Task Performance

This study is the first in a series which was conducted under the name STRANGER III, and which was to examine trainee's long-term memory of motor skills. This phase examined the effects of varying fidelity of training devices on acquisition, retention, and reinstatement of ability to perform a 92-step procedural task. Three versions of the Section Control Indicator Console of the Nike-Hercules guided missile system were utilized. One version was a physical duplicate, fully powered and operational; a second had no power; and a third was a full sized color illustration of the powered version. Sixty U.S. Army trainees were randomly assigned to one of five training conditions, 12 to a group. Each subject was tested immediately after training, 4 weeks later, and 6 weeks later, and each was retrained to a criterion level. There was no difference in training time to learn the procedural task, initial performance level, amount remembered after 4 and 6 weeks, or retraining time between individuals trained on high fidelity devices and those trained on low fidelity devices. (EM)
Acquisition, Retention, and Retraining: Effects of High and Low Fidelity in Training Devices

by

Douglas L. Grimsley

HumRRO Division No. 3 (Recruit Training)

February 1969

Prepared for:
Office, Chief of Research and Development
Department of the Army

Contract DA-44-008-ARO-2

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HumRRO Division No. 3 (Recruit Training)
Presidio of Monterey, California
The George Washington University
HUMAN RESOURCES RESEARCH OFFICE

Technical Report 69-1
Work Unit STRANGER
Sub-Unit III
The Human Resources Research Office is a nongovernmental agency of The George Washington University. The research reported in this Technical Report was conducted under contract with the Department of the Army (DA 44-188-ARO-2). HnRRO's mission for the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.
FOREWORD

The objective of HumRRO Work Unit STRANGER is to examine and obtain a better understanding of long-term memory of motor skills. STRANGER III deals with retention and retraining of skills acquired under various simulated procedures.

The research reported here is the first of a series of studies that have been conducted under STRANGER III. Subsequent reports will describe further studies on group rather than individual training, variations in low fidelity devices, and aptitude level in relation to device training. These studies are of theoretical importance for the area of simulation training and of practical significance both for economy in training and for effectiveness of training, remembering, and retraining.

The STRANGER III studies were performed during 1967 by HumRRO Division No. 3 (Recruit Training) at the Presidio of Monterey, California. Director of Research was Dr. Howard H. McFann.

Military support for the study was provided by the U.S. Army Training Center Human Research Unit. Military Chief of the Unit at the time the study was conducted was LTC David S. Marshall.

Assisting in the collection of the data were SP 4 Lynn C. Fox, SP 4 Eugene R. Brown, and SP 4 Louis E. Moore. Data analysis was performed by Mr. William H. Burckhartt.

HumRRO research for the Department of the Army is conducted under Contract DA 44-188-ARO-2 and Army Project 2J024701A712 01, Training, Motivation, Leadership Research.

Meredith P. Crawford
Director
Human Resources Research Office
SUMMARY AND CONCLUSIONS

Military Problem

There is strong evidence that simulating devices having relatively low fidelity are as effective as high fidelity devices or even the tactical equipment when training is for procedural tasks. Little is known, however, about the long-term retention and reinstatement of performance following training on low fidelity simulators. If relatively inexpensive training devices are as efficient for acquisition, retention, and reinstatement of performance as the real equipment, using them could lead to greater efficiency and training economy.

Research Problem

The purpose of STRANGER III is to examine the effects of varying fidelity of training devices on acquisition, retention, and reinstatement of ability to perform a procedural task.

Method

The subjects were trained to operate the Section Control Indicator console of the Nike-Hercules guided missile system during Blue (preparation) and Red (firing) Status. The procedure taught and the training devices used had been employed in an earlier study under HumRRO Work Unit RINGER (1). In that study men trained with a number of devices varying in functional and/or appearance fidelity were evaluated on their acquisition of ability to perform the 92-step procedural task.

