design improvements.

The intention of this study was to determine specific problem areas rather than to obtain an overall evaluation of the weapon system.

Machine Gun, M73C

- A Human Factors Engineering Evaluation of the M73C Tank Machine Gun
TM 3-61, Uncl.
L. V. Clark, W. D. Norlander

An M73C Tank Machine Gun was evaluated to determine any design features in the weapon or its accessory equipment that would inhibit maximum effective usage of the weapon. A 1919A6 Machine Gun was used during parts of the evaluation to provide a standard of evaluation for the M73C. The many deficiencies found in the M73C cause the practicality of adopting this weapon to be questioned without consideration of the suggested recommendations.

Mauler

- A Human Factors Evaluation of the Mauler Weapon System: System Noise Evaluation (U)
TM 12-63, Confidential Report
G. R. Garinther

(U) A noise survey conducted on the Mauler Engineering Model Pod #1 and the XM546 Guided Missile Equipment Carrier Pilot #2 to evaluate: (1) if a hearing hazard exists, (2) what communications problems can be anticipated, and (3) the detection distance of the system. At the time of this survey the following pod equipment was operational: (1) turbine, (2) air conditioner, (3) on-turret hydraulic system, and (4) azimuth hydraulic system.

MAW

- See Antitank Weapons, page I-48.

Mohawk OV-1

- Missions Analysis for OV-1 Mohawk Aircraft
TM 13-64, For Official Use Only Report
R. K. Cassatt

This report presents a missions analysis of the OV-1 Mohawk aircraft. The study was undertaken partly to support an evaluation of terrain-avoidance equipment for the OV-1, as well as to provide framework, or overview, of the total performance required of the Mohawk flight crew during representative tactical missions. Two missions were selected for analysis: aerial photography and radar surveillance. Two analytic methods were used. The first, a conventional block flow-and-functional description, delineates performance required during two normal missions. The second, a methodology which employs symbolic logic, describes performance required during a mission having selected emergency conditions.

Mortar, 4.2", T201

- Human Factors Engineering Evaluation of the 4.2" Mortar, T201
TM 4-61, Uncl.
Short Range Direct Fire Weapons Branch

A comparative study was conducted using the T201 and M30 mortars to evaluate man-machine relationships under simulated firing missions and to provide a basis for future mortar studies. Two mortar crews were trained in the operation of both weapons and then run through a series of tests simulating firing missions. The findings show that: operational times of both weapons are similar, the T201 is less fatiguing to carry, and cross-leveling is the principle factor in the time required for sighting.

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Mortar, Heavy

- A Preliminary Human Engineering Evaluation of Heavy Mortar System Performance
TM 3-62, Uncl.
R. T. Gschwind, G. L. Horley

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I-1.
A field investigation was conducted to measure the terminal accuracy of the heavy mortar system with all aspects of field operation included. Twenty-seven officer students performed the field-test phase of training at the completion of a U. S. Army Infantry School course in heavy mortars. They performed forward observation, fire-direction-center operation, mortar laying, and ammunition handling during several types of typical mortar missions. The accuracy and number of rounds used were recorded for 22 missions. The mean number of rounds to achieve fire for effect was 5.3, with an associated average deviation from the target of 4.4 percent of the observer-target range. However, there were definite differences in results for different types of missions.

Nike I

- Human Engineering Survey of Nike Field Installations
TM 15, Uncl.
R. C. Kaehler, G. M. Davidson, C. B. Lansill, A. C. Notary

Survey of human engineering problem areas in the Nike I Missile System.

Nike Zeus

- A Human Factors Engineering Evaluation of the Nike-Zeus Missile System
TM 19-62, Uncl.
Surface to Air Weapons Branch

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AD-1.
Summary of a human factors engineering survey of the Nike-Zeus Missile System. This study attempted to determine the adequacy and extent of human engineering applied in the design of Nike-Zeus equipment items. Each item of equipment was classified as adequate or inadequate from the human factors engineering point of view, and recommendations were suggested for correcting the deficiencies observed.

Nuclear Reactor, ML-1, ML-1A

- A Human Engineering Evaluation of the ML-1 Mobile Low-Power Nuclear Power Plant
TM 8-62, Uncl.
J. E. McMurrer, Jr., M. E. McCahan

This report is the result of a human engineering evaluation of the ML-1 Mobile Low-Power Nuclear Power Plant, conducted at the request of the Corps of Engineers. The objectives were to conduct a human factors evaluation of the system, contribute to equipment design, and to provide human factors design criteria for future related systems. Because of the non-availability of operational equipment, the evaluation was limited to a static evaluation of the

Control Cab. Numerous human factors shortcomings were found, and recommendations are presented. The Human Engineering Laboratories entered the program after equipment fabrication had begun. However, Human Engineering Laboratories' engineers have participated in redesign discussions of Control Cab components that are being modified. Human engineering design criteria are presented for use in the design of future systems.

- A Human Engineering Evaluation of the ML-1 and ML-1A
Mobile Low-Power Nuclear Power Plant
TM 19-63, Uncl.
B. L. Sova, Jr., M. E. McCahan, R. H. Dewey

This report is a continuation of the U. S. Army Human Engineering Laboratories' human engineering evaluation of the ML-1 Mobile Nuclear Power Plant and is being conducted at the request of the U. S. Army Corps of Engineers. It covers the period 1 April 1962 to 30 April 1963 and includes a simultaneous task analysis of the ML-1 start-up procedures, a review of the layout and operation of the Reactor, Power Conversion Skid, and Gas Storage Skid, the monitoring of the contractor's product improvement program, a proposed layout of the ML-1A Control Cab, a review of the training-simulator design. Recommendations are made for improving the operation and maintenance of this system. A brief description of the reactor plant is also included.

