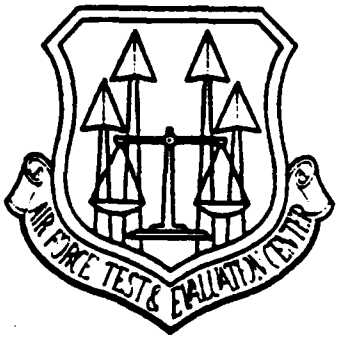
AFTECP 800-2
VOLUME IV

AIR FORCE TEST AND EVALUATION CENTER PAMPHLET



SOFTWARE OPERATIONAL TEST & EVALUATION GUIDELINES

(SOFTWARE OPERATOR — MACHINE INTERFACE)

— EVALUATOR'S GUIDE —

10 NOVEMBER 1982

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE TEST AND EVALUATION CENTER

DEPARTMENT OF THE AIR FORCE
HQ Air Force Test and Evaluation Center (AFTEC)
Kirtland Air Force Base, New Mexico 87117

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Acquisition Management

SOFTWARE OPERATOR-MACHINE INTERFACE EVALUATOR'S GUIDE

The purpose of this pamphlet is to provide to the machine operator information needed to participate in the Air Force Test and Evaluation Center's (AFTEC's) software operator-machine interface evaluation. This evaluation methodology provides a standardized approach to determine the adequacy of the software which controls interaction between a computer-driven system and its operator.

This volume is one in a series of Software Operational Test and Evaluation Guidelines prepared by the Software Evaluation Division of the Logistics Directorate. It is intended for use in the operational test and evaluation of software. Comments should be directed to the office of primary responsibility (OPR). When complete, the series will be as follows:

AFTEC Pamphlet 800-2, Volume 1 - Software Test Manager's Guide

AFTEC Pamphlet 800-2, Volume 2 - Guide for the Deputy for Software Evaluation

AFTEC Pamphlet 800-2, Volume 3 - Software Maintainability - Evaluator's Guide

AFTEC Pamphlet 800-2, Volume 4 - Software Operator-Machine Interface - Evaluator's Guide

AFTEC Pamphlet 800-2, Volume 5 - Software Support Facility Evaluation - User's Guide

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1. Overview. This guide is divided into three parts.

a. The first part provides the evaluator with a generalized introduction to the evaluation concept including a basic understanding of the evaluation procedures and background information. Procedures for recommending changes in the evaluation process are also included.

b. The second part, attachment 1, contains a one-page explanation of each question used in the evaluation. Applicable examples and any unique definitions are provided for each question. The questions are arranged into six groups separated by pages that define each group.

c. The third part, attachment 2, contains a cross-reference index of questions versus subject matter.

2. Background.

a. In the past, the operator-machine interface for a piece of computer-driven equipment has been evaluated on an exception-only basis; i.e., each operator would address only those areas of the interface with which he was particularly disturbed. This method of analysis naturally resulted in highly subjective, nonspecific results. Operators would rate the interface "good" or "bad" according to the number and difficulty of problems each encountered. Experienced operators often have less problems than inexperienced operators merely because they have learned to live with system peculiarities.

b. Highly subjective evaluations are undesirable because they may not yield accurate estimates of operational capabilities and they may not yield descriptions of specific problems that need to be fixed to increase operational capabilities.

c. HQ AFTEC, in an effort to decrease the subjectivity of analyses of the software portion of the operator-machine interface, has generated the Software Operator-Machine Interface Questionnaire (SOMIQ). The concept behind the SOMIQ is that each operator/evaluator is directed to isolate and consider each of a number of quality factors about the equipment being evaluated. Through this organized approach, the operators all consider the same subjects, thereby providing a more uniform analysis. Furthermore, the operators are guided to consider subjects which they might overlook if asked to generate lists of problem areas. Additionally, information is obtained as to which aspects of a system contribute positively to operational capabilities.

d. The SOMIQ was conceived in the spring of 1978 and the first version was published in the winter of 1979. That version was advertised widely through the Air Force Systems Command's and Air Force Logistics Command's embedded computer resource newsletters and through the automatic test equipment (ATE) newsletter published by the Navy. Approximately 200 interested parties responded to the advertisements, and about half that number provided comments to Headquarters (HQ) Air Force Test and Evaluation Center (AFTEC). In addition, the SOMIQ has been used by several AFTEC test teams on a variety of systems since the first version was published.

3. Evaluation Method.

a. The method for evaluating the software portions of the operator-machine interface is based on the use of a closed-form questionnaire with

optional written comments. This questionnaire is designed to determine the extent of the presence of certain desirable attributes in a given system.

b. The desirable attributes addressed by the questionnaire are divided into six groups called characteristics. A complete understanding of the definitions of the characteristics is of prime importance to an accurate evaluation; thus, the evaluator should study these definitions carefully.

4. Definitions.

a. Assurability. A computerized system contains the quality of assurability to the extent that it aids the operator in validating data, avoiding errors, and correcting errors once made. A system which has been designed to aid the operator in error avoidance may or may not achieve this goal. A system should also be designed so that errors are easy to correct, and above all, so that errors do not have catastrophic effects.

b. Controllability. A computerized system contains the quality of controllability to the extent that it allows the operator to direct the operations of the machine. The operator must be able to direct or control the operation of the machine in order to utilize it effectively and efficiently.

c. Workload reasonability. A computerized system contains the quality of workload reasonability to the extent that the tasks required of the operator are within the operator's capability and require the operator to perform a useful, meaningful role. Optimum design of a system which involves an operator and a computerized machine takes advantage of the best capabilities of both: the machine to perform repetitive tasks rapidly and the operator to make command decisions involving unusual situations.

d. Descriptiveness. A computerized system contains the quality of descriptiveness to the extent that the operator has available adequate explanations of every function the operator is required to perform and every function the machine performs. The operator need not be informed in detail of every task the machine performs, but there definitely are certain things the operator must know to fulfill the mission. The questionnaire relies upon the knowledge of the operator to define what it is the operator needs to know.

e. Consistency. A computerized system contains the quality of consistency to the extent that the behavior of the machine and documentation corresponds to the expectations of the operator. There should be a near one-to-one correspondence between what the machine does, what the documentation says it will do, and what the operator has been trained to expect the machine to do.

f. Simplicity. A computerized system contains the quality of simplicity to the extent that information presented to the operator or entered by the operator is grouped into short, readily understandable structures. Complicated data structures, data entry formats, or operator manuals all require the operator to spend more time in developing an understanding of the system and may have a tendency to confuse the operator as well.

5. What to Evaluate. The software operator-machine interface evaluation may be conducted in one or more of several areas within an overall weapons system operational test and evaluation. The evaluation for any given system may involve one or more weapon system operators as well as operators for one or more

levels of computer-driven support equipment. Each of these different types of operator functions must be evaluated separately from the other since the design of the operator-machine interface is different for each type of operator.

6. When to Evaluate. It is left to the software test manager and deputy for software evaluation to determine when to perform this evaluation. However, it is appropriate to present some general guidelines and considerations.

a. One of the assumptions made in the design of the SOMIQ is that the operators performing the evaluation are familiar with the equipment being evaluated. Therefore, this evaluation should not be performed before the evaluators are familiar with the equipment.

b. The evaluation could be done once toward the middle of the test period and again at the end of the test period to see what effect increased operator experience has and to see the impact of contractor updates.

7. Evaluators.

a. One of the major assumptions of this evaluation method is that the evaluators have a working knowledge of the system from the perspective of the specific operator station being evaluated. The more experience an operator has, the more accurate the judgments which the evaluator must make. The bottom line is that the most experienced operators available should perform the evaluation.

b. However, if the number of highly experienced operators is exceedingly small but an adequate number of evaluators of lesser experience are available, then all those operators should perform the evaluation. HQ AFTEC can run the analysis of results by comparing and combining the results from both groups of evaluators.

c. Occasionally, the situation will arise in which no evaluators with any actual operator experience exist. This might occur when no hardware has been produced and the evaluation is being performed on a prototype system. Such a situation will, of course, produce an evaluation extremely dependent on the evaluator's subjective opinion, experience, and consistency between the prototype and operational systems.

8. Evaluation Phases. The software operator-machine interface evaluation consists of four phases: planning, calibration, assessment, and analysis.

a. During the planning phase, the deputy for software evaluation and the software test manager identify the operator-machine interface that is to be evaluated, when and where the evaluation is to take place, and who the evaluators (operators) are to be. They are responsible for assuring that required resources are available to the operators at evaluation time.

b. During the calibration phase, the operators receive a detailed procedures briefing on use of the questionnaire. During this briefing, each question in the questionnaire is discussed in detail. It is extremely important that each operator leave the briefing with a thorough understanding of each and every question.

c. The assessment phase is the period of time during which the operators complete the questionnaire. This phase will require 1 day or less for each operator per questionnaire completed.

d. During the analysis phase, the deputy for software evaluation will collect the completed questionnaires, perform a quality check, and forward the answer sheets to HQ AFTEC for data reduction and a preliminary analysis of results. The results will be returned to the deputy for software evaluation for final analysis and inclusion in operational test and evaluation reports. The features of the AFTEC analysis program and an explanation of its output are contained in AFTEC Pamphlet 800-2, volume 2.