In the STRANGER III experiment, subjects were trained individually on one of three panels differing in appearance and/or functional fidelity:

1. Hot Panel, a physical duplicate of the tactical panel in which all lights, meters, intercom, and other indicators worked.
2. Cold Panel, identical to the Hot Panel except there was no electric power.
3. Reproduced Panel, a full-size artist’s representation (in color) of the Hot Panel.

Sixty trainees in Advanced Individual Training from the U.S. Army Training Center at Fort Ord, California, were the subjects. They were randomly assigned to one of five training conditions, 12 to a group.

Immediately after training, each subject was tested on his ability to perform the 92-step procedural task. Each man was tested again approximately four weeks and six weeks later to see how much of the procedure he remembered; after the final test he was retrained to criterion.

Results

There were no differences in training time to learn the procedural task, initial performance level, amount remembered after four and six weeks, or retraining time between individuals trained on high, and those trained on low fidelity devices.

These results were similar to those in the research performed under Work Unit RINGER (1), in which none of the differences in average proficiency at the end of training, or average training time, were statistically significant. Men trained on low fidelity devices were as proficient as those trained with devices high in functional and appearance fidelity.
Conclusions

The fidelity of training devices used to train individuals on procedural tasks can be very low with no adverse effect on training time, level of proficiency, retention, or time to retrain. Since substantial financial savings can be realized by using low fidelity devices, training device selection should be based on a careful review of the tasks to be taught, so that inexpensive devices can be used where possible.
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Acquisition, Retention, and Retraining: Effects of High and Low Fidelity in Training Devices
INTRODUCTION

There have been a number of reviews and general summaries of the literature dealing with simulator training (2-6) and its usefulness as preparation for training on the actual equipment (7, 8). Simulating devices are used extensively because the real equipment is expensive, limited in supply, and often inefficient or even dangerous for training purposes.

Devices simulating tactical equipment have been developed and tested in a number of training programs, and there is strong evidence that devices having relatively low fidelity are as effective for training certain specialties as high fidelity devices or even the tactical equipment (9-15). Most of the studies have been concerned with procedural tasks in which every action must be done in sequential order.

In a series of experiments performed under HumRRO Work Unit RINGER (1), the fidelity of devices used to train men on the Nike-Hercules missile system was varied in either a functional or an appearance dimension. The results showed that the requirements for fidelity in the training device were quite low; use of the photographic reproduction trained men just as effectively as the device of highest fidelity or the actual equipment. Lowering the fidelity by reducing the size of the photographic reproduction had no effect on proficiency, as long as the elements were clearly visible.

Thus, there is evidence that even very simple devices can be used for training on procedural tasks with no loss in training time or degree of proficiency. Since demonstrations of the efficacy of training with low fidelity devices have been provided on airplanes (13), submarines (14), and tanks (17), the utility of such devices seems widely applicable.

Even though it has been shown that under certain circumstances device fidelity is relatively unimportant in training to a specified criterion, this does not answer equally important questions concerning the retention of the task performance. Is material learned under low fidelity procedures retained as long as that learned under high fidelity conditions? Is a task trained on a simulator retained equally well for high and low aptitude subjects? Is there a difference in reinstatement of performance between subjects trained on low vs. high fidelity devices? If retention is not as good, or reinstatement of performance more difficult, after training on low fidelity devices than after high fidelity device training, the latter may, in the long run, be more economical.

There are virtually no experimental results currently available that adequately answer the questions of the effect of fidelity of training devices on retention. Although some studies have been done (17, 18), results remain ambiguous.

If relatively inexpensive training devices are as efficient as the real equipment or very high fidelity devices for training and in later recall, expensive training or tactical equipment would not have to be allocated and maintained for training purposes. Savings could be substantial if the training involves expensive items.

---

1As defined by R. B. Miller, a procedural task is one in which discrete, principally "all-or-none" responses are made to given cues or to specific values of cues in a continuous series of stimuli (16).
such as missiles, airplanes, and tanks. The purpose of STRANGER III is to examine the effect of varying fidelity of the training device on both acquisition and retention of a procedural task.