- Control-Cab Design for ML-1A Nuclear Power Plant: Human Engineering Considerations
TM 15-65, Uncl.
B. L. Sova, Jr.

This report summarizes the human engineering considerations in the preliminary detailed design of the ML-1A control cab. It discusses the pros and cons of alternate designs for the cab interior and the cab sub-system, with conclusions.

Pershing

- A Human Factors Engineering Evaluation of the Pershing Weapon System: Evaluation and Procedure Analysis of the FY59 Ser #005 Transporter-Erector-Launcher and Ground Handling Equipment (U)
TM 6-61, Confidential Report
B. L. Sova, Jr., T. B. Pomeroy, J. F. Coyne

(U) This report presents the results of a human factors engineering evaluation and procedure analysis of the FY59, Ser #005, Transporter-Erector-Launcher and Ground Handling Equipment. The objectives of the study were: (1) investigation of the man-machine relationships between the individual operators and the equipment; (2) investigation of the interaction and coordination of the team of operators; (3) suggested redesigns of the equipment to improve both individual and team man-machine relationships; (4) development of an optimal tactical operating procedure; (5) timed operations for application to countdown.

SYSTEMS

- A Human Factors Engineering Evaluation of the Pershing Weapon System: Communications Pack (AN/TRC-80)
TM 7-61, Uncl.
R. Weiss

A presentation of results of the Human Factors engineering evaluation of the Pershing Communications Pack (AN/TRC-80) conducted during the period 10 Jun 60 to 14 Jan 61. The unit studied contained many deficiencies and shortcomings. The Communications Pack is presently undergoing redesign.

- A Human Factors Evaluation of the Pershing Weapon System: System Noise Evaluation (U)
TM 12-62, Confidential Report
Acoustical Research Branch

(U) Noise measurements of the near-field noise of the Power Station and Power Station Equivalent, the interior noise levels of the Programmer Test Station, Communications Hut, Components Test Station, and System Test Station, the noise at the driver's position of the XM474 Missile Carrier, and the noise spectra in the extreme far-field of the Power Station noise are presented. Each component is discussed in reference to the effects of noise on communication and hearing. No serious damage to hearing is to be expected from these items.

Personnel Carrier, Armored

- ✓ ● Human Engineering Problems of the Armored Personnel Carriers T113 and T117
TM 10-57, Uncl.
A. S. Bacon, D. R. Cronk, A. J. Rose

This report discusses human engineering problems in the Armored Personnel Carriers T113 and T117 and makes recommendations for solving them. The areas covered include seating, vision, accessibility, access-egress, working space, drainage, communication controls, ventilation, weapon stowage, noise, exteriors, and maintenance.

- ✓ ● A Dynamic Human Engineering Evaluation of the Armored Personnel Carriers T113 and T117
TM 7-58, Uncl.
G. R. Garinther, J. P. Torre, Jr., J. E. Tiernan, D. E. Holzen

Report of a static evaluation of the T113 and T117 Armored Personnel Carriers. This evaluation was conducted to uncover human engineering design deficiencies and to note areas in which the vehicles proved adequate from a human engineering standpoint. Findings indicated necessity for more intensive investigation. Primary investigation was done in: (1) sound measurement and analysis within vehicles with full complement of personnel; (2) effects of noise on audition, communication, and performance; (3) effects of vehicle configuration and design on crew performance, safety, and comfort; (4) crew's opinion on 1, 2, and 3 above.

- An Accuracy Investigation of Armored Personnel Carrier Armament (U)
TM 9-67, Confidential Report
R. T. Gschwind

(U) New concepts for armored personnel carriers include several armament changes from the M113. The Human Engineering Laboratories have conducted field experiments to assist the evaluation of these new concepts. The immediate objective was to provide firing accuracy data needed for cost effectiveness studies. However, of equal importance was the knowledge gained through variations of system design and firing mode throughout the experiments. The experiments were carried out in two distinct phases. Phase I evaluated small arms accuracy, and Phase II evaluated the Vehicle Rapid Fire System accuracy. These phases are presented separately in this report.

Rifles

- Auditory and Acoustical Evaluation of Several Shoulder-Rifles
TM 1-65, Uncl.
G. R. Garinther, K. D. Kryter

The threshold of audibility of each ear of 178 soldiers was measured before and after firing various types of shoulder rifles at the rate of one trigger pull every five seconds. The acoustical impulses from each type of weapon were evaluated (peak pressure, time history, and spectrum). The peak pressures of the acoustic impulses from firing the weapons were highly correlated with threshold shifts caused by exposure to the gun noise. From these and related data, estimates are made of the expected permanent hearing level in the frequency region from 1000 cps to 6000 cps to be equalled or exceeded in 50, 25, and 10 percent of ears repeatedly exposed to gun noise at various peak sound-pressure levels.

