Technical Research Note 212

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# THE TRANSFORM OPERATION IN TOS: ASSESSMENT OF THE HUMAN COMPONENT

James D. Baker
U. S. Army Behavioral Science Research Laboratory

and

Douglas J. Mace and James M. McKendry
HRB-Singer, Incorporated



BESRL

U. S. Army
Behavioral Science Research Laboratory

August 1969



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James D. Baker
U. S. Army Behavioral Science Research Laboratory

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Douglas J. Mace and James M. McKendry
HRB-Singer, Incorporated

Seymour Ringel, Task Leader

SUPPORT SYSTEMS RESEARCH DIVISION
Joseph Zeidner, Chief

U. S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY

Office, Chief of Research and Development
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## FOREWORD

The Command Systems program within the U. S. Army Behavioral Science Research Laboratory (BESRL) is concerned with problems of information presentation, processing, and utilization in Command and Control Systems. Specific aspects of information processing systems are examined with respect to the requirements for and the capabilities of handling information and its presentation to the human users of the system. The entire research program is responsive to requirements of RDT&E Project 2Q062106A723, "Human Performance in Military Systems," FY 1969 Work Program.

Coincident with BESRL research interests, the U. S. Army Computer Systems Command (USACSC), Headquarters, United States Army, Europe (USAREUR), and the Seventh Army have initiated plans for the design verification testing of an automated Tactical Operations System (TOS). This test program is aimed at verifying the efficacy of the design of a field system conceptually representative of the operations and intelligence aspects of the Automatic Data Systems within the Army in the Field (ADSAF) master plan. To design and test such a system, the TOS Development Group was formed and assigned the task of developing a field version of the TOS of ADSAF. The TOS automates aspects of Intelligence (G2) and Operations (G3) functions which the commander may monitor and use to direct tactical operations.

In September 1967, the Behavioral Science Research Laboratory established a Command Systems Field Branch in Europe to conduct human factors performance research in connection with the evaluation of an experimental Tactical Operations System. In the present study, problems of message format unique to the experimental TOS were examined and a newly devised job aid for selecting a format appropriate to a given message was evaluated.

BESRL research in command systems is conducted as an in-house research effort augmented by research contracts with organizations selected as having unique capabilities for research in the area. The present study was conducted jointly by personnel of the Behavioral Science Research Laboratory and of HRB-Singer, Incorporated, under program direction of Seymour Ringel.

J. E. UHLANER, Director
U. S. Army Behavioral Science
Research Laboratory

# THE TRANSFORM OPERATION IN TOS: ASSESSMENT OF THE HUMAN COMPONENT

## BRIEF

Requirement:

The experimental version of the automated Tactical Operations System (TOS) utilizes over 40 different message formats. At the present stage of TOS development, G3 staff action officers have to determine which message format or formats to use with each set of incoming data. The present study was conducted by BESRL's Command Systems Field Branch to examine systematically the human factors problems related to error rate, processing time, and confidence in format selection. A second objective was to evaluate a newly devised job aid for use in selecting the appropriate formats.

Procedure:

Forty-seven simple messages were given to 14 individuals familiar with TOS or G3 operations, or both. Their task was to select an appropriate format for each message. Half the men used a simple job aid devised by the experimenters, the other half used a "menu" type listing of available formats. The time taken to complete the entire task was recorded. Individuals also rated the degree of confidence they had that the proper format had been selected.

Findings:

Average error rate in format selection was 22%. Mean time to read the message and select a format was approximately 50 seconds.

Performance with the job aid was neither better nor worse than with the menu type listing.

Messages of different types and subject matter differed in error rate of format selection.

Utilization of Findings:

The study provided baseline data with which future performance can be compared. The findings suggested some approaches to training and alternative methods for the transform process.

TABLES



FIGURES

THE TRANSFORM OPERATION IN TOS: ASSESSMENT OF THE HUMAN COMPONENT

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# THE TRANSFORM OPERATION IN TOS: ASSESSMENT OF THE HUMAN COMPONENT

## SCOPE OF THE STUDY

### Operational Framework

The U. S. Army is developing an automated Tactical Operations System (TOS) to assist commanders and their staffs in the conduct of tactical operations by collecting, processing, and summarizing information required for command decisions and staff actions. The development is part of an Army-wide project, the Automatic Data Systems within the Army in the Field (ADSAF). In TOS, emphasis is on the intelligence (G2) and Operations (G3) functions.

While the introduction of automatic data processing (ADP) equipment into tactical operations can be expected to speed up data processing and reduce errors, the effective performance of the system depends ultimately on its human component. The introduction of ADP alone cannot be expected to extend significantly the capabilities of the system nor alleviate the limitations of man as an information processor. Further, it is realistic to expect that the introduction of ADP into tactical operations will produce new human performance problems. Solutions to these problems therefore become of paramount importance. In recognition of this fact, BESRL has established the Command Systems Field Branch to work closely with TOS developers to enhance system performance through facilitation of operations depending wholly or in part on the performance of personnel in the system.