An initial study, utilizing the same procedural task and devices as the RINGER research but extending the experiment to retention, is reported here. Other reports are in preparation to describe further studies on the effects of group rather than individual training, of further variations in low fidelity devices, and of aptitude level in relation to device training.

APPRAOCH TO THE RESEARCH

Defining the Task

In a procedural task, every action or response is specified and is so simple or well known that any subject will either already know how to do it or can learn it almost immediately. What he must learn is the sequence in which the actions are to be taken, and to avoid taking any action out of turn.

The task used in this study required responses such as those made by an operator of a Section Control Indicator (SCI) panel of a Nike-Hercules guided missile system during preparation and firing status. The equipment (Figure 1) was identical to that employed in Work Unit RINGER (1). The entire sequence consists of 92 actions, which are presented in Table 1 according to the different kinds of actions and their frequency of occurrence. The complete, 92-step sequence is presented in Appendix A.

In each step, the operator receives a signal and must make a specific response to it. The signal for an action may simply be the completion of the previous action, or the action to be taken may be to monitor or wait for the next signal. Each such unit, signal and action, is considered an individual step in this procedure.

Subjects

Sixty trainees in Advanced Individual Training from the U.S. Army Training Center

Table 1

<table>
<thead>
<tr>
<th>Action</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating a toggle switch</td>
<td>29</td>
</tr>
<tr>
<td>Operating a push-button switch</td>
<td>8</td>
</tr>
<tr>
<td>Operating a rotary switch</td>
<td>2</td>
</tr>
<tr>
<td>Operating a rheostat control</td>
<td>2</td>
</tr>
<tr>
<td>Operating a banana plug</td>
<td>1</td>
</tr>
<tr>
<td>Writing the time</td>
<td>3</td>
</tr>
<tr>
<td>Giving a verbal response on phone or intercom</td>
<td>11</td>
</tr>
<tr>
<td>Monitoring a light</td>
<td>18</td>
</tr>
<tr>
<td>Monitoring a sound, oral or machine originated</td>
<td>16</td>
</tr>
<tr>
<td>Monitoring a meter</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 1

Tactical Section Control Indicator (SCI)
at Fort Ord, California were randomly assigned to one of five training groups, with 12 trainees in each group. No one with an Armed Forces Qualification Test (AFQT) score below 30 was included.

Training Devices

Subjects were trained on one of three panels that differed in appearance or functional fidelity. These devices—three of those developed in the RINGER research—were:

1. **Hot Panel.** This device is a physical duplicate of the tactical SCI. Every light, switch, meter, intercom, and telephone is functional.
2. **Cold Panel.** This device is identical to the Hot Panel except that it has no electric power. Therefore, no light, meter, intercom, or telephone functions, though the switches can be operated.
3. **Reproduced Panel.** This is a full-size artist's reproduction of the Hot Panel and is painted to resemble an illuminated Hot Panel.

### Design

The training and test design is presented in Figure 2. Three of the trainee groups (Groups 1, 2 and 4) were always tested on the high fidelity simulator (Hot Panel), regardless of the panel on which they had been trained.

To avoid the possibility that mere exposure of all groups to the Hot Panel at the time of proficiency testing might affect retention, the two other trainee groups were not originally tested on the Hot Panel. One group (Group 3) was trained on the Cold Panel and was given the proficiency test on the Cold Panel. Similarly, one group (Group 5) was trained on the Reproduced Panel and tested initially on the Reproduced Panel. Neither of these groups was exposed to the Hot Panel until retesting, four and six weeks after training.

In addition to the acquisition and retention data, General Technical Aptitude Area (GT) and AFQT scores were obtained for each subject.

### CONDUCT OF THE RESEARCH

**Training Procedures**

The subjects were trained individually, with two enlisted men on the research staff serving as instructors. The subject was told that he would be trained to operate a piece of Nike-Hercules equipment. The instructor then showed a

--

1. Low-aptitude personnel were omitted from this study and studied separately at a later date.
2. Each instructor trained approximately the same number of subjects. All retesting was conducted by one instructor. Statistical tests indicated no significant differences between instructors on proficiency scores or on time to train for the trainees.
diagram of a typical Nike-Hercules site (see Appendix B) and described the
functions of the major pieces of equipment.