Rocket-Blast Simulator

- Development of a Rocket-Blast Simulator: Design and Test
TM 4-64, Uncl.
E. A. Spellman

This report describes the engineering design, development, and testing of a facility used to simulate the effects of rocket blast upon military personnel. The most formidable problems encountered were (1) the necessity of achieving a high-order reliability to assure safety, and (2) the requirement for a total pressure rise within five milliseconds to achieve high blast impulse. Both of these problems were resolved through the design of a novel side-mounted valve actuated by a sudden pressure differential resulting from the bursting of a pressurized diaphragm.

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SYSTEMS

Rocket Launcher, 115mm, M91

- A Human Factors Engineering Evaluation of the M91, 115mm Multiple Rocket Launcher
TM 13-62, Uncl.
W. D. Norlander

The M91 Multiple Rocket Launcher was evaluated against its military characteristics and human factors criteria. The operation of the launcher was successfully handled by a six-man crew, although the work was extremely strenuous. In some areas, design changes should be made in order to make operations safer and faster. The immobility of the ground-mounted launcher seriously impairs its use as a tactical weapon.

Rockets - Long-Burning, Shoulder-Fired

- Dynamic Pressure and Thermal Hazards of Shoulder-Fired Long-Burning Rockets
TM 8-64, Uncl.
R. T. Gschwind

This report evaluates the dynamic pressure and thermal hazards of a hypothetical shoulder-fired rocket. This rocket differs from current rocket weapons (LAW and Bazooka), since the rocket motor continues to burn long after it has left the launch tube. The rocket exhaust coming back onto the gunner after the rocket has left the tube might knock him down or burn him. These hazards were evaluated by rocket firings to measure the hazards and controlled simulations to determine effects on humans.

Sergeant

- A Human Engineering Evaluation of the Sergeant
Transport and Loading Equipment and Procedures (U)
TM 5-59, Confidential Report
M. Schneider, C. G. Moler, D. Holzen, K. D. Foster

(U) In light of the extremely fast, precise loading required with the Sergeant System, a study was undertaken to uncover human engineering deficiencies, suggest consequent equipment modifications, derive an optimum vehicle arrangement for loading, evolve an optimized loading procedure, and provide data for evaluation of the equipment to function within present technical requirements.

- Acoustical Evaluations of the Sergeant Missile System:
45-kw. Generator and Proposed Headsets
TM 4-63, Uncl.
G. R. Garinther, W. B. Kahl

The intelligibility provided by three different headsets was evaluated in the Sergeant Missile System erector-launcher noise field. Two of the tested headsets provided adequate intelligibility; the third was only marginally acceptable. These tests were conducted using the 27-kw. generator. The noise of the 45-kw. generator was also evaluated. These tests indicated that intelligibility would be improved slightly by substituting the 45-kw. generator for the 27-kw. generator. The 45-kw. generator met the 90-decibels-at-10-feet criterion in all but the 8000-cycles-per-second octave band. No damage to hearing may be expected for less than eight hours per day continuous exposure except in front of the turbine exhaust.

Special Purpose Individual Weapon (SPIW)

- Human Factors Affecting Rifle Accuracy in Automatic and Semiautomatic Fire (U)
TM 11-63, Confidential Report
J. P. Torre, Jr. ✓ D-1.

(U) This report presents the findings of human factors studies pertinent to rifle design conducted in support of the Special Purpose Individual Weapon Feasibility Program. The effects of rifle design parameters such as impulse, stock configuration, and cyclic rate on semiautomatic and automatic accuracy were determined. The results of testing firing fixtures, developed to determine SPIW feasibility, are also presented.

- Effects of Rifle Configuration on Quick-Fire Accuracy (U)
TM 6-64, Confidential Report
R. R. Kramer, J. P. Torre, Jr. ✓

(U) Rapid rifle-fire accuracy was investigated as a function of weapon configuration. Short-range targets were used (20 - 60 meters) and short exposure times (two - three seconds).

- Human Factors Evaluation of Three Prototype Special Purpose Infantry Weapons (SPIW) (U)
TM 8-65, Confidential Report
R. R. Kramer ✓

(U) Summary of human factors studies of three prototype Special Purpose Weapons (SPIW) with particular emphasis on pointability and potential damage to the firer from noise and particles produced in firing. These are some of the studies evaluating the three prototype SPIW weapons that were fired at Fort Benning and Aberdeen Proving Ground. ✓ D-1.

Stinger

- Human Engineering Evaluation of Stinger, Preliminary Report of Progress
TM 2, Uncl.
HEL Staff

Human engineering evaluation of Stinger.

Stoner

- Human Factors Evaluation of the Stoner 63 Assault Rifle (U)
TM 7-64, Confidential Report
J. P. Torre, Jr., R. R. Kramer, R. V. Krogh, L. G. Walchour

(U) The U. S. Army Human Engineering Laboratories evaluated the Stoner Assault Rifle as a part of the Joint Advanced Research Project Agency Service Program for the Test and Evaluation of the Stoner 63 Weapons System. The human factors engineering evaluation consisted of: (a) assessing the operability of the assault rifle on the basis of its configuration, (b) assessing the pointing characteristics of the rifle in its present configuration, (c) modifying its basic configuration to improve its pointing capability, (d) attaching a muzzle-brake compensator to the weapon so that it could be fired automatically in two-round bursts, (e) conducting a quick-fire test whereby the effectiveness of the basic weapon was compared with that of the modified weapon while varying both type of fire and type of ammunition.