In laying out a program of research aimed at resolving some of these problems, Ringel[1] speculated that at least five critical human performance areas requiring experimental attention would accompany the advent of the TOS. In his words:

> "An automated TOS will receive vast amounts of information from many and varied sources. The information will vary widely in content, form, and degree of completeness . . . The raw data will require a great deal of handling and processing by man and equipment . . . Looking at the system as a whole, there appear to be five critical operations that man and equipment will have to perform:
>
> 1. Screen incoming data for pertinence, credibility, impact, priority, and routing.

---

[1] Ringel, S. Command information processing systems--A human factors research program. BESRL Technical Research Report 1148, June 1966.

2. Transform the raw data for input into storage devices.
3. Input the transformed data into storage devices for subsequent computation and display.
4. Assimilate data displayed.
5. Decide on courses of action based on information displayed and information from other sources."

The flow of these operations is diagrammed in Figure 1. While each of the areas cited by Ringel has special significance to the operation of automated systems, each of these operations exists also in completely manual systems. The specifics governing methods of operation may change, but the overall purpose remains the same. Screening is always required to aid in the decision about what information should enter the system. Data transformation is necessary to organize material in a way which at least partially facilitates storage and retrieval. Although the popular connotation of the word "inputting" suggests automation, a broader view of the term could include making entries in charts, journal files, and other reference materials in manual systems. The point made here is that at least some of the problems which confronted command and control information systems before automation will continue to be problems within automated systems as well.

These basic human factor problems are compounded by the fact that the trend in the design of military information systems is to allow the user on-line communication with the computer and intervention in computer operations. Accompanying this trend has been the development of rigidly defined user/computer languages. The languages these systems use are, and within the current state-of-the art must be, most precise. They are intolerant of errors. Errors, even if slight, usually result in the computer's rejecting a message.

This typical inflexibility of computerized information systems accounts, in part, for the first two human performance problem areas which Ringel identified. Screening is required because most systems are not capable of accepting every iota of data. Redundant, irrelevant, and unimportant data are filtered out because the software is typically unprepared to respond appropriately. Transformation generally involves formatting and translating. "Formatting" is necessary because of input hardware restrictions and the fact that computers read character positions, or fields, and not words or sentences. A further restriction is that software frequently assigns differential meanings to positions and fields. Thus a "2" in column one is not necessarily equal to a "2" in column ten. This restriction leads to translation requirements. The language of the "real world" must be converted to the symbolism of the computer. In spite of the fact that sophisticated hardware is capable of converting alphanumerics to computer-compatible electronic binary representations, the software "expects" the input alphanumerics to conform to a specified form. Therefore, certain words must be abbreviated in a particular way, special names converted to numerical representations, continuous measurements categorized into interval scores, exponential notation substituted to shorten number length, and sundry other symbolic representations implemented to synthesize input data.