Using the appropriate simulator on which the subject would be trained, a
demonstration "talk-through" of the 92-step procedure was then presented. The
instructor showed and described the signal for an action, and the action itself,
and gave a brief, simple explanation of why the action was taken. For example,
the first signal is the simultaneous onset of a Blue Status light and sound of an
alarm buzzer. The proper action is to turn the power switch to the ON position.
The explanation given was "turning the power switch ON provides electric power
to this panel."

When the instructor had completed the 92-step demonstration, the subject
attempted to perform the procedure. When an error was made, it was immedi-
ately corrected and the procedure continued. The instructor pointed out that
certain sections of the procedure could be grouped for easier learning. He used
verbal expressions, such as "good" and "that's right" to reinforce correct actions.
(Not every action was reinforced, and no attempt was made to follow an exact
schedule, although reinforcement was used more frequently in the early stages
of training.)

Cueing was also used when a subject hesitated to take some specific action
after he had apparently recognized the signal. For example, completion of the
seventh action ("Plug the Headset-Handset into Station 2") is the signal for the
eighth action, which is to announce over the Headset-Handset, "Blue Status
received, Section A." If, during the training, the subject completed the seventh
action and hesitated too long in making his announcement, the instructor might
say, "You plugged it in, now use it." As with the verbal reinforcement, cueing
was used more often in the early part of training.

A tactical SCI automatically furnishes knowledge of results to an operator
after many of his actions. For example, when the prepared button for Launcher #1
is pressed, the red prepared light goes out and the green prepared light goes on.
Of the simulator training devices, only the Hot Panel provided this same knowl-
edge of results. For the other two devices, the instructor provided the trainee
this information orally. Using the example above, when the prepared button was
pressed, the instructor would say, while pointing to the proper lights, "Now this
red light is off, and this green light is on."

On the Cold and Reproduced Panels, the subject could only "speak" certain
actions instead of actually performing them. The trainee had to verbalize that
"the red light is off, and the green one now is on." Trainees on the Cold Panel
actually threw the switches on the panel while Reproduced Panel trainees simply
went through the motions of throwing the switches.

The training session was continuous, except for an occasional brief rest
break, until the subject could perform one errorless trial, or until the maxi-
mum time of three hours was reached. All subjects completed training in the
time allotted.

The procedures that had been followed in the RINGER research differed in
that men were trained in groups of five, rather than individually as in STRANGER.
The instructor gave a demonstration "talk-through" of the procedure, then selected
a trainee to attempt to perform it while the other trainees observed and helped
him when he made an error. After the trainee had gone through the 92 steps, a
second trainee was selected to perform and the first became an observer. Each
trainee in the group performed twice and observed eight times, before being tested
on the Hot Panel, whereas in STRANGER an individual's training continued until
he achieved one errorless trial (or until three hours had passed) before being tested on the Hot Panel.

**Testing**

**Groups Initially Tested on the Hot Panel**

Approximately five minutes after a subject had been trained, he was tested in order to ascertain his level of proficiency. For three of the five treatment groups, proficiency was tested on the Hot Panel, which was considered equivalent to a tactical SCI. The trainee was told that he was to perform the 92-step procedure using the Hot Panel, and that all parts of the device operated. He was cautioned to take his time and asked if he had any questions before starting. Then the instructor operated a switch that turned on the Blue Status light and the alarm buzzer, and the trainee began the test.

In every case, the alternate instructor was present in the room and acted as scorer, keeping a record of the trainee's errors. Each step omitted or taken out of sequence constituted an error. Any question the trainee asked during the procedure was answered by the instructor, and an error was scored for that step. If the trainee made an error that would have prevented continuance, the instructor corrected the error and recorded it, and the trainee continued with the test.

The trainee was told that he would be scored on accuracy only, and that time was not a factor on the test. The proficiency score was the number of steps performed correctly.