SYSTEMS

Tanks

- System Evaluation of the Tank 76-mm Gun, M41A1
TM 1-57, Uncl.
M. I. Kurke, J. A. Stephens

Several sources of information were investigated to catalogue the operations which the M41A1 is expected to accomplish under combat conditions. The authors integrated these data to develop a description of idealized battle conditions and the way an ideal light-gun tank and an ideal crew would react to those conditions. It was then possible to determine the tank characteristics required. Evaluating the M41A1 system thus was a matter of determining how close the equipment comes to fulfilling the requirements for an ideal light-gun tank.

- Human Engineering Survey of M-48 Tank
TM 16, Uncl.
E. Charney, A. J. Rose, L. T. Lee

Summarizes a preliminary field investigation and two user surveys to determine what significant human engineering problems were being encountered with the M-48 tank. In addition, an attempt was made to discover field expedients crewmen used to solve these problems and to elicit their suggestions for improving the design of the tank. This survey attempted to determine specific problem areas, rather than to obtain crewmen's general opinions of the M-48 tank. A detailed list of problem areas is reported.

- Human Factors Engineering Evaluation of the M60 Main Battle Tank
TM 8-60, Uncl.
K. D. Foster

This study reports the results of an evaluation of the M60 tank from a human factors engineering standpoint. The report is primarily concerned with noise evaluation and crew area evaluations to determine their conformity with human factors design practice.

- A Human Factors Evaluation of the Main Battle Tank, 105-mm Gun, M60E1
TM 14-62, Uncl.
N. F. Dickinson, J. L. Brown

A preliminary report on a human factors evaluation of the Main Battle Tank, 105-mm Gun, M60E1. The workspace available to each crew member in relation to his task and the efficiency of maintenance operation, including proper utilization of available tools, skills, and supplies, was investigated.

- An Evaluation of the Human and Space Engineering Studies -- Tank 90mm Gun T42
TM 3, Uncl.
J. R. Hollis, F. F. Imhof

Various human engineering aspects of a proposed tank design were evaluated with a checklist, and a written commentary keyed to the checklist. This checklist has not been fully validated yet, but it shows promise for broader future use. The writers emphasize that many questions cannot be answered adequately by studying reports and documents. They recommend that future contracts should define proposed design modifications by showing them in mock-ups.

- Cross-Country Speed and Driver Vibrational Environment of the M60 Main Battle Tank
TM 7-65, Uncl.
R. W. Fernstrom, Jr., R. T. Gschwind, G. L. Horley

This study investigated the g environment encountered by M60 tank drivers. It was conducted in two phases. In Phase I, the subjects drove an M60 tank over standard courses at constant speed. This phase examined the repeatability of measuring g loads when different drivers were subjected to the same environment. In Phase II, the subjects drove an M60 tank at maximum speed over two types of cross-country courses. This phase established a correlation between speed and g loads and determined the maximum g load the drivers would accept.

- See TM 6-66, page I-45.

Transporters - 280mm Gun

- Human Engineering Field Survey of 280mm Gun and Transporters
TM 4-57, Uncl.
D. K. Andrew, T. W. Miller, C. B. Lansill

This report compiles both obvious and latent human factors deficiencies in the 280mm gun and transporters M249 and M250, as revealed by discussions with using troops. This report is intended not to portray the equipment's best features, but to point out its human engineering problems and to suggest possible solutions, as well as some field expedients that were observed.

Trucks

- Human Engineering Evaluation of Truck 1/4 Ton, 4x4, Utility, M38A1
TM 12, Uncl.
J. R. Hollis

Human factors evaluation of the 1/4 ton, 4x4, M38A1 utility truck.

- Human Engineering Evaluation of Truck, 1/4 Ton, 4x4, XM151
TM 21, Uncl.
E. C. Weiss, A. L. Taylor

An evaluation of man-machine relationship in the XM151 1/4-ton truck. As a guide for future design, optimal specifications were developed. Appropriate comparisons are made with the M38A1. User information is provided to supplement and partially validate the preceding evaluation and recommendations.

SYSTEMS

Weapons - Psychological Preference

- ✓ ● Platoon Weapons Preference: A Questionnaire Study: Psychological Weapons Study I
TM 18-63, Uncl.
K. R. Laughery, R. W. Bauer

This study of the psychological effects of weapons followed the general plan of a similar research project reported by Vaughan and Walker in 1957 (Psychological Research Associates Report 57-10). The earlier study measured the dangerousness of the weapons as perceived by troops being fired upon, whereas the present study measured the preference for use of the weapons in action. In addition, this study related preference to experience with the knowledge of the weapons. Sixty-one enlisted men completed a paired-comparison rating form and provided additional questionnaire information. Weapons rated were the M1 rifle, Browning automatic rifle, light machine gun 81mm mortar, hand grenade, and 106mm recoilless rifle. The weapons were assessed for use in both offense and defense.

- ✓ ● Weapons Preference in South Viet Nam (U)
TM 9-64, Confidential Report
J. M. B. Keyser

(U) A pattern of weapons choice is reported for South Vietnamese troops. It is assumed that this pattern implies a pattern of use, an implicit tactical doctrine. It is further assumed that this pattern of weapons choice is congruent with patterns in other aspects of Vietnamese society. A small sample of Special Forces returnees was interviewed to elicit information concerning military operation in South Viet Nam and other aspects of life in that country. It was found that the choice of weapons was related to a specific tactical pattern. The informants' reports also suggested broader aspects that might reveal patterns similar to patterns of weapons choice and use.