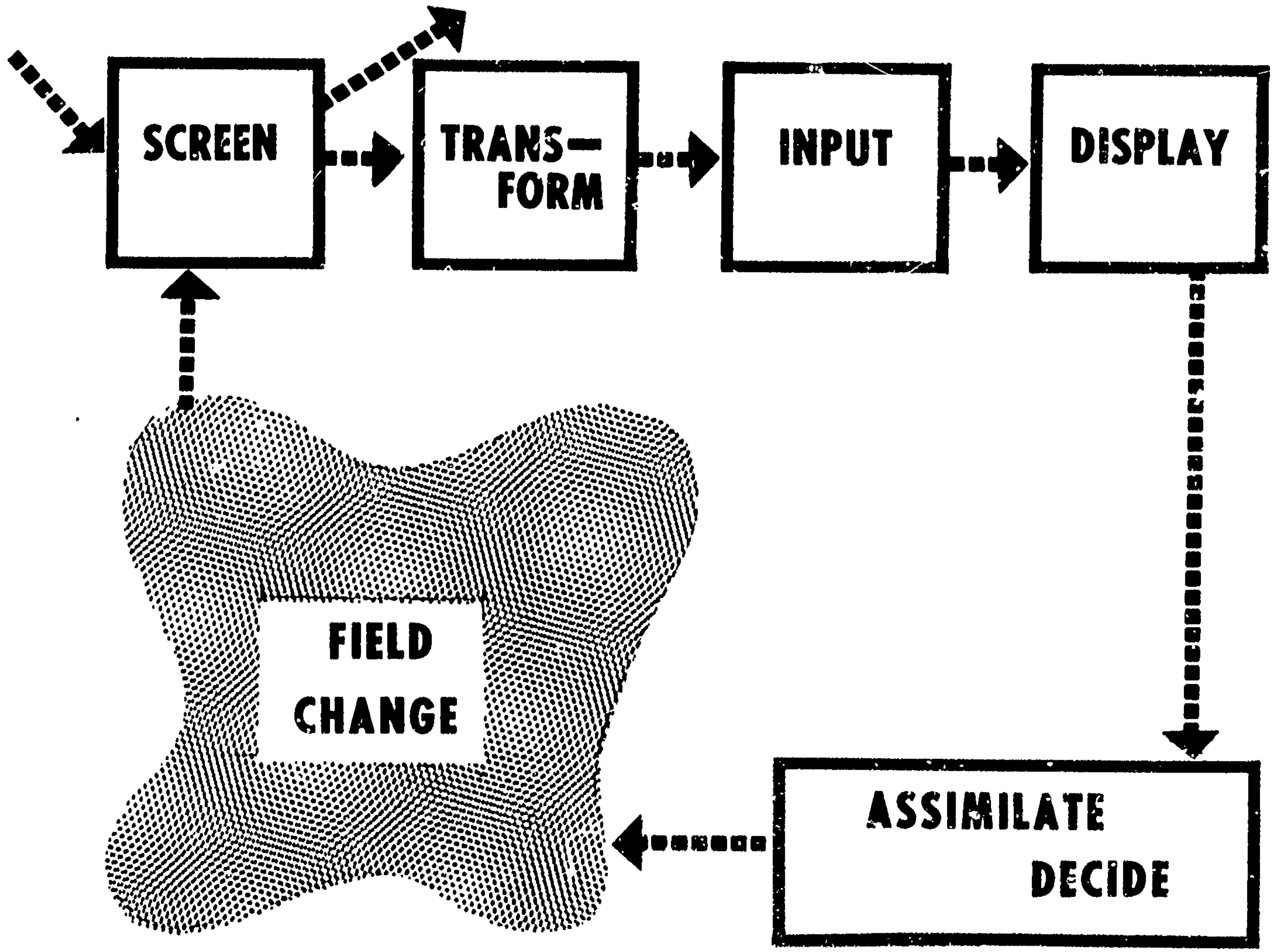


Figure 1. Schematic representation of operations and information flow in an automated TOS
*(Taken from Ringel, S. , Command information processing systems--A human factors research program. BESRL Technical Research Report 1148. June 1966.)*

Thus, the macro-structure introduced by Ringel[2] concerning the operations and information flow for an automated TOS can be made more specific by inserting micro-structure descriptions into the "black boxes" he presented. In Figure 2, the insertions have been made for <u>Screen</u> and <u>Transform</u> operations. The micro-structure presented in Figure 2 is specific to the current Seventh Army TOS in its present state of development. The present TOS has reached a stage in its development where speculation concerning these human performance areas can be replaced by system-specific experimentally generated data.

Concern in the present study was with a particular aspect of the transform process which is peculiar to the formatting requirements of the Seventh Army TOS.

## Problems of Format Selection

<u>Message Worksheet Approach</u>. Because the user/computer language of TOS requires exact syntactic structure, abbreviations, and terminology in order for the message to be accepted by the computer, the typically unconstrained free-English text that characterizes G3 messages in the manual system must be transformed into a rigidly defined format before the user can interact with the system. This operation will be accomplished in TOS, in accordance with current plans, by having a G3 staff action officer format the input, utilizing a message worksheet. This message worksheet is subsequently used to provide the text for the User Input-Output Device (UIOD) operator when he enters the message into the system. Additionally, the staff action officer will interpret any resulting output messages arriving at his UIOD. These messages will be structured essentially the same as input messages.

To illustrate this process, assume that the very busy G3 at Seventh Army Main has appointed a TOS staff action officer to assist him. He hands this staff action officer the following unclassified message:

> I WANT TO KNOW IMMEDIATELY ALL U. S. COMBAT UNITS SUBORDINATE TO V CORPS, OF DIVISION ECHELON OR LESS, WHICH HAVE MORE THAN 80 PERCENT TOE PERSONNEL AND MORE THAN 70 PERCENT COMBAT EFFECTIVENESS. ADDITIONALLY, THESE UNITS MUST HAVE AT LEAST 700 PERSONNEL.

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[2] See footnote 1 on page 1.