9. Response Form.

a. The form on which an evaluator records his response to questions is the General Purpose (NCS) Answer Sheet. To avoid confusion when the answers are transferred to the computer, any errors should be completely erased. Note that the NCS answer sheet contains little explanatory information since it was designed to be a general form for use by any group using questionnaires. There are three blocks on the answer sheet: evaluator name block, numerical identification block, and evaluator response block.

b. The evaluator name block contains as a minimum the last name of the evaluator; it can also contain the system name (alpha only) at the choice of the software test manager. The accuracy of this block is not as critical as the following two blocks. The suggested format with an example is given in figure 1.

c. The numerical identification block contains numeric codes for the questionnaire type, four levels of system identification, and the evaluator. The numeric codes are entered in the appropriate column fields (A through L), and the associated numbered circles are darkened. Extreme care should be taken to enter all data in this block correctly since this block is the only output information which uniquely associates the evaluator responses with the correct evaluator and system. Do not leave any blanks in items A through L; use zeros rather than leave blanks. The system code (items B and C) must be supplied by the software test manager. Additional system identification should be agreed to by the deputy for software evaluation and the software test manager and supplied to each evaluator. The required format is shown in figure 2 with an example given in figure 3. At the option of the software test manager, additional data can be entered in this block, such as the date of the evaluation (in the birthdate field), or the number of hours required to complete the answer sheet (fields O and P).

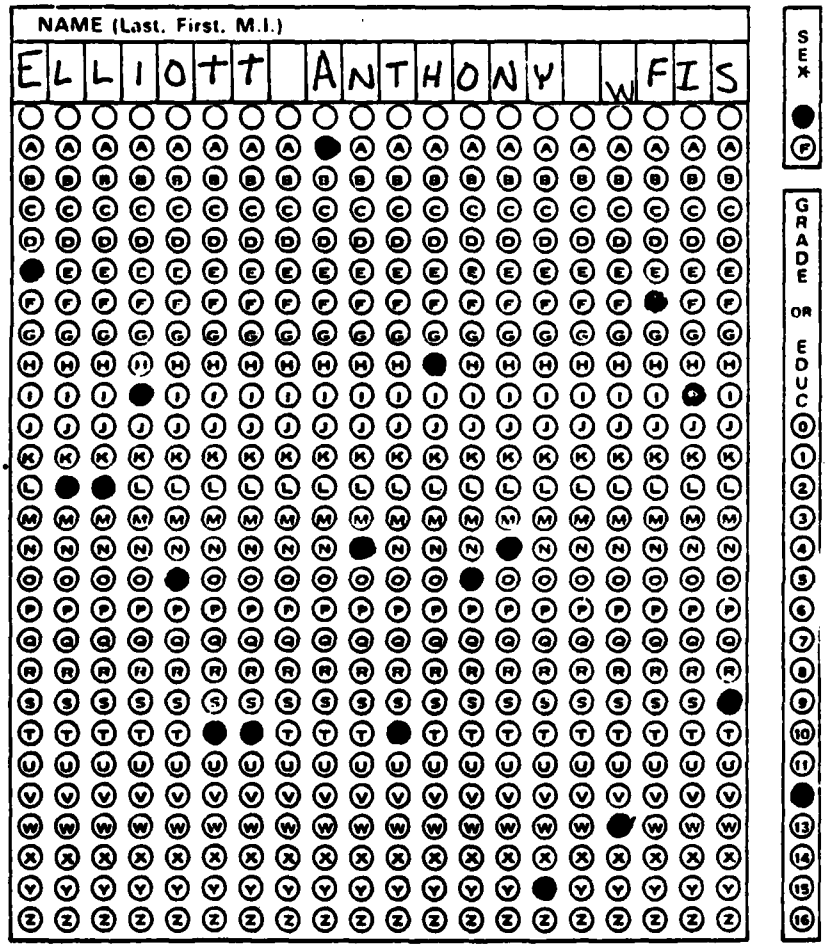
d. The evaluator response block is filled in using the following response scale to answer each question:

A. COMPLETELY AGREE (absolutely no doubt)
B. STRONGLY AGREE
C. GENERALLY AGREE
D. GENERALLY DISAGREE
E. STRONGLY DISAGREE
F. COMPLETELY DISAGREE (absolutely no doubt)

One of these responses must be given for each question. In addition, one or more of the following standardized comment responses can be selected:

I. I had difficulty answering this question.
J. A written comment has been submitted.

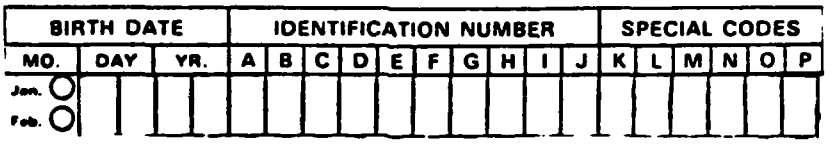
The following example is provided for completing the Name Identification Block on the General Purpose (NCS) Answer Sheet used with the AFTEC questionnaires.



NOTE: The SEX block and the GRADE or EDUC block need not be filled in.

Figure 1. Evaluator (Operator) Name Block Example

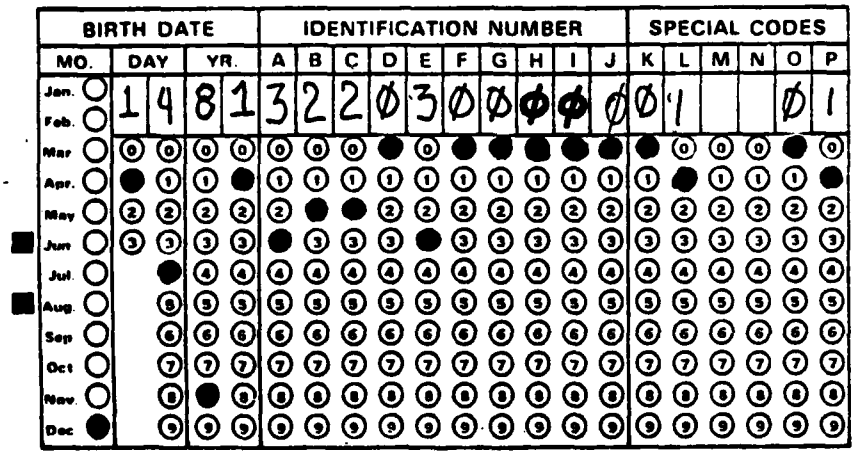
The following format is required for completing the Date and Numerical Identification Block on the General Purpose (NCS) Answer Sheet used with the AFTEC questionnaires. The correct numerical integers must be written in the appropriate fields. Extreme care should be taken in entering these data and in completely covering the associated numbered circle in each column. This is the only way that the questionnaire response can be correlated with the system/subsystem/evaluator...



Columns	Data Description	Range
Birth Date	Date Evaluation Started	
Mo.		Jan - Dec
Day		01-31
Yr.		80-99
A	Type of Questionnaire	3 (SOMIQ)
B,C	System Code	01-99
D,E	Subsystem Code	01-99
F,G	Further system identification if needed	01-99
H,I	Further system identification if needed	01-99
J,K,L	Evaluator Code	001-999
M,N	(not used)	(Blank)
O,P	Time (hrs) to complete questions	00-99

Figure 2. Numerical Identification Block Example

The following example is provided for completing the Date and Numerical Identification Block on the General Purpose (NCS) Answer Sheet used with the AFTEC questionnaires.



Columns	Value	Meaning
Birth Date		
Mo. Day Yr.	14 Dec 81	Evaluation conducted on 14 Dec 1981
A	3	SOMIQ Evaluation
B,C	22	System #22 (JTIDS)
D,E	03	Subsystem #03 (Fault Isolation Software)
F,G	00	not used
H,I		not used
J,K,L	001	Evaluator #001 (Elliott)
O,P	01	Elliott took 1 hour to complete this questionnaire on FIS

Figure 3. Numeric Identification Block Example

The responses G and H currently have no meaning. The responses A to F indicate the extent to which the evaluator agrees/disagrees with the question statement. Depending on the application area and the type of question, these responses can be interpreted differently. In general, however, the response scale can be interpreted as follows:

A. COMPLETELY AGREE. There must be absolutely no doubt when using this response that the product being evaluated cannot be any better with respect to the characteristic addressed.

B. STRONGLY AGREE. This response indicates that the product being evaluated is very good and very helpful to the software maintainer.

C. GENERALLY AGREE. This response indicates that the product being evaluated is acceptable and helpful to the software maintainer.