- The Wolof: Some Action Considerations: A Preliminary Report.
Psychological Weapons Study III (U)
TM 12-64, Confidential Report
R. W. Bauer, J. D. Weisz

(U) A preliminary report of implications for action among the Wolof, a Muslim negro group, in Senegal, in West Africa. The recommendations and conclusions are drawn from current literature and current anthropological field work among rural Wolof.

VOLUME II - NUMERICAL LISTING

(Technical Memoranda, Technical Notes, Reports, Standards)

TECHNICAL MEMORANDA

<u>No.</u>	<u>Title</u>	<u>Author</u>	
1	Personnel Protection Padding for Military Vehicles (Uncl), 1953	Snyder Reno	(I-41)*
2	Human Engineering Evaluation of Stinger, Preliminary Report of Progress, (Uncl), 1953	Staff HEL	(I-61)
3	An Evaluation of the Human and Space Engineering Studies - Tank, 90mm Gun, T42, (Uncl), 1953	Hollis	(I-62)
4	A Discussion of the Concept of the Prone Arrangement for Track Laying Combat Vehicles, (Uncl), 1953	Stephens	(I-44)
5	Report on Conference Reviewing Project DA 502-08-032 Weapon, Short Range, Antiaircraft, Including Mount, (Uncl), 1953	Snyder	(I-47)
6	A Literature Survey of Human Performance Under Arctic Environment, (Uncl), 1953	Revesman Hollis Mattson	(I-27)
7	Manual Rotary Performance, (Uncl), 1954	Weisz	(I-19)
8	Evaluation of Vehicle Rating Scale, (Uncl), 1954	Hollis	(I-44)
10	The Legibility of Letter and Number Castings, (Uncl), 1954	Kurke	(I-9)
11	Report on Preliminary Observations of Human Engineering Problems Under Desert Conditions, (Uncl), 1954	Revesman	(I-31)
12	Human Engineering Evaluation of Truck, 1/4 Ton, 4x4, Utility, M38A1, (Uncl), 1955	Hollis	(I-63)
13	Driver's Position in Tanks, (Uncl), 1955	Stephens Weisz Hodge	(I-44)

* TM abstract on this page in Volume I (white section).