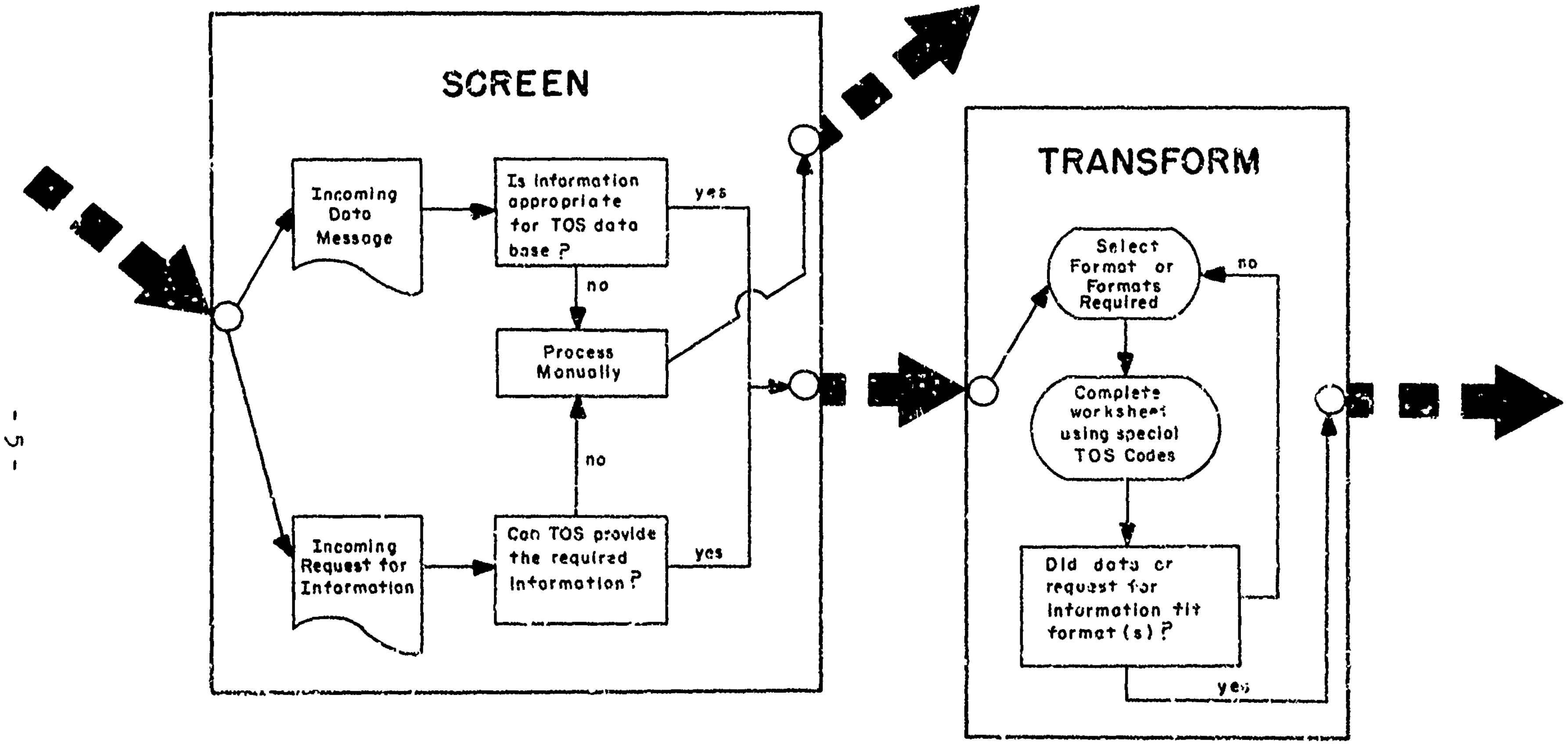


Figure 2. Schematic representation of the screen and transform operations and data flow in the Seventh Army automated TOS

The staff action officer notes that the Seventh Army G3 is interested in the present size and combat capability of specific units. The G3 message requires a reply which TOS is capable of providing and the information is requested on a one-time basis. The Unit Status Query message (see worksheet, Figure 3) is designed specifically to meet these criteria. The staff action officer begins to complete it once the proper format is selected. His job is to transform the message from the vernacular into a language the computer understands and will accept.[a]

### Complexity of the Format Selection Procedure

In the situation just described, an "ideal" staff action officer screened incoming messages. He had no difficulty in determining that the information request cited here was pertinent to the TOS data base. Further, he encountered no difficulty in selecting the correct format worksheet and presumably had no trouble completing it. But what about the "real men" who will be using the system?

The present study was conducted to provide some baseline data on the transform function. The primary question addressed was a practical one, namely: In the present version of the experimental TOS, is the task of selecting an appropriate message format to use for a particular message s difficult or a time-consuming one? If so, just how difficult is the task and what error rates can be anticipated? For example, listed in Table 1 are 43 message-worksheet formats specially intended for use by the G3 element in the TOC. Nine additional message-worksheet formats common to all staff elements are not included in this table (one exception is the Relay message which is included because of its relation to the question at hand). On the basis of number alone, this basic operation of format selection is potentially troublesome for the system.

It is unlikely that even the ideal staff action officer would commit to memory the operator communication field code number and the worksheet subject titles shown in Table 1, although after a while he may remember a few key ones. More likely, in normal operations he would refer to a "menu", or index, similar to Table 1, when presented with the task of pairing a message with an appropriate worksheet or worksheets. But a "menu" type job-aid, although typically used in this kind of situation, may not be best suited to the task. A secondary question was therefore raised: Could a job-aid be developed which would improve human performance in format selection?