**Groups Initially Tested on Cold and Reproduced Panels**

Two of the treatment groups were not tested initially on the Hot Panel. Following the five-minute wait after training, the men in each group were tested on the panel on which they had been trained (one on Cold Panel, one on Reproduced Panel). The test procedure was generally the same as that followed with the Hot Panel.

**Retesting and Retraining**

Approximately four weeks after training (26-30 days), each subject was brought back and all were tested on the Hot Panel. The same testing procedure as previously described was used. After the test the instructor reviewed any errors made by the subject and pointed out the correct actions.

Two weeks (14-18 days) after the first retest, a second retest was given following the same test procedure. After the test, if any errors had been made they were corrected and the trainee attempted to perform the procedure correctly. Continued attempts were made until the trainee reached a criterion of 90 correct or better. Both the number of trials and time to reach criterion were recorded.

**RESULTS**

Data analyses are based on 12 men in each training group. Analysis of variance procedures were used to test for differences related to the use of the three training panels. Details of these analyses are presented in Appendix C. Individual scores on each variable are presented in Appendix D.

Mean scores of the five experimental groups for all of the variables studied are presented in Table 2. In conducting the analyses of variance, the two groups
initially tested on the Hot Panel and the two groups initially tested on the Cold and Reproduced Panels were compared separately with the group trained and tested on the high fidelity simulator.

Table 2

<table>
<thead>
<tr>
<th>Test</th>
<th>Treatment Groupb</th>
<th>Hot/Hot</th>
<th>Cold/Hot</th>
<th>Cold/Cold</th>
<th>Repro/Hot</th>
<th>Repro/Repro</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFQT Scorec</td>
<td>Mean</td>
<td>78.1</td>
<td>78.8</td>
<td>58.4</td>
<td>79.2</td>
<td>70.5</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>22.3</td>
<td>20.2</td>
<td>20.0</td>
<td>10.3</td>
<td>23.2</td>
</tr>
<tr>
<td>GT Scorec</td>
<td>Mean</td>
<td>122.0</td>
<td>124.0</td>
<td>106.0</td>
<td>126.0</td>
<td>116.0</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>17.7</td>
<td>16.9</td>
<td>21.7</td>
<td>11.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Time to Train (minutes)</td>
<td>Mean</td>
<td>114.0</td>
<td>113.3</td>
<td>118.3</td>
<td>97.3</td>
<td>132.3</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>21.9</td>
<td>30.1</td>
<td>30.0</td>
<td>30.5</td>
<td>37.2</td>
</tr>
<tr>
<td>Proficiency Score</td>
<td>Mean</td>
<td>90.9</td>
<td>89.2</td>
<td>90.1</td>
<td>88.3</td>
<td>89.5</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.0</td>
<td>3.1</td>
<td>1.6</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Retest 1 Score</td>
<td>Mean</td>
<td>75.7</td>
<td>75.0</td>
<td>75.4</td>
<td>75.1</td>
<td>71.7</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>5.2</td>
<td>4.3</td>
<td>6.1</td>
<td>8.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Retest 2 Score</td>
<td>Mean</td>
<td>82.9</td>
<td>83.3</td>
<td>83.3</td>
<td>83.6</td>
<td>83.3</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>4.6</td>
<td>4.8</td>
<td>6.5</td>
<td>5.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Trials to Retrain</td>
<td>Mean</td>
<td>2.5</td>
<td>2.5</td>
<td>2.3</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.0</td>
<td>0.8</td>
<td>0.4</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Time to Retrain (minutes)</td>
<td>Mean</td>
<td>20.7</td>
<td>19.9</td>
<td>19.0</td>
<td>17.8</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>10.3</td>
<td>6.9</td>
<td>4.0</td>
<td>8.3</td>
<td>10.4</td>
</tr>
</tbody>
</table>

aDesignation indicates method by which the subject was trained and method by which his proficiency was originally tested.

bAnalyses of variance for these groups showed that differences were not significant.

Mean scores somewhat above the average Army input for all groups.