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>
14	Measurement of Temperatures in Various Ordnance Equipment Under the Desert Environment, (Uncl), 1956	Revesman Schulze (I-31)
15	Human Engineering Survey of NIKE Field Installations, (Uncl), 1956	Kaehler et al (I-56)
16	Human Engineering Survey of M-48 Tank, (Uncl), 1956	Charney Rose, Lee (I-62)
17-1	Psychological and Physiological Effects of Muzzle and Breech Blast, (Uncl), 1956	Blair Schulze (I-36)
17-2	First Interim Report - Psychological and Physiological Effects of Muzzle and Breech Blast, (Uncl), 1957	Blair (I-37)
18	Human Engineering Evaluation of the Mock-Up Equipment of the LACROSSE B Forward Guidance Station, (Uncl), 1956	Revesman Stephens Schulze Pohlmann (I-52)
19	Human Engineering Arctic Field Liaison Study, (Uncl), 1956	Charney Rose, Lee (I-27)
20	Visual Efficiency Under Desert Conditions, (Uncl), 1956	Katchmar Jelinek Hodge (I-31)
21	Human Engineering Evaluation of Truck, 1/4 Ton, 4x4, XM 151, (Uncl), 1956	Weiss Taylor (I-63)
22	Minimum Cubic Dimensions for Operators of an Integrated Fire Control System, (Uncl), 1956	Nelson Leopardo (I-27)
23	Effectiveness of Warning Lights as a Function of Flash Rate, (Uncl), 1956	Katchmar Azrin (I-3)
24	Human Engineering Survey of Honest John Weapon System, (Uncl), 1956	Van Huyck Davidson Notary (I-51)
25	The Effects of Modified M1 Rifle Sights on Marksmanship at Low Levels of Illumination, (Uncl), 1956	Hodge (I-7)
26	Human Engineering Survey of Armored Infantry Vehicle, M59, (Uncl), 1956	Charney Rose, Lee (I-49)
27	Driver's Position in Tanks: A Field Evaluation of the Prone Position, (Uncl), 1956	Pohlmann Leopardo (I-44)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>
1-57	System Evaluation of the Tank, 76mm Gun, M41A1, (Uncl), 1957	Kurke Stephens (I-62)
2-57	Human Engineering Comparison Study of the Ground Guidance Stations of Corporal Missile System Type II and Type III, (Uncl), 1957	Van Huyck Miller Sova (I-50)
3-57	Physical Force Problems: I. Hand Crank Performance for Various Crank Radii and Torque Load Combinations, (Uncl), 1957	Katchmar (I-20)
4-57	Human Engineering Field Survey of 280mm Gun and Transporters, (Uncl), 1957	Andrew Miller Lansill (I-63)
5-57	Low Power Optical Systems and Aerial Target Detection, (Uncl), 1957	Kurke McCain (I-11)
6-57	A Study of Cold Weather Organizational Maintenance Problems (M29, M59, M76), (Uncl), 1957	Andrew Bacon, Rose (I-27)
7-57	An Evaluation of Selected Rifle Sights Under Two Levels of Illumination, (Uncl), 1957	Pohlmann Katchmar (I-8)
8-57	An Evaluation of Three Proposed Sets of Radar Symbols, (Uncl), 1957	Blair (I-5)
9-57	Literature Review: Tracking Control Mechanisms and Displays (Light Artiaircraft System Oriented), (Uncl), 1957	Hicks (I-24)
10-57	Human Engineering Problems of the Armored Personnel Carriers T113 and T117, (Uncl), 1957	Bacon Cronk, Rose (I-58)
1-58	An Investigation of Symbol Meaning Combinations for use in Radar Displays, (Uncl), 1958	Torre Sanders (I-5)
2-58	Evaluation of Radar Symbols for Target Identification, (Uncl), 1958	Dardano Donley (I-5)
3-58	Human Engineering Evaluation of the LaCrosse Assembly Area and Launch Area, Task III Missile, Launcher Series 3000 (U), (Conf), 1958	Estrine Sova (I-53)
4-58	Discriminability of AAOC Symbols, (Uncl), 1958	Dardano Stephens (I-5)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>	
5-58	An Evaluation of 50 and 60 lb. Ammunition Containers and Recommendations for Improved Package Design, (Uncl), 1958	Hicks McCain	(I-22)
6-58	Some Effects of Noise on Human Behavior, (Uncl), 1958	Azrin	(I-35)
7-58	A Dynamic Human Engineering Evaluation of the Armored Personnel Carriers, T113 - T117, (Uncl), 1958	Garinther Torre Tiernan Hoizen	(I-58)
8-58	A Human Engineering Review of Special Weapons Stockpile to Target Sequence (U), (Secret RD), 1958	Congleton Smith Boezinger	
9-58	Indicating (Read-Out) Tube: Human Engineering Applications for Informational Displays, (Uncl), 1958	Cruse	(I-7)
10-58	An Analysis of the Infantry Assault Weapon, Light (LAW) TV-1 Prototype Rocket Noise, (Uncl), 1958	Donley Curran King	(I-54)
1-59	A Human Engineering Evaluation of the Dart Missile System - The Range Finder (U), (Conf), Feb 1959	Torre Schneider	
2-59	A Guide to Color Banding for Indicators (Meters), (Uncl), Mar 1959	Wokoun Chalkin	(I-1)
3-59	Investigation of Natural Movements in Azimuth and Elevation Lever Control Adjustments for Horizontal and Vertical Positions, (Uncl), Apr 1959	Lazar Williams	(I-19)
4-59	A Human Engineering Evaluation of Spotting Rounds with Respect to Fire Direction Capabilities, (Uncl), Jun 1959	Fried Ivey	(I-12)
5-59	A Human Engineering Evaluation of the Sergeant Transport and Loading Equipment and Procedures (U), (Conf), Jun 1959	Moler Schneider Holzen Foster	(I-60)
6-59	Evaluation of Sighting Devices for a Small Hand-Held Rocket Launcher, (Uncl), Sep 1959	Curran Gschwind	(I-8)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>	
7-59	Relationships of Intermittent Noise, Inter-Signal Interval and Skin Conductance to Vigilance Behavior, (Uncl), Jul 1959	Dardano Mower	(I-36)
8-59	The Motivational Effects of Rest Periods on Performance, (Uncl), Aug 1959	Hicks	(I-41)
9-59	A Study of the Effects of Continuous Wave Jamming on the Detection of Antiaircraft Operations Center Symbols, (Uncl) Sep 1959	Fried	(I-8)
10-59	An Evaluation of Mode Selector Switch Arrangements, (Uncl), Aug 1959	Wattles Weiss Holzen	(I-19)
11-59	An Exploratory Study into the Effects of Low Blast Pressure on Behavior in Rhesus Monkeys, (Uncl), Oct 1959	Romba Martin	(I-28)
1-60	A Human Engineering Evaluation of the LaCrosse Missile System. Evaluation of Sight Unit XM43 and its Application to the LaCrosse Lightweight Launcher, (Uncl), Feb 1960	Lazar Sova	(I-53)
2-60	Studies on the Kinetic Depth Effect as a Means for Presenting Three Dimensional Information. I. Methodology and Selection of Forms for Study, (Uncl), Mar 1960	Fried	(I-9)
3-60	The Effects of Four Hours of Confinement in Mobile APCs on the Performance of Selected Combat Relevant Skills: A Pilot Study, (Uncl), Mar 1960	Hicks	(I-28)
4-60	An Evaluation of Observer Errors in Spotting Round Fire Control, (Uncl), Mar 1960	Gschwind	(I-12)
5-60	A Human Factors Evaluation of Seven Digital Read-Out Indicators, (Uncl), Jul 1960	Fried	(I-7)
6-60	A Human Factors Engineering Evaluation of Little John Launchers XM34 and XM80, (Uncl), May 1960	Pomeroy	(I-54)
7-60	Detection of Random Low-Altitude Jet Aircraft by Ground Observers, (Uncl), Jun 1960	Wokoun	(I-15)
8-60	Human Engineering Evaluation of the M60, Main Battle Tank, (Uncl), Jun 1960	Foster	(I-62)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>	
9-60	The Effects of Missile Lengths and Weight on Loading Time, (Uncl), Jul 1960	McIntyre	(I-21)
10-60	Closed Circuit Television Vehicle Driving: I. A Preliminary Investigation, (Uncl), Aug 1960	Moler Brown	(I-8)
11-60	Synthetic Video as an Electronics Counter-Counter Measure: A Study of Pulsated and Steady State Symbology, (Uncl), Aug 1960	Fried	(I-9)
12-60	Muzzle Blast Measurements on Howitzer 105mm, M2A2E2 with Muzzle Brake No. 8, (Uncl), Aug 1960	Holland	(I-51)
13-60	A Human Factors Engineering Evaluation of the LaCrosse Missile System: Final Report, (Uncl), Dec 1960	Pomeroy	(I-53)
14-60	Not used		
15-60	Not used		
16-60	A Human Factors Engineering Evaluation of the SS-11 Antitank Guided Missile, (Uncl), 1960	McIntyre Torre	(I-48)
17-60	The Effects of Eight Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: Study II, (Uncl), Nov 1960	Hicks	(I-29)
18-60	Studies on the Kinetic Depth Effect as a Means for Presenting Three Dimensional Information: II. Effects of Variation in Angle and Length of a Two Dimensional Form, (Uncl), Dec 1960	Fried	(I-10)
19-60	A Human Engineering Evaluation of the Davy Crocket Graphical Firing Scale (U), (Conf), Dec 1960	Short Range Branch	(I-50)
1-61	The Effects of 12 Hours Confinement in Static Armored Personnel Carriers on Selected Combat Relevant Skills: Study III, (Uncl), Feb 1961	Hicks	(I-29)
2-61	The Effects of 12 Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: Study IV, (Uncl), May 1961	Hicks	(I-29)
3-61	A Human Factors Engineering Evaluation of the M73C Tank Machine Gun, (Uncl), Jan 1961	Clark	(I-54)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>
4-61	A Human Factors Engineering Evaluation of the 4.2 Mortar, T201, (Uncl), Feb 1961	Short Range Branch (I-55)
5-61	A Human Factors Engineering Evaluation of the Trailer-Mounted 762mm (Honest John) Rocket Handling Unit XM405A1 (U), (Conf), May 1961	Doherty (I-51)
6-61	A Human Factors Engineering Evaluation of the Pershing Weapon System: Evaluation and Procedure Analysis of the FY-59, Serial 005, Transporter-Erector Launcher and Ground Handling Equipment (U), (Conf), May 1961	Sova Pomeroy Coyne (I-57)
7-61	A Human Factors Engineering Evaluation of the Pershing Weapon System Communication Pack (AN/TRC-80), (Uncl), Sep 1961	Weiss (I-58)
8-61	Relationships Between Galvanic Skin Resistance and Reaction Time on Visual Monitoring Task, (Uncl), Jun 1961	Karsh (I-22)
9-61	The Effectiveness of Various Spotting Techniques in Fire Control: A Pilot Study, (Uncl), Jun 1961	Glucksberg Klein (I-12)
10-61	Handbook of Color Notation Systems, (Uncl), Sep 1961	Fried Gibson (I-1)
11-61	A Human Factors Engineering Evaluation of the Davy Crocket Graphic Firing Scale FRE-24776 (U), (Conf), Jul 1961	Short Range Branch (I-50)
12-61	Performance of a Pursuit Tracking Task with Different Delay Times Inserted Between Control Mechanism and Display Cursor, (Uncl), Aug 1961	Wallach (I-26)
13-61	Not used	
14-61	Muzzle Blast Measurements on Howitzer 155mm M1A2E3 with Muzzle Brake No. 8, (Uncl), Jul 1961	Holland (I-52)
15-61	Not used	
16-61	An Investigation of Portability Principles for Two-Man Loads as Applied to T201 Mortar, (Uncl), Sep 1961	Clark, Torre Gschwind (I-21)
17-61	The Propagation of Air Shock Waves on Biophysical Model, (Uncl), Sep 1961	Romba Martin (I-28)
18-61	Not used	