---

[a] The reader interested in pursuing this translation process through all the steps to completion, i.e., to the point where the worksheet shown in Figure 3 has been completed, should consult Appendix A.

| U | J | 4 |
|---|---|---|
| PRECEDENCE ! | | HARDCOPY ! |

FRIENDLY UNIT INFORMATION

(UNIT STATUS QUERY)

ORIGIN ! / ; SCTY ! / ;

/R-O/A-N; PERS / / ; /R-O/PCT-OF-TOE; PERS-PCT / / ;

/R-O/A-N; TANKS / / ; /R-O/PCT-OF-TOE; TANKS-PCT / / ;

/R-O/A-N; WHEEL-VEH / / ; /R-O/PCT-OF-TOE; WH-VEH-PCT / / ;

/R-O/A-N; TRACK-VEH / / ; /R-O/PCT-OF-TOE; TR-VEH-PCT / / ;

/R-O/A-N; ARTY / / ; /R-O/PCT-OF-TOE; ARTY-PCT / / ;

/R-O/A-N; MISSILES / / ; /R-O/PCT-OF-TOE; MSL-PCT / / ;

/R-O/A-N; ACFT / / ; /R-O/PCT-OF-TOE; ACFT-PCT / / ;

/R-O/A-N; CBT-EFFECT / / ;

/ID OR SWBD-DSGTN; UNIT / ;

/R-O/ECHELON; ECHELON / / ; /UNIT-TYPE TYPE / ;

BRANCH / ; CATEGORY / ; NATION / ;

/ASGD OR ATCHD/ARTY-MISSION; SUBOR-TYPE / / ;

SUBOR-TO / ;

TIME FRAME / FROM / / TO / ;

/DATA MSG ORIGINATOR; ENTERED-BY / ; /R-O/SCTY-LEVEL; CLASSIFIED / / ;

Figure 3. Sample Unit Status Query worksheet

Table 1

LIST OF TOS MESSAGE-WORKSHEET FORMATS FOR G3 OPERATIONS
WITH ALPHA-NUMERIC SYMBOLS

---

Data Input Messages

UA1[a] Task Organization Data Message
UA2 Task Organization Data Change Message
UA3 Task Organization Data Delete Message
UB1 Task Force Data Message
UB2 Task Force Data Change Message
UB3 Task Force Data Delete Message
UC2 FLT and Coordinating Points Data Change Message
UD2 Command Post and Center of Mass Data Change Message
UE2 Boundary Data Change Message
UF2 Control Lines Data Change Message
UG2 Current Activity Data Change Message
UH2 Planned Activity Data Change Message
UJ2 Unit Status Data Change Message
UL2 SITREP Data Change Message
UM3 Periodic Preparation of SITREP Delete Message
UN3 Pending Change Delete Message

Query Messages

UA4 Task Organization/Task Force Query Message
UD4 Command Post, Center of Mass Locations Query Message
UE4 Boundaries Query Message
UF4 Control Lines Query Message
UG4 Operational Activity Query Message
UJ4 Unit Status Query Message
UL4 Situation Report Query Message
UN4 Pending Change Query Message

SRI Messages

UA6 Task Organization/Task Force SRI Establish Message
UA7 Task Organization/Task Force SRI Change Message
UD6 CP/COM Locations SRI Establish Message
UD7 CP/COM Locations SRI Change Message
UE6 Boundary SRI Establish Message
UE7 Boundary SRI Change Message
UF6 Control Lines SRI Establish Message
UF7 Control Lines SRI Change Message
UG6 Operational Activity SRI Establish Message
UG7 Operational Activity SRI Change Message
UJ6 Unit Status SRI Establish Message
UJ7 Unit Status SRI Change Message
UK6 Front Line Trace SRI Establish Message
UK7 Front Line Trace SRI Change Message
UL6 SITREP SRI Establish Message
UL7 SITREP SRI Change Message

Special Process Requests

UK5 Front Line Trace Special Process Request Message
UL5 SITREP Special Process Request
UN5 Request for Periodic SITREP

Relay Message

AA0 Free Text Relay Message

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[a] Operator communications field code number for each message.

## METHOD

### Test Material

It was considered desirable to keep the initial study fairly simple. For this reason, appropriate message/situation descriptions were abstracted from existing documentation where they function as more or less homogeneous examples for the application of specific formats.

One such message was found for most of the format-worksheets listed in Table 1; in a few cases, more than one message was obtained. The result was a pool of G3 message/situation descriptions which were similar to the one used in the illustration on page 4 of this report.