D. GENERALLY DISAGREE. This response indicates that, although the product being evaluated is acceptable, some improvements are required to make it helpful to the software maintainer.

E. STRONGLY DISAGREE. This response indicates that the product being evaluated is unacceptable and major improvement is required before it would be helpful to the software maintainer.

F. COMPLETELY DISAGREE. There must be absolutely no doubt when using this response that the product being evaluated is unacceptable and must be completely redesigned or rewritten to be acceptable with respect to the characteristic addressed. It is emphasized that responses of A or F are in general not expected since these responses indicate a best possible or worst possible characteristic relative to software in general.

e. Not applicable. Occasionally the evaluator will encounter a question that does not seem to apply to the system being evaluated. In this circumstance, the evaluator will have to work harder at formulating an answer. When a question seems to be "not applicable", it is usually because some feature or function of the idealized systems is entirely absent in the system under consideration. In this case, the evaluator must formulate an answer based upon any system deficiency caused by the lack of the desired feature. If operation of the system would be enhanced by the presence of the missing feature, then the question should be answered in the D, E or F range. If, on the other hand, presence of the missing feature would not help the operator, the question should be answered in the A,B, or C range. The reason that the answer in such "not applicable" cases is not always A or F is that the missing feature may be a nice-to-have item. It is up to the evaluator to judge how seriously lack of certain features affect the operator's ability to complete the mission. Every question must have an answer of A through F. The deputy for software evaluation must review each questionnaire for completeness before sending it to HQ AFTEC for data processing.

10. Evaluation Concepts. When performing the software operator-machine interface evaluation, the operator must keep several important concepts in mind:

a. Questions. The "questions" in the questionnaire are not questions at all. Each question is a positive statement about a desirable design feature as it would be implemented in an ideal system. The question is answered by the evaluator indicating how well the system under evaluation lives up to the ideal described in the question.

b. Keep the characteristic in mind. When answering a question in a given characteristic group, answer the question only as it applies to the definition of that characteristic. For instance, question 9 (the data entry has a cursor or pointer) under assurability should only be answered as to how effective the display is in telling the operator where his next character will be typed in a line of text, thereby avoiding the error of no blanks or too many blanks. True, this contains a certain amount of descriptiveness (as do almost all questions), but the emphasis here is on assurability (error avoidance in this case). If the evaluator is confused about the difference in meaning among two or more questions, he or she can refer to attachment 2 to find all of the questions related to that subject and compare them to one another.

c. Take your time. Heavy emphasis must be placed upon the best, most carefully considered answers you can give. A few extra minutes of careful thought right now may easily save the Air Force hundreds of hours of needless hassle later on. System deficiencies revealed now can be corrected before the system is in field use.

d. Use the comment sheets. Everything said in the previous paragraph applies equally well here. This questionnaire, being a human product, cannot possibly be expected to reveal every shortfall of every system. Your knowledge as expressed in the comment sheets (AFTEC Form 207) is the only way that this analysis can reveal deficiencies not specifically or exactly addressed by questions. An example Form 207 is filled out in figure 4.

11. How to Recommend Changes. Since it is the considered opinion of AFTEC that this manual is not a "perfect" test tool (nor will it ever be), AFTEC must be prepared to change the document as time passes. One of the best sources of additional information to be included in this manual is the very people who use it. Therefore, a blank question data sheet has been provided in figure 5 to be used as a medium with which the evaluator (operator) may forward recommended changes to AFTEC. The question data sheet may be used to address exact questions (fill in the question number) or to suggest new questions. Please send the question data sheet along with any additional information to:

HQ AFTEC/LG5
Kirtland AFB, NM 87117

Please submit a Computer Program Observation Report (AFTEC Form 207) with the question data sheet to identify yourself and the circumstances which lead to your recommendation. AFTEC personnel will contact you and discuss the recommendation with you.

COMPUTER PROGRAM OBSERVATION REPORT | SERIAL NUMBER

I. COMPUTER PROGRAM IDENTIFICATION

SYSTEM (A-7, B-52G, 487L)	SUB-SYSTEM/COMPUTER (Nav system, Fire Control Computer)	COMPUTER PROGRAM (OFP, Aerodynamic Data Update Program)	SUB-PROGRAM MODULE (Include version designation)
IUS	Checkout Station	User's Manual	

II. ORIGINATOR IDENTIFICATION (Investigator, coordinator, approving officials, etc)

NAME (Last, First, Middle Initial)	GRADE	ORGANIZATION AND STATION	DUTY PHONE
Kelly, Robert J.	02	AFTEC	244-9421

III. OTHER DATA

DATE AND TIME OF OBSERVATION (If important, include elapsed times)	DEFICIENCY REPORT WATCH ITEM
23 Jun 82	☐ YES ☐ NO

DOCUMENT REFERENCES

DOCUMENT NO.	DATE	PUBLISHER (USAF, Rand Corp, etc)	PAGE NO.	FIGURE	SECTION	PARA NO.

IV. OBSERVATION (Include what did/did not happen, what should have happened, results, suggested changes, relevant conditions, etc)

SOMIQ QUESTION # 44

The COS user's manual (D290-70021-1) is very poorly organized. System menu pages could be referenced differently to help operator more easily located different pages. Currently there is no sequence to the menu/page #s in the procedure.

AFTEC FORM AUG 78 207

Figure 4. Sample Form 207

QUESTION DATA SHEET

Question Number

QUESTION:

CHARACTERISTIC:

EXPLANATION:

EXAMPLES:

GLOSSARY:

(Use this sheet to recomment new questions or changes to existing questions to AFTEC)

Figure 5. Question Data Sheet

OFFICIAL

ARTHUR K. KLEMP, Maj, USAF
Director of Administration

RICHARD W. PHILLIPS, Jr.
Brigadier General, USAF
Commander

ATTACHMENT 1

QUESTION RESPONSE GUIDELINES

The following sections contain information which should help clarify the intent of each question to the evaluator. There is one section per characteristic. Each page within each section corresponds to a question from the Software Operator-Machine Interface Questionnaire. Many questions have special response instructions which should be reviewed.

A. ASSURABILITY. A computerized system contains the quality of assurability to the extent that it aids the operator in validating data, avoiding errors, and correcting errors once made.

A system which has been designed to aid the operator in error avoidance may or may not achieve this goal. A system should also be designed so that errors are easy to correct, and above all so that errors do not have catastrophic effects.

QUESTION DATA SHEET

Question Number 1

QUESTION: Operator input errors do not cause system failures.

CHARACTERISTIC: Assurability.

EXPLANATIONS: Commands and data entered by the operator should not cause hardware or software errors inside the machine.

EXAMPLES: A bad command by the operator could be a request to the computer to connect a 12-VDC power supply to the same bus that a 5-VDC power supply is connected. Another bad command by the operator could be entering an "8" when the computer could be requesting a number between "1" and "7." Other bad commands could be instructions to start a device which is already running or stop one which is already stopped. The reason that these are not "don't care" situations is that the operator may have intended to start or stop a different device.

GLOSSARY: Operator input: Data or commands entered as typewritten text, pushbutton sequences, control stick movements, card decks, tapes, light pens, etc.

QUESTION DATA SHEET

Question Number 2

QUESTION: Operator input errors are detected.

CHARACTERISTIC: Assurability.

EXPLANATIONS: The machine must be designed to detect operator input errors or it will try to function using bad data. Anything the machine does based on the bad data may be wrong, as well as possibly dangerous to both equipment and personnel.

QUESTION DATA SHEET

Question Number 3

QUESTION: The causes of input errors are displayed to the operator.

CHARACTERISTIC: Assurability.

EXPLANATIONS: When an operator has made an error, the operator needs to know what the error was in order to correct it.

EXAMPLES: It is insufficient for a machine to display some message such as "input error". Such a message does not tell the operator what was wrong, only that something was wrong.

QUESTION DATA SHEET

Question Number 4

QUESTION: The action required to correct an operator input error is displayed to the operator.

CHARACTERISTIC: Assurability.

EXPLANATIONS: Having the machine tell the operator what to do to correct an error is much quicker than having the operator refer to manuals, etc., to look for the proper procedure.

EXAMPLES:
The machine: ENTER DATE
The operator: Jun 16, 1980
The machine: NO, FORMAT: YY, MM, DD
The operator: 80, 06, 16
The machine: OK

QUESTION DATA SHEET

Question Number 5

QUESTION: Input errors are easily corrected.

CHARACTERISTIC: Assurability.

EXPLANATIONS: The actions necessary to correct errors can vary all the way from completely reinitializing the system to simply correcting the erroneous portion of a command. The correction of operator errors should be as simple, easy, and straightforward as possible.

EXAMPLES: If the operator enters a long command, such as "Load Program TESTLRU17 frm disk 22," the machine should allow the operator to correct a misspelling easily rather than retype the entire command sequence.

The machine would redisplay the incorrect command (above) and allow the operator to insert the "o" in the word "frm" to create the word "from," and then accept the corrected command.