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>	
19-61	A Pilot Study of Temporary Threshold Shifts Resulting from Exposure to High-Intensity Impulse Noise, (Uncl), Sep 1961	Smith Goldstone	(I-37)
20-61	Muzzle Blast Measurements on XM-81 Gun Launcher, (Uncl), Dec 1961	Waugh Holland	(I-51)
21-61	Not used		
22-61	Design of a Picture Language to Identify Vehicle Controls: I. General Method, II. Investigation of Population Stereotypes, (Uncl), Dec 1961	Mudd Karsh	(I-6)
23-61	The Effects of 24 Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: Study V (Uncl), Nov 1961	Hicks	(I-29)
1-62	Helicopter Armament Program Air-to-Ground Target Detection and Identification, (Uncl), Jan 1962	Moler	(I-16)
2-62	Helicopter Armament Program Air-to-Ground Range Estimation, (Uncl), Jan 1962	Goldstone Oatman	(I-16)
3-62	A Preliminary Human Engineering Evaluation of Heavy Mortar System Performance, (Uncl), Jan 1962	Gschwind Horley	(I-56)
4-62	An Investigation Comparing the Relative Effects of Two Modes of Gun Turret Operation on Tracking Performance - Study I, (Uncl), Apr 1962	Wallach Klein	(I-25)
5-62	An Investigation Comparing the Relative Effects of Two Modes of Gun Turret Operation on Tracking Performance - Study II, (Uncl), Apr 1962	Snyder Oatman Wallach	(I-26)
6-62	Studies on the Perceived Threshold for Motion - I. Effects of Aperture Dimension on Threshold Velocity, (Uncl), Apr 1962	Fried	(I-10)
7-62	The Effects of 24 Hours Confinement in Mobile Armored Personnel Carriers on Selected Combat Relevant Skills: A Follow Up, (Uncl), Jun 1962	Hicks	(I-30)
8-62	A Human Engineering Evaluation of the ML-1 Mobile Low Power Nuclear Power Plant, (Uncl), Mar 1962	McMurrer McCahan	(I-56)
9-62	A Loading Rate Evaluation of a Pivot Chamber Breech and a XM102 Howitzer Breech (U), (Conf), Mar 1962	Norlander Torre	(I-52)