None of the comparisons indicated significant differences (see Appendix C). In training time, initial performance level, amount remembered after four and six weeks, or retraining time, results were similar for individuals trained on high and low fidelity simulators.

**DISCUSSION**

**Acquisition**

The results of the study indicate that men can be trained to perform a procedural task as well on very simple, low fidelity devices as on a functional, high fidelity device. These results are consistent with those of other researchers.
who have shown that for fixed procedural tasks, fidelity is relatively unimportant in the training device (1,9-16). Moreover, the actual proficiency scores obtained are similar to those reported under Work Unit RINGER (1) using the same equipment, even though the training procedures were somewhat different.

Retention

Regardless of the fidelity of the training device, all subjects retained the material equally well for more than a month. Of greatest interest was the finding that the groups remembered equally well even when they had not been exposed to the high fidelity device during training. Swanson (18) found, similarly, that differences associated with the use of various types of training aids were negligible immediately after training and also approximately six to eight weeks after training.

Reinstatement

When retraining to restore the original level of performance, men in the groups trained on the low fidelity devices relearned just as fast as men in the groups trained on the high fidelity device. This was true even though two of the groups had not been exposed to the high fidelity device until the time of retraining.

It seems clear from this study that high fidelity simulation is not a mandatory requirement for procedural tasks. Without exception, training on a simplified device resulted in high positive transfer to the criterion task, and, most important, retention of the skill was comparable for all groups.

Knowledge that simple devices are sufficient for training with no sacrifice of retention of performance can mean that it is feasible to use training devices that are less complex, less expensive, and easier to maintain than high fidelity devices. Low fidelity devices may serve as trainers for trainers, or to introduce procedures of practice in basic skills, or to prepare trainees for practice on complicated simulators or the tactical equipment. For instance, low fidelity devices have been shown to be as good as the real equipment for training the following tasks: learning basic instrument and radio-range procedures in aircraft (12); control of course and depth of a submarine (14); pre-start check, engine start, engine run-up, and engine shut-down of aircraft (13); preparation and firing status of a Nike-Hercules guided missile system (1), and starting and stopping procedures in a tank (11).

They may be used to advantage where practice on a task is impossible, for example, for reserve units.

CONCLUSIONS

The fidelity of training devices used to train men in procedural tasks can be very low with no adverse effect on training time, level of proficiency, amount remembered over time, or time to retrain. Trainees who do not even see the operational device can still perform efficiently with a high degree of transfer. High fidelity devices simply are not necessary to train on these types of tasks.

Since the financial saving realized in using low fidelity devices could be great, selection of training devices should be based on a careful review of the tasks to be taught to determine where inexpensive devices could be used.

1For example, the estimated cost of the high fidelity simulator (Hot Panel) developed in the RINGER research was $3,000 while the Reproduced Panel cost approximately $100.
LITERATURE CITED
AND
APPENDICES


Operator is standing before the SCI, which is open but "cold." He is monitoring for Blue Status light and Alarm buzzer to sound.

**SIGNAL**

1. Buzzer and Blue Status light.  
2. "All crewmen present" on IC.
3. "Battle Stations" on HH set.
4. Green ON DECK light.
5. "Launcher #1 prepared" on IC.

**ACTION**

1. Throw Power switch to ON.  
2. Throw Panel Light switch to ON.  
3. Put hand under Panel Light to check for illumination level.  
4. Adjust light level with control knob.  
5. Throw all four Intercom (IC) switches to ON.  
6. Throw all four Launcher Power switches to ON.  
7. Plug Handset-Headset (HH) set into Station 2.  
8. Announce "Blue Status received, Section A" on HH set.  
9. Put IC switch to TALK and hold.  
10. Announce "Blue Status" on IC.  
11. Check and adjust mike level while announcing.  
12. Release IC switch to LISTEN.  
13. Press Alarm shutoff button till buzzer stops.  
14. Monitor for "All crewmen present" on IC.  
15. Announce "All crewmen present, Section A" on HH set.  
17. Announce "Battle Stations received, Section A" on HH set.  
18. Operate IC switch.  
19. Monitor for green ON DECK light.  
20. Announce "Battle Stations" on IC.  
21. Monitor for "Launcher prepared" on IC.  
22. Press PREPARED button for #1.
**SIGNAL**