QUESTION DATA SHEET

Question Number 6

QUESTION: Input errors are quickly corrected.

CHARACTERISTIC: Assurability.

EXPLANATIONS: For an error to be termed "quickly correctable," the system must resume normal operation immediately after the error is corrected.

QUESTION DATA SHEET

Question Number 7

QUESTION: The operator can verify input before execution/entry.

CHARACTERISTIC: Assurability.

EXPLANATIONS: If the operator can see the instruction as it is entered, then mistyped characters, etc., can be corrected on-the-spot rather than after the machine indicates incorrect input.

QUESTION DATA SHEET

Question Number 8

QUESTION: Mission-peculiar data entered by the operator are checked for validity.

CHARACTERISTIC: Assurability.

EXPLANATIONS: When the operator enters mission data (altitude, voltage, range) the data should be checked by the machine as much as feasible to ensure that the mission is not completed with wrong data, resulting in reaccomplishment.

EXAMPLES: An aircraft simulator operator enters a simulated terrain altitude of 60,000 feet when it should have been 6,000 feet, thereby, causing a "crash" and subsequent restart of the simulation. The data should have been checked against a maximum of, approximately 26,000 feet.

ADDITIONAL EXAMPLES:

ERRONEOUS ENTRY	(SHOULD HAVE BEEN)
100 degrees North latitude	(10.0 N Lat)
32 Jan 80	(31 Jan 80)
Mach 12	(Mach 1.2)

GLOSSARY: Mission peculiar: any data which are entered by the operator as a part of normal operations but which may change mission-to-mission or task-to-task.

QUESTION DATA SHEET

Question Number 9

QUESTION: The data entry display has a cursor or pointer.

CHARACTERISTIC: Assurability.

EXPLANATIONS: The operator must know where the next character entered will be placed to avoid errors caused by too many spaces or "double" errors caused by correcting the wrong character.

EXAMPLES: The operator enters "REWIID TAPE 22," then notices the error. The system allows him to backspace and change "REWIID" to "REWIND." A cursor allows him to backspace quickly and accurately. Lack of a cursor causes him to count backspaces and perhaps change "REWIID" to "REWNID."

The communications system operator in an E-4B is entering a command when the aircraft suddenly hits turbulence and the operator's finger hits the space bar several times. With improper spacing, the command will be formatted incorrectly and the machine will reject the command, forcing the operator to reenter. A cursor would allow the operator to see how many extra spaces were entered, enter the appropriate number of backspaces, and resume entry where it was interrupted.

GLOSSARY: Cursor or pointer: a method of indicating on the display where the next character to be entered will appear on the display.

QUESTION DATA SHEET

Question Number 10

QUESTION: The operator is able to correct mistyped characters with a backspace key.

CHARACTERISTIC: Assurability.

EXPLANATIONS: It is much faster and less error prone to be able to backspace and change an incorrect character than it is to be forced to retype an entire entry.

GLOSSARY: Backspace: rubout, back arrow, etc.

QUESTION DATA SHEET

Question Number 11

QUESTION: The system does not require the operator to copy information by hand.

CHARACTERISTIC: Assurability.

EXPLANATIONS: Hand copying information from a computer display to some form of record is a source of errors and extra work which could be handled by the machine.

EXAMPLES: An operator is displaying satellite telemetry points on a screen and desires some form of hardcopy. If the operator is forced to copy the information by hand as the data are changing, the data are useless since the numbers copied down will not all be taken at the same time. The operator should have some kind of "picture taking" capability which would automatically produce printed forms of the data.

QUESTION DATA SHEET

Question Number 12

QUESTION: Task aborts and interrupts do not have detrimental side effects.

CHARACTERISTIC: Assurability.

EXPLANATIONS: Turning the machine off for an emergency power failure or stopping a test, etc., should not result in mechanical damage or loss of data files which would be difficult to replace.

EXAMPLES: The machine is performing a test from a tape drive. Power failure causes the tape drive to tear the tape in half. The tape can only be replaced by a new tape from the depot.

GLOSSARY:

Task aborts: emergency shutdown; (simulator) mission restart; and a variety of other reasons for wanting to simply quit at any time other than when the machine would normally expect.

Task interrupt: pause, freeze, or even "hold it--it's time for my coffee break."

QUESTION DATA SHEET

Question Number 13

QUESTION: Selecting a device off-line does not have detrimental side effects.

CHARACTERISTIC: Assurability.

EXPLANATIONS: When an operator takes a device off-line, the action should not interrupt system operation as it pertains to that device.

EXAMPLES: An operator is waiting for a long test to be completed. The printer is not in use, but the operator knows it is short of paper. Taking the printer off-line to replace the paper should not cause the test to stop.

A weapon system operator shuts off one display scope which is obviously malfunctioning and is distracting him. Shutting this one scope off should not cause any other changes to the system, and should certainly not cause the whole electronic warfare system to quit.

GLOSSARY: Off-line: out of operation, power off, or de-selection.

QUESTION DATA SHEET

Question Number 14

QUESTION: The system automatically ceases execution if internal errors are detected.

CHARACTERISTIC: Assurability.

EXPLANATIONS: When the computer detects an error, it should immediately halt all executions to avoid damage to data files and to avoid giving wrong answers.

EXAMPLES: Data words stored in the computer internal storage represent altitude above ground level. When recalled, the words had a read or parity error. If the words were interpreted and sent to the pilot it might tell him 2000 feet, whereas, the correct altitude might be 50 feet.

GLOSSARY: Parity: a method of checking the validity of data. A parity error indicates invalid data.

QUESTION DATA SHEET

Question Number 15

QUESTION: The operator is alerted to faults within the system.

CHARACTERISTIC: Assurability.

EXPLANATIONS: This question is aimed at eliminating operator work having to be redone once the fault is discovered. The software should be designed to detect as many failures as possible and to report them to the operator as soon as possible. Any unscheduled change in the status of any part of the system should be reported to the operator.

EXAMPLES:

1. The operator is entering a long sequence of instructions and does not realize the machine is in an unusable status. When he finally finds out the machine is "broken," he must turn it off, repair it, then reenter the long sequence of commands.
2. It is very nice for a pilot to know when the terrain avoidance radar ceases to function or, even worse, starts to give erroneous data.

GLOSSARY:

Diagnostic: fault detection and reporting hardware.
Faults: burned out power supply, out-of-calibration stimulus voltage, etc.

QUESTION DATA SHEET

Question Number 16

QUESTION: The causes of system halts are displayed to the operator.

CHARACTERISTIC: Assurability.

EXPLANATIONS: This is important information for anyone who must fix or restart the system. When the system halts, the cause should be displayed even if the cause may not be operator correctable.

EXAMPLES: An aircraft pilot needs to know whether the navigation computer shut itself down due to equipment bay overheat, faulty programming, or just random error. Restarting the computer in a hot compartment could damage the equipment. Restarting the computer to execute a scrambled program would be useless or possibly dangerous. Restarting the computer after a random error would probably be OK.

ASSURABILITY. A computerized system contains the quality of assurability to the extent that it aids the operator in validating data, avoiding errors, and correcting errors once made.

A system which has been designed to aid the operator in error avoidance may or may not achieve this goal. A system should also be designed so that errors are easy to correct, and above all so that errors do not have catastrophic effects.

B. CONTROLLABILITY. A computerized system contains the quality of controllability to the extent that it allows the operator to direct the operations of the machine.

The operator must be able to direct or control the operation of the machine in order to utilize it effectively and efficiently.

QUESTION DATA SHEET

Question Number 17

QUESTION: The operator can interrupt and resume automatic processes.

CHARACTERISTIC: Controllability.

EXPLANATIONS: It is often desirable for the operator to halt execution of a process, change some parameters, and then proceed with the process.

EXAMPLES: A test equipment operator notices that while both a voltage and resistance measurement are within tolerance, the voltage is borderline high and the resistance is borderline low. The operator interrupts automatic test, calculates current, and sees that it is actually still within tolerance. The automatic test is then resumed.

QUESTION DATA SHEET

Question Number 18

QUESTION: The operator has task-abort capabilities available.

CHARACTERISTIC Controllability.

EXPLANATIONS: It is often necessary to stop a task before it is completed because of time constraints, errors, or higher-priority workload.

EXAMPLES: A mission preparation operator is printing out a table of latitudes and longitudes when he notices that the first entry is in error. He must wait for the entire table to print out before he can correct the error and reprint because there is no abort capability. If he had an abort capability he could abort the print, fix the error, and then restart the print immediately.

QUESTION DATA SHEET

Question Number 19

QUESTION: The operator may initiate selected self-test systems.

CHARACTERISTIC: Controllability.

EXPLANATIONS: Automated troubleshooting procedures are a great help to operators, but not all of them may be used continuously. Therefore, some of them must be initiated by the operator at times when they would not interfere with normal system operation.

EXAMPLES: The self-test systems may be as simple as lightbulb checks or display callups.