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<u>No.</u>	<u>Title</u>	<u>Author</u>
10-62	The Influence of Military Rank of Experimenter on the Conditioning of a Verbal Response, (Uncl), Mar 1962	Glucksberg Lince (I-20)
11-62	A Method for the Study of Hearing Loss and Recovery in Rhesus Monkeys, (Uncl), May 1962	Martin Romba Gates (I-34)
12-62	A Human Factors Evaluation of the Pershing Weapon System: System Noise Evaluation (U), (Conf), Apr 1962	Acoustical Rsch Branch (I-58)
13-62	A Human Factors Engineering Evaluation of the M91, 115mm Multiple Rocket Launcher, (Uncl), May 1962	Norlander (I-60)
14-62	A Human Factors Evaluation of the Main Battle Tank, 105mm Gun, M60E1, (Uncl), May 1962	Brown Dickinson (I-62)
15-62	Design of a Picture Language to Identify Vehicle Controls: III. A Comparative Evaluation of Selected Picture Symbol Designs, (Uncl), Aug 1962	Karsh Mudd (I-6)
16-62	Test of the .30 cal. Cartridge XM76 (U), (Conf), May 1962	Donley
17-62	A Partial Review of the Literature on Physiological Disorders Resulting from the Operation of Motor Vehicles, (Uncl), Aug 1962	Lewis (I-43)
18-62	Studies on the Perceptual Threshold for Motion: II. Effects of Induced Motion on Threshold Velocity, (Uncl), Oct 1962	Fried (I-10)
19-62	A Human Factors Engineering Evaluation of the NIKE-ZEUS Missile System, (Uncl), Jun 1962	Surface to Air Wpns Br (I-56)
20-62	A Technique of Investigating Tank Gunner Tracking Error, (Uncl), Sep 1962	McIntyre (I-25)
21-62	Superseded by HEL Standard S-6-66 (see page II-25)	
22-62	Subjective Reports from Subjects in an Aircraft Detection Study: A Questionnaire Analysis, (Uncl), Aug 1962	Wokour. (I-15)
23-62	Muzzle Blast Measurements on Howitzer, 105mm, XM103E1, (Uncl), Sep 1962	Holland (I-52)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>
1-63	Effectiveness of the V-51R Ear Plug with Impulse Pressures up to 3 psi, (Uncl), Nov 1962	Jacobson Dyer Marone (I-40)
2-63	Gunner Tracking Behavior as a Function of Three Different Control Systems, (Uncl), Jan 1963	Gachwin (I-25)
3-63	Response Latencies in the Rhesus Monkey as a Function of Tone Intensity, (Uncl), Feb 1963	Gates Romba Martin (I-39)
4-63	Acoustical Evaluations of the Sergeant Missile System: 45-kw. Generator and Proposed Headsets, (Uncl), Mar 1963	Garinther Kahl, Sova (I-60)
5-63	Rotary Pursuit Tracking with Divided Attention to Cutaneous, Visual, and Auditory Signals, (Uncl), Mar 1963	Glucksberg (I-26)
6-63	A Method for Increasing Efficiency of Dial Check-Reading (Uncl), Mar 1963	Dashevsky Glucksberg (I-3)
7-63	The Effects of Repeated Confinement on the Performance of Men in a Hot-Wet Climate, (Uncl), Jan 1963	Hicks (I-30)
8-63	Recommended Paint Characteristics for Van Interiors: Hue, Brightness, and Saturation, (Uncl), Jul 1963	Wokoun (I-1)
9-63	Ability of Shooters to Gauge Two-Round Bursts from the AR15 Rifle, (Uncl), Jul 1963	Torre (I-48)
10-63	Not used	
11-63	Human Factors Affecting Rifle Accuracy in Automatic and Semiautomatic Fire (U), (Conf), May 1963	Torre (I-61)
12-63	A Human Factors Evaluation of the Mauler Weapon System: System Noise Evaluation (U), (Conf), Jun 1963	Garinther (I-55)
13-63	An Evaluation Technique and Feasibility Study of Shock and Vibration Protection for an Experimental Driver's Seat in the 8-Ton, 4x4 Cargo Truck, XM520E1, (Uncl), Jun 1963	Kung Lea (I-49)
14-63	Human Factors Evaluation of the Carrier, Command Post, Light, Tracked XM577: System Noise Evaluation, (Uncl), Jan 1963	Garinther Donley (I-49)
15-63	Auditory Localization of a Helicopter -- From Ground Position, (Uncl), Jul 1963	Bauer (I-15)

Technical Memoranda

<u>No.</u>	<u>Title</u>	<u>Author</u>
16-63	Vigilance with Background Music, (Uncl), Aug 1963	Wokoun (I-32)
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