6. Green #1 PREPARED and SAME light on.
7. “Launcher #2 prepared” on IC.
8. Green #2 PREPARED and SAME light on.
9. “Launcher #3 prepared” on IC.
10. Green #3 PREPARED and SAME light.
11. “Launcher #4 prepared” on IC.
12. Green #4 PREPARED and SAME light on.
13. “Launcher #1 ready” on IC.
14. Noise on IC.
15. “Launcher #2 ready” on IC.
16. Noise on IC.
17. “Launcher #3 ready” on IC.
18. Noise on IC.

**ACTION**

23. Monitor for green #1 PREPARED and SAME light.
24. Monitor for “Launcher prepared” on IC.
25. Press PREPARED button for #2.
26. Monitor for green #2 PREPARED and SAME light.
27. Monitor for “Launcher prepared” on IC.
28. Press PREPARED button for #3.
29. Monitor for green #3 PREPARED and SAME light.
30. Monitor for “Launcher prepared” on IC.
31. Press PREPARED button for #4.
32. Monitor for green #4 PREPARED and SAME light.
33. Monitor for “Launcher ready” on IC.
34. Operate IC switch.
35. Announce “Stand clear, Launcher #1 going up” on IC.
36. Throw Launcher Elevation (LE) switch for #1 to UP.
37. Monitor noise on IC till it stops.
38. Throw LE switch for #1 to OFF.
39. Monitor for “Launcher ready” on IC.
40. Operate IC switch.
41. Announce “Stand clear, Launcher #2 going up” on IC.
42. Throw LE switch for #2 to UP.
43. Monitor noise on IC till it stops.
44. Throw LE switch for #2 to OFF.
45. Monitor for “Launcher ready” on IC.
46. Operate IC switch.
47. Announce “Stand clear, Launcher #3 going up” on IC.
48. Throw LE switch for #3 to UP.
49. Monitor noise on IC till it stops.
50. Throw LE switch for #3 to OFF.
51. Monitor for “Launcher ready” on IC.
SIGNAL

19. “Launcher #4 ready” on IC.

20. Noise on IC.

21. Section Chief comes into revetment.

22. Section Chief turns safety keys to FIRE.

23. All four LAUNCHER READY lights on.

24. Green READY TO FIRE light #1 on.

25. Green LAUNCHER DESIGNATE light on.

26. Smooth movement of needle full left to full right twice.

27. SECTION READY green light on.

28. Section Chief says “Blue Status checks complete.”

ACTION

52. Operate IC switch.

53. Announce “Stand clear, Launcher #4 going up” on IC.

54. Throw LE switch for #4 to UP.

55. Monitor noise on IC till it stops.

56. Throw LE switch for #4 to OFF.

57. Wait for Section Chief.

58. Throw all four IC switches to OFF.

59. Monitor for four amber LAUNCHER READY lights.

60. Throw Heaters and Gyros (H&G) switch for #1 to ON.

61. Record time on log.

62. Monitor for green READY TO FIRE light for #1.

63. Throw DESIGNATE switch to #1 strip.

64. Press LAUNCHER DESIGNATE button.

65. Monitor for green LAUNCHER DESIGNATE light.

66. Press SLEW button and hold through check.

67. Throw SECTION READY switch to READY.

68. Monitor for green SECTION READY light.

69. Wait for Section Chief to OK.

70. Announce “Blue Status checks complete, Section A” on HH set.

Standard Red Status Procedures

Operator is standing in front of open SCI. Power is on. Blue Status is on. Checks are complete. Operator is wearing Handset-Headset (HH) set and is monitoring for Red Status.