### Sample

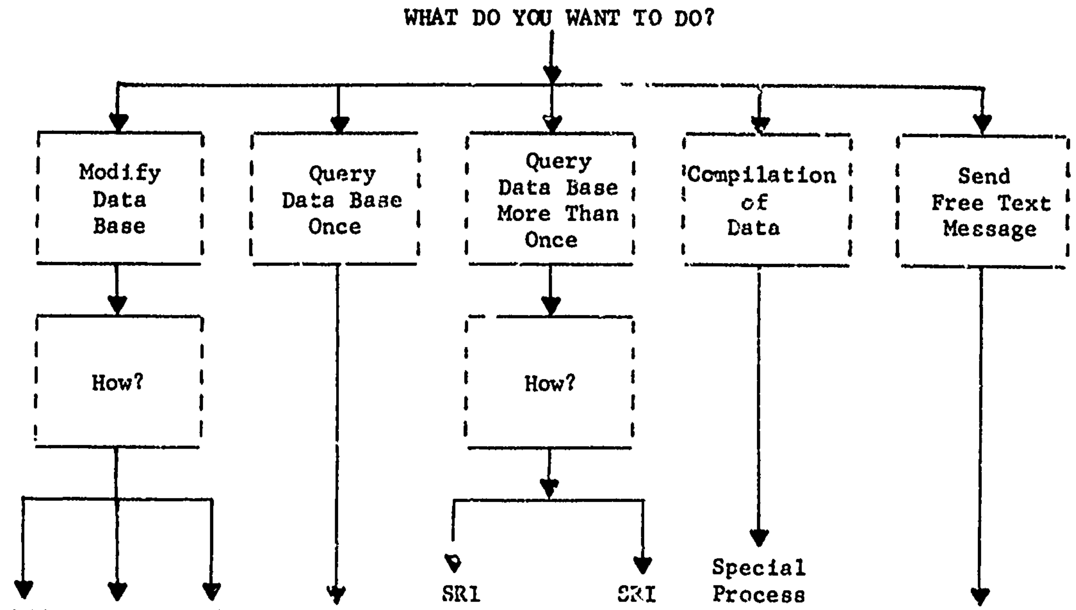
A list was compiled of military and civilian personnel working on the TOS development. All were considered by the authors to be experienced in TOS system operations or in G3 operations or both. These personnel were contacted and asked if they would serve as subjects. When a pool of fourteen was reached, the men were roughly matched and paired in terms of length of time they had worked on TOS development and experience in and related knowledge of G3 operations. This procedure provided two groups of equated subjects, one "standard" and the other "job-aided."

### Testing Procedure

The instructions presented to both groups are reproduced in Appendix B. Essentially, the standard group was told that they would be given a set of message/situation descriptions which they were to read. They were then to select from a list of message formats (Table 1) the one which was most appropriate for the situation covered in each description. They were also informed that each situation represented an isolated and independent case, and that it should not be considered in relation to other situations.

The other group was treated exactly the same way, with the exception that they were given a job-aid (Figure 4) to assist them in finding the correct format instead of the Table 1 list used by the standard group.

All subjects progressed through the test booklet of message/situation descriptions at their own pace. When they had selected what they considered was the appropriate message format, they entered the corresponding alpha-numeric operator communications field code in the space provided (see Figure 5). Each subject then checked the block at the bottom of the response sheet which best expressed his certainty concerning the correctness of his selection (Figure 5). When he had completed the task, he noted his finish time on the test booklet and then turned it in to the experimenter.




| MESSAGE SUBJECT | | Add | Change | Delete | Query | SR1 Establish | SRI Change | Special Process Request | Relay |
|---|---|---|---|---|---|---|---|---|---|
| A Task Organization | A | UA1[a] | UA2 | UA3 ) | UA4 | UA6 | UA7 | | |
| B Task Force | B | UB1 | UB2 | UB3 ) | | | | | |
| C FLT and Coordinating Points | C | | UC2 | | | | | | |
| D Command Post, Center of Mass Locations | D | | UD2 | | UD4 | UD6 | UD7 | | |
| E Boundary | E | | UE2 | | UE4 | UE6 | UE7 | | USE |
| F Control Lines | F | | UF2 | | UF4 | UF6 | UF7 | | |
| G Current Activity | G | | UG2 | ) | UG4 | UG6 | UG7 | | FORMAT |
| H Planned Activity | H | | UH2 | ) | | | | | |
| J Unit Status | J | | UJ2 | | UJ4 | UJ6 | UJ7 | | AAO |
| K Front Line Trace | K | | | | | UK6 | UK7 | UK5 | |
| L SITREP | L | | UL2 | | UL4 | UL6 | UL7 | UL5 | |
| M Periodic Preparation of SITREP Special Process | M | | | UM3 | | | | UM5 | |
| N Pending Change | N | | | UN3 | UN4 | | | | |

[a]The alpha numerics at the intersection of the rows and columns (e.g., UA1) is the Operator Communications Field Code Number called for on the answer sheet.

Figure 4. Device used by job-aided group to determine the message format-worksheet required

Example: The Third Battalion, Seventh-sixth Armor, is moving up causing a change to its boundaries. Spearhead TOC sends the following unclassified message: "3-BN-76-ARMD" moving up to on-line position 2. Left boundary LA31927864 and LA30647672. Right boundary LA33927461 and LA32847367. Effective time of boundaries is 150400ZAUG67.

Message Format UE2

My certainty of the message format being correct is:

| Absolutely Uncertain | Very Uncertain | Moderately Uncertain | Slightly Uncertain | Moderately Certain | Very Certain | Absolutely Certain |
|---|---|---|---|---|---|---|

Figure 5. Sample message/situation description used in the experiment
*Subject has responded that the message format needed to enter these data into TOS is a UE2, i.e., a "Boundary Data Change Message." He has also indicated that he was "slightly uncertain" when he made this response. The certitude scale used in this study was developed by R. Andrews and S. Ringel (Andrews, R. S. and S. Ringel. Certitude judgments and the accuracy of information assimilation in visual displays. BESRL Technical Research Note 145. April 1964.)*

## RESULTS

### Job-Aid Evaluation[4]

One of the questions posed in this study was: Could a job-aid be developed, specific to this task, which would improve human performance? The proposed aid is illustrated in Figure 4. Results summarized in Table 2 indicated that the answer is no, at least, not within the limits

[4] Although this aspect of the study was considered a secondary objective, the analyses of these data are presented first. The reason for this ordering will become obvious when the subsequent data analyses which support the rationale for pooling the data are presented.

of the present study.[5] Upon examination, the data did not warrant further analysis, since it was evident that no practical differences existed.