QUESTION DATA SHEET

Question Number 20

QUESTION: The operator may send output data to various devices.

CHARACTERISTIC: Controllability.

EXPLANATIONS: Giving the operator control over where to send output data allows the operator greater flexibility in completing the mission.

EXAMPLES:

1. An aircrew training device (ATD) operator can control which scope can display which information. Hardcopies can also be generated.

2. An automatic test station has a printer which is out of paper. If the operator can divert the printed output to the display screen, the necessary repair information can at least be copied down by hand and the item can be fixed. Otherwise, maintenance activities cease until paper for the printer is procured.

QUESTION DATA SHEET

Question Number 21

QUESTION: The operator can ask for and receive the current status of operation.

CHARACTERISTIC: Controllability.

EXPLANATIONS: Especially on long tasks, it is necessary for the operator to know that things are proceeding as they should. Otherwise, the operator might wait until the end of a 2-hour task only to find out that it has to be redone.

EXAMPLES:

1. A test equipment operator is performing a 6-hour alignment test on an inertial platform. After 15 minutes, he queries the test equipment system status and sees that the machine has been doing nothing but trying to connect a power supply which is not turned on. Since he could query the system status, he discovered the situation almost immediately rather than 6 hours later.

QUESTION DATA SHEET

Question Number 22

QUESTION: The operator can select the type of information shown on the display.

CHARACTERISTICS: Controllability.

EXPLANATIONS: The operator must be able to control what type of information is displayed so that desired information may be obtained in as easily understandable a method as possible.

EXAMPLES:

1. A student pilot is flying his aircraft on a strafing run. There are so many arrows, lines, and indicators on his head-up display that he is becoming confused. He tabs the "declutter" button and notices immediately that a "low airspeed" warning had been hidden amongst all the garbage. He corrects the situation and completes the mission.

2. A satellite ground controller notices from the satellite telemetry display that the satellite battery voltage is decreasing. He orders the battery temperature data to also appear on this display to see if any correlation exists.

QUESTION DATA SHEET

Question Number 23

QUESTION: The operator may command various displays of system status.

CHARACTERISTIC: Controllability.

EXPLANATIONS: The operator must often troubleshoot problems to correct bad situations. To do this, detailed information on the status of various systems and subsystems must be available.

EXAMPLES:

1. A data processing computer operator notices that his system has seemingly stopped. A system status display shows everything normal. A peripheral status display shows nothing wrong. A job control display shows that one small computer program is using all the system time. A display of the program status log shows no input and no output. The operator determines that a novice programmer has written another infinite loop; he aborts the program, and the normal processing of paychecks resumes.

2. At a change of shift on a weapon control system, the new operator would normally want to display the current status of all sensors, communications lines, system armament resources, etc.

QUESTION DATA SHEET

Question Number 24

QUESTION: The operator may control the display text that explains what input is needed or explains the output.

CHARACTERISTIC: Controllability.

EXPLANATIONS: Explanatory text is often helpful to a beginning operator, but it is just extra trash on the display to an experienced operator.

EXAMPLES: One system has two commands which control this feature. The command "VERBOSE" tells the machine to display information with plenty of explanatory text. The command "CONCISE" tells the machine to display the bare essentials.

QUESTION DATA SHEET

Question Number 25

QUESTION: The operator may edit the data base prior to use by the system.

CHARACTERISTIC: Controllability.

EXPLANATIONS: Many systems have a "scratchpad" data base which can be edited by the operator to create a data base which applies to the current task.

EXAMPLES:

Mission Data Preparation: Prepare a bombing run with standard ingress and egress route, changing the target.

Aircrew Training Device: Prepare a mission scenario involving an air intercept using nonstandard differential altitude.

Automatic Test Equipment: Change some test parameters to reflect that the line-replaceable unit undergoing test is a specially modified box.

GLOSSARY: Data base: a set of parameters used by a computer program as opposed to the computer program itself.

QUESTION DATA SHEET

Question Number 26

QUESTION: The operator may create and execute strings of commands as a single command.

CHARACTERISTIC: Controllability.

EXPLANATIONS: The operator must often perform repetitive tasks. It is desirable that the operator be able to reduce the workload of repetitious tasks as much as possible.

EXAMPLES:

1. The operator must perform a series of 10 instructions a great number of times. If he can create a file containing the 10 instructions and then use 1 instruction to execute the entry file, his workload is reduced by a factor of 10.

2. So called "function keys" are an example of built-in work reduction techniques. If the operator can program the function keys to perform a specific task, then the operator has the desired control.

QUESTION DATA SHEET

Question Number 27

QUESTION: The operator can command stepped execution of automatic processes.

CHARACTERISTIC: Controllability.

EXPLANATIONS: The capability for stepped execution of automatic processes gives the operator detailed information about what is occurring during a normally automatic process.

EXAMPLES:

1. An automatic test equipment operator is having trouble with a supposedly "good" black box failing an automatic test. He reruns the test in stepped-execution mode which gives him time to read every action the machine performs. He sees that one part of the test measures a voltage at 5.2 volts. The test program fails the box, stating the voltage should be 5.0 ± .1 volts. Documentation states the voltage should be 5.0 ± .25 volts. The box is good, the test program is wrong.

2. A similar visibility function within an aircraft cockpit would be the capability provided by the gun camera. Within an Aircrew Training Device it would be videotape replay.

GLOSSARY: Stepped execution: computer provides output (numerical value, status, etc.) after each intermediate step of the calculations rather than only an output when all of the steps in the calculations are complete.

QUESTION DATA SHEET

Question Number 28

QUESTION: The operator may command different modes of operation.

CHARACTERISTIC: Controllability.

EXPLANATIONS: The capability to command different modes of operation gives the operator the ability to use the machine in a manner consistent with his need and experience level.

EXAMPLES:

1. Aircraft: The ability to drop bombs in single, pairs, or ripple mode as the pilot deems appropriate.
2. Aircrew Training Device (ATD): The capability to operate two side-by-side simulators as opposing forces, one complete crew, or as entirely separate ATDs.
3. Automatic Test Equipment: Automatic versus stepped execution testing.
4. Missile Warning System: The capability to transmit messages automatically or manually.

QUESTION DATA SHEET

Question Number 29

QUESTION: The operator may control the type and quantity of output.

CHARACTERISTIC: Controllability.

EXPLANATIONS: Control of type and quantity of output gives the operator control over what the operator must read. Too much output, or output the operator doesn't even want to see, just slows things down.

EXAMPLES:

1. Under normal conditions the analyst may desire to watch the console display and shut off the printer.
2. In order to concentrate on important parameters during a satellite maneuver, the analyst can selectively prevent some of the other parameters from printing on the CRT during the maneuver.

QUESTION DATA SHEET

Question Number 30

QUESTION: Bypass procedures are available so that in cases of partial system failure the more important system functions can still be performed.

CHARACTERISTIC: Controllability.

EXPLANATIONS: It is often desirable to get the job done even though the usual tools are not available. This question refers to degraded modes of operation.

EXAMPLES:

1. An automatic test equipment operator sees that his test has halted because the "test station fault" light is on. Researching the problem, he sees that the test program was requesting the B5 power supply be connected to the unit under test. The B5 power supply was sent to PMEL the previous week. He causes the test program to substitute the B18 power supply which can do the same job as the B5. The test proceeds.
2. A simulator has a electronic warfare office (EWO) station. The EWO station is down for repair. It is highly desirable to be able to continue training of other crew members.
3. Aircraft: It sure is nice to be able to fly home even if the navigational computer quits.

CONTROLLABILITY. A computerized system contains the quality of controllability to the extent that it allows the operator to direct the operations of the machine.

The operator must be able to direct or control the operation of the machine in order to utilize it effectively and efficiently.

C. WORKLOAD REASONABILITY. A computerized system contains the quality of workload reasonability to the extent that the tasks required of the operator are within the operator's capabilities and the extent to which the operator performs a useful, meaningful role.

An optimum design of a system which involves an operator and a computerized machine takes advantage of the best capabilities of both: the machine to perform repetitive tasks rapidly and the operator to make command decisions involving unusual situations.

QUESTION DATA SHEET

Question Number 31

QUESTION: It is easy to enter mission (task) peculiar data.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Data must often be added, revised, or changed to accomplish the mission. To do this as efficiently as possible, the operator must be given control over selecting the most efficient manner to perform the task.

EXAMPLES: A strike planning officer must enter 150 coordinates in a table. Each coordinate must be preceded by the coordinate number; latitudes and longitudes must be entered with East or West, North or South, including degree signs and decimal points. This procedure is a time consuming task. He selects "automatic" mode to speed the task. Coordinate numbers are now automatically sequenced, all latitudes are automatically "East" and longitudes are "North." The machine enters the degree signs and decimal points for him.

QUESTION DATA SHEET

Question Number 32

QUESTION: Data preparation is usually performed using on-line devices.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Preparation of data using off-line devices results in using some transfer medium (such as punch cards or magnetic tape) to transfer the prepared data from the off-line device to the computer. This procedure increases the workload.