SIGNAL

1. Red Status light on.

2. Green SELECTED light on.

ACTION


2. Announce over HH set, “Red Status received, Section A.”


4. Throw Heaters and Gyros (H&G) switch for #2 to ON.

5. Record time on log.
3. Buzzer, green FIRE, LAUNCH ORDER, and MISSILE AWAY lights on.

4. Green #2 READY TO FIRE light on.

5. Green LAUNCHER DESIGNATE light on.

6. Smooth movement of needle left to 0, right to 0, twice.

7. Green SECTION READY light on.

8. Green SELECTED light on.

9. Buzzer and green FIRE, LAUNCH ORDER, and MISSILE AWAY lights on.

10. Move LAUNCHER ELEVATION switch for #1 to DOWN.

11. Throw DESIGNATE switch to #2 strip.

12. Press LAUNCHER DESIGNATE button.


14. Press SLEW button.

15. Monitor SLEW METER for correct check.

16. Throw SECTION READY switch up (ON).

17. Monitor for green SECTION READY light.


19. Throw H&G switch for #3 to ON.

20. Record time on log.

21. Monitor for Buzzer and green FIRE, LAUNCH ORDER, and MISSILE AWAY lights.

22. Throw SECTION READY switch down (OFF).
Appendix B

ORIENTATION TO THE NIKE HERCULES SITE AND
THE SECTION CONTROL INDICATOR (SCI)

The Nike Hercules is primarily an antiaircraft missile and can be armed with a nuclear warhead. The site consists of approximately eight major pieces of equipment. The layout varies from site to site, depending on geographic conditions, and on this chart you see one example of a basic site layout. This could represent an area of several miles, and the only consistency is the separation of the IFC (Integrated Fire Control) area (the upper half of the diagram) from the launching area.

Acquisition Radar (AR)

The AR operates continually as it searches the area of protection. When a target has been acquired, the AR sends azimuth and range data to the Target Tracking Radar through the computer.
Target Tracking Radar (TTR)

The TTR locks on the target and tracks it until the target is either released by the Battery Control Officer (BCO) or destroyed by the selected missile. The tracking data is fed to the computer to enable it to plot the missile course to the intercept point.

Missile Tracking Radar (MTR)

When the missile is fired the MTR controls the flight pattern and sends missile position data to the computer.

The three radars have operators constantly monitoring the display scopes.

Battery Control Officer (BCO)

The computer information is monitored by the BCO who makes the final decision whether a missile should be launched.

Launcher Control Officer (LCO)

The LCO relays the commands from the BCO to the Section Control Indicator (SCI) operators. The LCO controls 12 missiles through three SCI panels, and it is his responsibility to select a missile for firing.

Section Control Indicator (SCI)

The operator of the SCI coordinates his duties with his Section Chief and the LCO. He checks the SCI daily and maintains communication between the LCO and the launcher crew. The SCI supplies the power to the four missiles on the launchers. The SCI operator is responsible for the crewmen and the status of the missile during this procedure.

You are here to learn the SCI procedures in Blue Status and Red Status. Blue Status is the procedure taken to prepare a missile for firing, and Red Status is the actual firing procedure.

Do you have any questions?
### Appendix C

**ANALYSIS OF VARIANCE TABLES**

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### Appendix D

**INDIVIDUAL SCORES ON EACH INDEPENDENT VARIABLE**

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**Individual Scores on Hot-Hot**

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Individual Scores on Repro-Repro

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**Document Title:** Acquisition, Retention, and Retraining: Effects of High and Low Fidelity in Training Devices

**Abstract:**
To examine the effects of varying fidelity of training devices on acquisition, retention, and reinstatement of a procedural task, soldiers were trained individually to operate the Section Control Indicator (SCI) console of the Nike Hercules guided missile system during preparation and firing status. Subjects with no previous experience on the equipment were trained on one of three panels differing in appearance, functional fidelity, or both, and tested immediately after training. Approximately four and six weeks later they were retested and retrained to the original level of proficiency. Results indicated that there was no difference in training time, initial performance level, amount remembered after four and six weeks, or retraining time, between individuals trained on high and low fidelity devices for procedural tasks.
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300 North Washington Street • Alexandria, Virginia 22314

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