Table 2

COMPARISON SCORES OF THE EQUATED SUBJECTS (Ss) ON THE THREE MEASURES OBTAINED IN THE STUDY--ERRORS, TIME TO COMPLETION, AND EXPRESSED CERTITUDE

| Pair | Errors (Job-aid Group) | Errors (Standard Group) | Time (in minutes) (Job-aid Group) | Time (in minutes) (Standard Group) | Average Certitude (Job-aid Group) | Average Certitude (Standard Group) |
|---|---|---|---|---|---|---|
| A | 5 | 2 | 49 | 30 | 6.7 | 7.6 |
| B | 4 | 9 | 60 | 37 | 5.2 | 5.0 |
| C | 9 | 8 | 32 | 34 | 7.5 | 5.7 |
| D | 7 | 7 | 31 | 35 | 5.4 | 6.0 |
| E | 10 | 5 | 36 | 26 | 6.5 | 7.2 |
| F | 15 | 17 | 30 | 60 | 4.3 | 3.9 |
| G | 16 | 21 | 46 | 39 | 3.2 | 4.5 |
| Average | 9.43 | 9.86 | 40.6 | 37.3 | 5.5 | 5.7 |

[5] One of the limits of the study was that the standard and job-aided groups could only be assumed to be equivalent. No independent comparative measure of the efficacy of this pairing was obtained. Time factors, not to be delineated here, precluded the development of an appropriate device for obtaining the required measures. Use of each S as his own control (i.e., each S serving under both conditions in some counter-balanced order) was eliminated as a means for getting around this problem. The reason was twofold, one pragmatic and the other a study design problem. The pragmatic reason is simply that the limited number of appropriate stimulus materials ruled out this approach. In terms of experimental design, serial learning effects encountered in this type of experimental task are very difficult to handle statistically. Thus, even if paucity of appropriate stimuli could have been overcome, another negative factor would have been encountered.

### Accuracy, Time, and Certitude

The time and certitude data (Table 2) were obtained using test booklets which contained 47 situation/messages (Figure 6). The time data were obtained by measuring from start time of session to finish time and were not item-by-item measures. Hence, "average time per item" statements are based upon computations for 47 items. However, the error score data and the average certainty data are based on an N of 44 items, a drop of three items from the total number. First, two situation messages were inadvertently replicated when the booklets were collated and the two extra items were dropped from the analysis. Second, during data analysis, one item was found that every subject answered incorrectly. A careful examination of the item indicated that no unequivocal criterion existed for stating that any available response was in fact correct. Hence, it was assumed to be a "bad" item and dropped from the sample.

The data summarized in Table 2 show that the two groups were nearly identical in terms of mean number of errors made (job-aided, 9.43; standard, 9.86). The average time required to complete the task was essentially the same for both groups (job-aided, 40.6 minutes; standard, 37.3 minutes). The mean expressed certainty that the selection of format worksheet was in fact correct was almost the same (job-aided, 5.5; standard, 5.7). This particular finding came as a surprise since it was originally hypothesized that the men using the aid would, at the very least, be more confident in their choice. On the basis of these data, it must be concluded that the job-aid failed to improve performance in the present study.

### Overall Performance

Since, as noted in the job-aid evaluation section, no significant differences between the two groups were found, the data from the two groups were combined for purposes of the overall analysis.

In terms of errors, the average rate for the total sample was 9.6. Stated another way, an average of 9.6 errors in the experimental situation involving 44 messages represents a 22 percent error rate. The reader should keep in mind that the messages used in this experiment were purposely kept simple and that the experimenters were in effect begging the question with regard to level of "user" performance in the case of the more complex task of determining how many and what kinds of formats are required for messages that cannot be accommodated by a single format.

By the same token, these "users" were going into the situation "cold." With experience, error rate could be expected to decrease. For example, the feedback-loop shown in Figure 2 (seeing whether the format selected in fact accommodates the data in the message) should temper subsequent selections. While this assumption appears logically sound, its validity remains to be tested.

| | Message Subject | | Add | Change | Delete | Query | Establish | Change | Request |
|---|---|---|---|---|---|---|---|---|---|
| A | Task Organization | A | UA1 | UA 2 | UA3[a] | UA4 | UA6 | UA7 | |
| B | Task Force | B | UB1 | UB 2 | UB3 | | | | |
| C | FLT and Coordinating Points | C | | | | | | | |
| D | Command Post, Center of Mass Locations | D | | UD 2 | | UD4(2) | UD6 | UD7 | |
| E | Boundary | E | | UE 2 | | UE4 | UE6 | UE7 | |
| F | Control Lines | F | | UF 2 | | UF4 | UF6 | UF7 | |
| G | Current Activity | G | | UG 2 | | UG4 | UG6 | UG7 | |
| H | Planned Activity | H | | UH 2 | | | | | |
| J | Unit Status | J | | UJ 2(2) | | UJ4(2) | UJ6 | UJ7 | |
| K | Front Line Trace | K | | | | | UK6 | UK7 | UK5 |
| L | SITREP | L | | UL 2 | | UL4 | UL6 | UL7 | UL5 |
| M | Periodic Preparation of SITREP Special Process | M | | | UM3 | | | | UM5(2)[b] |
| N | Pending Change | N | | | UN3 | UN4(2) | | | |