GLOSSARY:

On-line: connected directly to the computer system.

Data preparation: Any entry or changing of numbers, malfunctions, etc., performed by the operator.

Special Response Instructions: For an aircraft mission data base this is not a desirable feature. Data preparation should definitely be done away from the aircraft, probably in the strike planning shop.

QUESTION DATA SHEET

Question Number 33

QUESTION: The system will accept free-format commands and data.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Acceptance of free-format commands and data decreases operator workload by decreasing the requirement for the operator to meet rigid, inflexible formatting standards.

EXAMPLES: A voltage, hours to destination, or angle of attack value (e.g., five) that the operator must enter is acceptable in any of the following formats, including leading and trailing blanks: "5", "5." "5.0", "5.00", "05", "05.00", "0.5 x 10**1", ".5E+01", "5D+00."

GLOSSARY: Free-format: any legitimate representation is acceptable.

QUESTION DATA SHEET

Question Number 34

QUESTION: Menu techniques are used to aid the operator in making decisions.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Having the machine list possible alternatives to the operator when an operator decision is called for, aids the operator in making a quick decision and in giving consideration to each alternative. The operator would not forget to consider seldom used functions.

EXAMPLES: Weapons Selection:

A.Single	D.Slick
B.Pairs	E.HI-Drag
C.Ripple	F.LO-Drag

GLOSSARY: Menu: a list of items displayed on a console display.

QUESTION DATA SHEET

Question Number 35

QUESTION: The system may be operated without reference to manuals during normal operations.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: An experienced operator will be slowed down if forced to make constant reference to manuals while performing tasks. Machines can be designed to include appropriate manual-type information in the displays presented to the operator.

QUESTION DATA SHEET

Question Number 36

QUESTION: The operator needs to know a reasonable number of commands to effectively operate the system.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: The larger the number of commands an operator must memorize in order to use the machine, the more difficult and the more error-prone the process.

EXAMPLES: Operators which need to use thousands of different commands (such as programmers) must make constant reference to manuals. This procedure is a time consuming task.

QUESTION DATA SHEET

Question Number 37

QUESTION: Messages to the operator are easy to understand.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS:

EXAMPLES: "Ratio of actual speed to speed of sound" is much more difficult to understand than "Mach Number."

QUESTION DATA SHEET

Question Number 38

QUESTION: The device used to send messages to the operator provides information at a rate comfortable to the operator.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: A display device which sends information to the operator too fast can cause him to miss important information, possibly resulting in task reac-complishment and frustration. A display device which is too slow causes the operator to waste a lot of time and is also frustrating.

QUESTION DATA SHEET

Question Number 39

QUESTION: The amount of data presented to the operator at one time is appropriate.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Displaying too much information to the operator at one time does nothing more than add a confusion factor and makes the operator work harder to get exactly the information desired.

EXAMPLES: When a radar system technician wants nothing more than to know antenna power output, it is not desirable to give him the power output of every component of the system.

QUESTION DATA SHEET

Question Number 40

QUESTION: The system software may be reloaded quickly.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Some computerized systems require the operator to load new or different software at regular or frequent intervals. The quicker this can be done, the less demanding and frustrating it will be to the operator. For those systems where the mission software is reloaded by someone other than the prime mission operator, such reloading still has an impact on the prime mission operator in areas such as idle time and workload backlog.

EXAMPLES: The operator is able to load the software from a disk by merely setting some toggle switches and depressing a "Reboot" button.

GLOSSARY: Reloaded: reboot, reprogram.

QUESTION DATA SHEET

Question Number 41

QUESTION: The system software needs to be reloaded infrequently.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: An aircrew training device is usually reloaded quickly and easily with little downtime; however, training is interrupted and realism is destroyed. Therefore, reload is considered a reason for a low rating.

QUESTION DATA SHEET

Question Number 42

QUESTION: System warm-up time is small.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: A machine which requires large amounts of warm-up time before use causes the operator to waste time, lowers productivity, and often frustrates the operator. For systems which run continuously, this question only applies to power failures, changing software loads, bringing peripherals on line, instrument warm-up, etc.

QUESTION DATA SHEET

Question Number 43

QUESTION: The operator's manual makes minimal use of cross-references.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Excessive cross-referencing in the operators manual forces extra work on the operator. The worst case happens when the operator has used all fingers and toes and forgotten the original question. Cross-referencing should be restricted to cases where it serves a useful purpose.

QUESTION DATA SHEET

Question Number 44

QUESTION: It is easy to locate specific information within the operator's manual.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Manuals which an operator must or might use during operation of a machine should be arranged, indexed, and have a table of contents such that the operator can locate specific information rapidly.

EXAMPLES: The evaluator should think up some information desirable to retrieve from the operator's manual, then see how hard it is to find it. This process may be repeated several times.

QUESTION DATA SHEET

Question Number 45

QUESTION: The operator's manual is a reasonable size.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Oversize operator manuals are physically difficult to work with as well as reflecting poor organization and lack of consideration of what the operator needs to know.

QUESTION DATA SHEET

Question Number 46

QUESTION: The operator performs no tedious functions which could be handled by the system.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Functions which could be performed by the machine but which are forced upon the operator represent a source of additional workload for the operator.

EXAMPLES:
1. Hand copying of information from computer display to records.
2. Entry of degree signs and decimal points.
3. Repeated entry of duplicated data, such as the words "Year" and "Month" when entering dates.

QUESTION DATA SHEET

Question Number 47

QUESTION: The operator is rarely bored and performs a dynamic function.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: A well-designed system takes into consideration the best capabilities of the computer (repetitive tasks) and the best capabilities of the operator (decision making, experience).

EXAMPLES: The machine should allow the operator to make decisions which save time and increase productivity, such as skipping tests which the operator already knows the "black box" will pass.

QUESTION DATA SHEET

Question Number 48

QUESTION: The operator is not forced to wait for the machine to respond.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: An operator who is continuously forced to wait for the machine to become available for use is less than optimally productive and is probably frustrated. Machines which respond slowly are probably overloaded. Consider the action taken and the response time of the system as it relates to mission accomplishment.

QUESTION DATA SHEET

Question Number 49

QUESTION: The operator is not a slave to the machine.

CHARACTERISTIC: Workload reasonability.

EXPLANATIONS: Operators which are "chained" to a machine get worn out rapidly, tend to become inattentive, and make more and more errors as time passes. Furthermore, they have little job satisfaction and have a high turn-over rate, resulting in increased training costs and low organizational productivity.

EXAMPLES: Automobile assembly-line workers are perfect examples of operators "chained" to a machine.

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WORKLOAD REASONABILITY. A computerized system contains the quality of workload reasonability to the extent that the tasks required of the operator are within the operator's capabilities and the extent to which the operator performs a useful, meaningful role.

An optimum design of a system which involves an operator and a computerized machine takes advantage of the best capabilities of both: the machine to perform repetitive tasks rapidly and the operator to make command decisions involving unusual situations.

D. DESCRIPTIVENESS. A computerized system contains the quality of descriptiveness to the extent that the operator has available adequate explanations of every function the operator is required to perform and every function the machine performs.

The operator need not be informed in detail of every task the machine performs, but there definitely are certain things the operator must know to fulfill the mission. The questionnaire relies upon the knowledge of the operator to define what it is the operator needs to know.

QUESTION DATA SHEET

Question Number 50

QUESTION: Power-on and power-off procedures are well documented.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: Since the machine cannot aid the operator during power-on and power-off activities, an easy-to-use, understandable, and correct set of written procedures must be available to the operator.

QUESTION DATA SHEET

Question Number 51

QUESTION: The operator has adequate instructions for handling emergencies.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: The operator must have adequate emergency instructions available if he is to avoid harm to personnel or damage to equipment. This includes emergency power-on and power-off instructions.

QUESTION DATA SHEET

Question Number 52

QUESTION: Legitimate responses for all conditions are explained.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: In order for a system to be considered properly described, all situations which the normal operator will encounter must be addressed by either the documentation or by computer-generated descriptions.

GLOSSARY: Explained: documented and/or prompted by the software.

QUESTION DATA SHEET

Question Number 53

QUESTION: The software provides a question-answer type aid.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: The availability of question-answer operator aids can greatly aid operator work by making technical information quickly and readily available.

EXAMPLES:

1. One system uses a "help me" command. If the operator needs information on how to format a tape advance command, for instance, he enters "HELP ME, TAPE ADVANCE" and he is instantly presented with a detailed explanation of various tape control commands.

2. Another system responds with a more detailed data request whenever the operator enters a question mark. For instance the operator leaves the machine and later returns to find the machine requesting "ENTER ALTITUDE." The operator has forgotten which altitude was being requested when he left. A question mark is entered and the machine responds "ENTER SIMULATED AIRCRAFT ALTITUDE IN THOUSANDS OF FEET."

QUESTION DATA SHEET

Question Number 54

QUESTION: The system will explain each command upon user's request.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: Descriptions of operator commands should be readily available to the operator. This is especially helpful when the operator makes regular use of a very large number of commands.

EXAMPLES: One system automatically displays a short explanation of what is required anytime an illegal command is entered. Therefore, anytime the operator needs more information before making his decision(s), he enters an "X" or other illegal command. The machine then gives him a short summary of legal responses to the situation and automatically re-asks the original question.

QUESTION DATA SHEET

Question Number 55

QUESTION: Explanations of how to interpret all output data are available.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS:

EXAMPLES: Explanations may be available through an on-line question-type aid or through the operator's manual.

QUESTION DATA SHEET

Question Number 56

QUESTION: The operator is adequately alerted when the system requires operator action.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: When the machine is performing a long task which requires no operator actions, the operator may do something else, such as take a coffee break or carry on a conversation. However, if no time is to be wasted, he must be told when to end the break.

EXAMPLES: Alerted:

Optimum: a combination of audible and visual signals.
Acceptable: either audible or visual prompts.
Unacceptable: no signal other than apparent machine inactivity.

QUESTION DATA SHEET

Question Number 57

QUESTION: The machine gives the operator decision aids if tasks cannot be executed as ordered.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: When a task cannot be performed as ordered by the operator, the machine should display information to aid the operator in making a decision about alternative ways to get the job done.

EXAMPLES:

1. If an automatic test equipment operator has a test stop because a certain power supply is not installed in the test equipment, then the machine should list other power supplies available for replacements. The operator would then be able to choose a different power supply and continue the test.

2. On a simulator, the machine should tell the operator exactly what procedures to use to simulate a partial mission if one of the student stations is inoperative.

QUESTION DATA SHEET

Question Number 58

QUESTION: The version number (revision number) of the software is readily available to the operator.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: Frequent software updates dictate that the operator be aware of exactly which version of an operational program is being used.

EXAMPLES:

1. An automatic test equipment operator must usually use a new test program after a Time Compliance Technical Order (TCTO) has been implemented on a given black box. Modified black boxes will often fail an old test program even though they are good.

2. In Aircrew Training Devices, the version number is normally carried on a Form 781.

QUESTION DATA SHEET

Question Number 59

QUESTION: Data base configuration data are readily available to the operator.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: Many systems use data bases, the configuration of which is as important as the configuration of the computer programs.

EXAMPLES:

1. Simulators: The flight characteristics of a given aircraft may exist as a data base.
2. Automatic Test Equipment: Parameters of stimulus and measurement devices may exist as a data base.
3. Mission Data Preparation: Mission data tapes of latitudes and longitudes from a data base containing thousands or millions of mensurated points.

GLOSSARY: Data base: a collection of numeric parameters which describe an entity such as flight characteristics of an aircraft or the contents of all accounts with a credit union.

Configuration identification: some means of knowing which data base is which (usually an alpha-numeric system).

QUESTION DATA SHEET

Question Number 60

QUESTION: All documents the operator requires (including cross-references) are easily available to him.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: The operator will be unable to perform his duties if he does not have available documents which contain the information he needs.

QUESTION DATA SHEET

Question Number 61

QUESTION: The operator's manual clearly explains the normal sequential steps of operation.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: Lack of descriptions of normal sequential steps of operation results in poor training and in operator uncertainty. Poorly organized manuals make the operator hunt and dig through all the information available to figure out what may be simple, straight-forward "normal" procedures. The normal sequential steps of operations should not be hidden amid verbiage describing unusual situations.

QUESTION DATA SHEET

Question Number 62

QUESTION: The operator's manual contains a useful table of contents.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: A table of contents is the key to the organization and content of an operator's manual.

GLOSSARY: Useful: The table of contents not only exists, but actually reflects the organization and content of the operator's manual.

QUESTION DATA SHEET

Question Number 63

QUESTION: The operator's manual contains a useful index.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: An index is required to allow the operator to locate specific information within the operator's manual by subject matter. Important subject matter often does not appear in the table of contents under a heading the operator is familiar with.

EXAMPLES: The table of contents may have a 300-page section titled "Malfunctions," whereas the operator would find "engine bleed air malfunctions" through the index without leafing through the 300 pages.

GLOSSARY: Index: an alphabetical listing of names and topics and the corresponding page numbers on which they are discussed.

QUESTION DATA SHEET

Question Number 64

QUESTION: The operator's manual contains a useful glossary.

CHARACTERISTIC: Descriptiveness.

EXPLANATIONS: A glossary of terminology is often essential to an operator's manual which is clear, concise, and, above all, descriptive.

GLOSSARY: Glossary: a list of terms used in the manual and their corresponding definitions.

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DESCRIPTIVENESS. A computerized system contains the quality of descriptiveness to the extent that the operator has available adequate explanations of every function the operator is required to perform and every function the machine performs. The operator need not be informed in detail of every task the machine performs, but there definitely are certain things the operator must know to fulfill the mission. The questionnaire relies upon the knowledge of the operator to define what it is the operator needs to know.

E. CONSISTENCY. A computerized system contains the quality of consistency to the extent that the behavior of the machine and documentation corresponds to the expectations of the operator.

There should be a near one-to-one correspondence between what the machine does, what the documentation says it will do, and what the operator has been trained to expect the machine to do.

QUESTION DATA SHEET

Question Number 65

QUESTION: The operator uses systematic formats to enter commands.

CHARACTERISTIC: Consistency.

EXPLANATIONS: To operate the machine, the operator must memorize a set of command instructions. The more systematic the naming convention and format used for the commands, the easier it is to memorize and use.

GLOSSARY: Systematically formatted: It should be obvious that the software designers used a naming convention and formatting convention in designing the set of commands which an operator must enter.

QUESTION DATA SHEET

Question Number 66

QUESTION: The commands are entered in a standard manner.

CHARACTERISTIC: Consistency.

EXPLANATIONS: Use of a standard entering technique has several advantages:

1. The new operator may already know it.
2. Manuals describing it are available.
3. Usually more people are around who can offer assistance.

EXAMPLES: If a keyboard is used, it should be a standard typewriter keyboard. Likewise, numeric key pads, curser arrow key pads, and light pens should be standard.

QUESTION DATA SHEET

Question Number 67

QUESTION: Requirements for operator input agree with the operator's manual.

CHARACTERISTIC: Consistency.

EXPLANATIONS: When there is inconsistency between the operator's manual and actual operations, it leads to operator confusion, frustration, errors, and reaccomplishment.

QUESTION DATA SHEET

Question Number 68

QUESTION: Messages to the operator are systematically formatted.

CHARACTERISTIC: Consistency.

EXPLANATIONS: When messages to the operator are systematically formatted they aid the operator in that he can read faster and always knows where to look within a message to get exactly the information desired.

GLOSSARY: Systematically Formatted: It should be obvious that the software designers used both a naming convention and a formatting convention.

QUESTION DATA SHEET

Question Number 69

QUESTION: Messages requiring action by the operator are always highlighted in some fashion.

CHARACTERISTIC: Consistency.

EXPLANATIONS: To minimize the necessity for the operator to constantly watch the machine, the machine must tell the operator every time it needs operator attention, and it should always do it in the same manner so that the operator knows what to expect.

EXAMPLES: A combination of audio and visual signals is best. Either audio or visual is next best; in any case, the operator should always be alerted in the same manner.

QUESTION DATA SHEET

Question Number 70

QUESTION: Operator entries always result in some type of response.

CHARACTERISTIC: Consistency.

EXPLANATIONS: For the operator to know that the machine has deciphered the operator commands, and is taking action upon them, the machine must so indicate to the operator.

EXAMPLES: One system responds with an asterisk, another simply moves the display cursor. Yet another system replies with "COMMAND" each time it has completed action on the previous command.

QUESTION DATA SHEET

Question Number 71

QUESTION: Response times are similar for groups of similar activities.

CHARACTERISTIC: Consistency.

EXPLANATIONS: To minimize operator frustration, the machine must "behave" similarly in similar situations. Response time is an important factor in measuring similar behaviors.

Another system which would minimize operator frustration concerning response time would be for the system to display to the operator the amount of time remaining before the system would require operator action.

EXAMPLES: Remote terminal systems have notoriously inconsistent response times. Some systems have response times that can vary between .1 seconds and 20 minutes.

QUESTION DATA SHEET

Question Number 72

QUESTION: System performance corresponds with documented performance (specifications, user manuals, etc.).

CHARACTERISTIC: Consistency.

EXPLANATIONS: Much instruction and almost all troubleshooting depends heavily upon documentation. If machine performance does not agree with what is documented, then the value of formal training is decreased, and troubleshooting efforts (as well as daily operations) are made more difficult.

QUESTION DATA SHEET

Question Number 73

QUESTION: Checklists agree with the operator's manual.

CHARACTERISTIC: Consistency.

EXPLANATIONS: A checklist should be a summary of essential information contained in the operator's manual. It should not be developed independently of the operator's manual. If regulations prohibit using checklists, the operator should answer as to whether they would be beneficial (reference section B, paragraph 7.e).

QUESTION DATA SHEET

Question Number 74

QUESTION: Operator manuals are systematically formatted.

CHARACTERISTIC: Consistency.

EXPLANATIONS: In cases where there is more than one operator's manual, all such manuals should be laid out the same way. Thus operators who must use more than one such manual may pay attention to content rather than wasting time trying to locate information.

EXAMPLES: There is a standard for the layout of aircraft -1 manuals.

CONSISTENCY. A computerized system contains the quality of consistency to the extent that the behavior of the machine and documentation corresponds to the expectations of the operator. There should be a near one-to-one correspondence between what the machine does, what the documentation says it will do, and what the operator has been trained to expect the machine to do.

F. SIMPLICITY. A computerized system contains the quality of simplicity to the extent that information presented to the operator or entered by the operator is grouped into short, readily understandable structures.

Complicated data structures, data entry formats, or operator manuals all require the operator to spend more time in developing an understanding of the system, and may have a tendency to confuse the operator as well.

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QUESTION DATA SHEET

Question Number 75

QUESTION: If different operator stations doing similar functions exist, the input commands on the various stations are similar.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: The less the operator needs to know, the easier it is to know it well. If he must know two commands to operate the system, the task of learning the operating instructions is about twice as complex.

EXAMPLES: Automatic Test Equipment: commands used to test various line-replaceable units should be the same where the functions of the command is the same.

QUESTION DATA SHEET

Question Number 76

QUESTION: Operator entered instructions are relatively short.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: In general, the shorter an instruction the easier it is to formulate because it contains fewer ideas which must be combined to build the instruction.

QUESTION DATA SHEET

Question Number 77

QUESTION: It is easy to understand actions required of the operator.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: In order to make it easy for the operator to understand what is supposed to be accomplished, the instructions must be relatively simple and easy to understand.

QUESTION DATA SHEET

Question Number 78

QUESTION: Messages to the operator are short.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Shorter messages generally contain less information than long messages. The less information contained in a message, the easier it is understood. This includes messages on console displays and printouts.

QUESTION DATA SHEET

Question Number 79

QUESTION: Each new message contains only one idea to which the operator must respond.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: The simplest message is one that contains only one idea. The simpler a message, the easier it is to understand.

QUESTION DATA SHEET

Question Number 80

QUESTION: Only essential or useful information is displayed to the operator.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Excess information makes it more difficult to find required information and the nonessential information may confuse the operator. The amount of data displayed to the operator should not be a hindrance to understanding.

EXAMPLES: Displays can be expanded or decreased so that a 240 by 240 mile area can be decreased to a 60 by 60 mile area of concern.

QUESTION DATA SHEET

Question Number 81

QUESTION: The display is not overcrowded (unless commanded to be so).

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Crowded displays decrease the ability to organize the information displayed. The less organized a display, of course, the harder it is to find useful information therein.

QUESTION DATA SHEET

Question Number 82

QUESTION: Difficult words or characters are rarely used.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Using a hard-to-understand word or symbol in a message makes the whole message hard to understand.

QUESTION DATA SHEET

Question Number 83

QUESTION: Data formats are easily understandable.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: For an operator to be able to rapidly withdraw necessary data from a data structure, the structure of the data must enhance understanding.

GLOSSARY: Data structure: a list or table of data, such as a malfunction list or parameter list.

QUESTION DATA SHEET

Question Number 84

QUESTION: The operator has appropriate checklists available.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Excess information makes understanding of essential information difficult. For an experienced operator, checklists should contain essential information condensed from the detailed procedures manuals.

QUESTION DATA SHEET

Question Number 85

QUESTION: The number of checklists required is manageable.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: A single checklist is the ideal situation for a given operator's station. No operator should be required to use more than two or three checklists simultaneously.

QUESTION DATA SHEET

Question Number 86

QUESTION: The operator's manual is a single volume (except for checklists).

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Multivolume operator manuals represent a level of complexity higher than single-volume operator manuals. Classified second volumes are necessary, but still more complex than single volumes.

QUESTION DATA SHEET

Question Number 87

QUESTION: The operator's manual is easy to understand.

CHARACTERISTIC: Simplicity.

EXPLANATIONS: In general, the easier an operator's manual is to understand, the easier it is to use, the more it will be used, and the more it will be used correctly.

QUESTION DATA SHEET

Question Number 88

QUESTION: Alternatives to normal operating sequences are described separately (not embedded within normal procedures).

CHARACTERISTIC: Simplicity.

EXPLANATIONS: Excess information makes understanding of essential information difficult. Alternative procedures usually represent excess information if contained within the normal procedures (which hopefully are most often used). Alternative procedures should, therefore, be contained in a separate section of the documentation.

SIMPLICITY. A computerized system contains the quality of simplicity to the extent that information presented to the operator or entered by the operator is grouped into short, readily understandable structures.

Complicated data structures, data entry formats, or operator manuals all require the operator to spend more time in developing an understanding of the system, and may have a tendency to confuse the operator as well.

G. GENERAL QUESTIONS: The following section contains general questions about characteristics of the system. The evaluator should formulate a subjective opinion based on general feelings without reference to previous answers.

QUESTION DATA SHEET

Question Number 89

QUESTION: The concepts of assurability as implemented in the system contribute to the usability of the system.

CHARACTERISTIC: General questions.

EXPLANATIONS:

GLOSSARY: Assurability: A computerized system contains the quality of assurability to the extent that it aids the operator in validating data, avoiding errors, and correcting errors once made.

A system which has been designed to aid the operator in error avoidance may or may not have good assurability. A system should also be designed so that errors are easy to correct, and, above all, so that errors do not have catastrophic effects.

QUESTION DATA SHEET

Question Number 90

QUESTION: The concepts of controllability, as implemented in the system, contribute to the usability of the system.

CHARACTERISTIC: General questions.

EXPLANATIONS:

GLOSSARY: Controllability: A computerized system contains the quality of controllability to the extent that it allows the operator to direct the operations of the machine.

The operator must be able to direct or control the operation of the machine in order to utilize it effectively and efficiently.

QUESTION DATA SHEET

Question

QUESTION: The concepts of workload reasonability, as implemented in th contribute to the usability of the system.

CHARACTERISTIC: General questions.

EXPLANATIONS:

GLOSSARY: Workload reasonability. A computerized system contains th of workload reasonability to the extent that the tasks required of the are within the operator's capabilities and the extent to which the performs a useful, meaningful role.

Optimum design of a system which involves an operator and a com machine takes advantage of the best capabilities of both: the ma perform repetitive tasks rapidly and the operator to make command involving unusual situations.

QUESTION DATA SHEET

Question Number 92

QUESTION: The concepts of descriptiveness as implemented in the system contribute to the usability of the system.

CHARACTERISTIC: General questions.

EXPLANATIONS:

GLOSSARY: Descriptiveness: A computerized system contains the quality of descriptiveness to the extent that the operator has available adequate explanations of every function the operator is required to perform, and every function the machine performs.

The operator need not be informed in detail of every task the machine performs, but there definitely are certain things the operator must know to fulfill the mission. The questionnaire relies upon the knowledge of the operator to define what it is the operator needs to know.

QUESTION DATA SHEET

Question Number 93

QUESTION: The concepts of consistency as implemented in the system contribute to the usability of the system.

CHARACTERISTIC: General questions.

EXPLANATIONS:

GLOSSARY: Consistency: A computerized system contains the quality of consistency to the extent that the behavior of the machine and documentation corresponds to the expectations of the operator.

There should be a near one-to-one correspondence between what the machine does, what the documentation says it will do, and what the operator has been trained to expect the machine to do. Furthermore, the documentation normally available to the operator should agree.

QUESTION DATA SHEET

Question Number 94

QUESTION: The concepts of simplicity as implemented in the system contribute to usability of the system.

CHARACTERISTIC: General questions.

EXPLANATIONS:

GLOSSARY: Simplicity: A computerized system contains the quality of simplicity to the extent that information presented to the operator or entered by the operator is grouped into short, readily understandable structures.

Complicated data structures, data entry formats, or operator's manuals all require the operator to spend more time in developing an understanding of the system, and may have a tendency to confuse the operator as well.

QUESTION DATA SHEET

Question Number 95

QUESTION: Overall it appears that the operator-machine interface has been well designed.

CHARACTERISTIC: General questions.

EXPLANATIONS: This is the bottom-line, most highly subjective question asked. Rate the system according to your personal feeling.

ATTACHMENT 2

Subject Matter Versus Question Number Cross-Reference (Index)

This attachment contains information that should help the evaluator locate specific question subject matter and glossary definitions. The Index contains question subjects listed alphabetically and cross-referenced to the question addressing that subject.