[a] The message situation description used as an example for this format was a complex one requiring both a UA3 and UA2 response. Either answer was therefore accepted in the scoring.

[b] This format was referred to as UN5 in Table 1 to conform with its current designation in the TOS. It was changed to UM5 in the job aid to conform to the letter of its row title.

Figure 6. List of 47 message/situation descriptions used. A (2) indicates where 2 messages of this category were used.

Mean format selection time was 49.8 seconds per message. Interviews with G3 action officers and the analysis of data obtained during Corps and Division exercises have revealed that the G3 action officer, during peak periods, may expect to receive an average of 40 to 50 messages per hour.[6] In other words, the action officer could be dealing with a new message every 70 to 90 seconds. However, not all these messages will be applicable to the TOS. In any case, the time required simply to choose an appropriate message format for messages applicable to TOS is nearly 50 seconds. It seems reasonable to assume that the G3 action officer could be quickly overloaded in peak action periods.

Even if these time comparisons could be disregarded, there are several other reasons to expect that, unless precautions are taken, the action officer will become over. ided. At least some of the messages he will receive during peak periods are likely to be more complex than those included in the stimulus set of the present experiment, perhaps requiring multiple formats for inserting all the information into the data base. Consequently, both error rate and response time are likely to increase. Additionally, some portion of an action officer's time will be spent screening the incoming data to determine the appropriateness to TOS (see Figure 2). The data then will need to be translated into computer-acceptable TOS language. As noted earlier, some translation effort is also involved in handling TOS output. Finally, the action officer will be involved in correcting errors which are bound to occur at each step during this information handling.

Taken together, the error rate and time data just presented, as well as the impact of the other steps described, lead to the conclusion that the transformation process is potentially a major problem in the experimental TOS.

## ANALYSIS OF ERROR SOURCE

A detailed examination of the messages which produced the most frequent errors was then undertaken. The intention was to determine if the pattern of errors could provide some meaningful insights into the "why" behind the subjectively high error rate observed in this study.

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[6] The interviews, supplemented by a questionnaire, were conducted by the authors in conjunction with a corps level exercise. The manual system data were extracted from a report by Reese C. Wilson of the User Planning Group entitled: "FRONT CENTRE 68 - Data Reduction and Analysis Results," dated May 1968.

The percentage error rates presented in Table 3 were computed for individual message subjects and message types. The percentages were weighted to take into account the differential frequency of occurrence of each message subject and type in the total sample. There were, for example, six messages in the stimulus set with "Task Organization" as the subject. These six messages were rated by the 14 subjects. They made 17 errors--a weighted error rate of 20 percent (6 x 14 = 84; 17 ÷ 84 = 20%). Table 3 reveals that certain of the message subjects and message types contributed more than others to the error rate. Message subjects concerned with "Planned Activity" and message types of the "Data Add" variety were clearly front-runners in the production of erroneous responses. Table 3 also shows that the difference between the message subject errors and message type errors was minimal (95 vs 89 respectively).

## Analysis of Erroneous Response Patterns

While the data in Table 3 serve to point out which message subjects and message types contributed most to errors, they do not reveal the nature of the confusion. To identify possible reasons for confusion in the responses made, a detailed examination was made of a selected set of the stimulus items in the sample and subject responses. The items selected were those which produced error rates above the median of the total distribution of weighted error scores. Results of this examination are summarized in Table 4.

In Table 4, the message categories have been rank-ordered in terms of highest to lowest error score. Associated with each category is the most frequent erroneous response to that message category. Also shown is the likelihood, given an error, that the error will be of a particular type. For example, if the stimulus message was one which originated from a situation requiring a "Planned Activity" format, the probability of an error's occurring on that item was .5. Stated another way, 50% of the responses made to these messages were in error. Of the errors made, 57% consisted of responding that the data called for a "Relay Message" response, while the remaining 43% consisted of erroneously stating that a "Task Force" format was required.

To present the data in Table 4 in the framework of an operational analogy, if the user in the field performs as the subjects in the study did, he will be serving as a buffer in the transform process, depriving the data base of valid information (if he selects a relay message) and introducing time delays in the data base up-date (if he selects an erroneous format in an attempt to "wedge" the data into the system). The impact of the man in the system is illustrated in Figure 7, by taking some liberties with the data in Table 4.

In spite of the small number of messages involved, the data in Table 4 are nonetheless suggestive of some significant sources of error in the transform process.

Table 3

PERCENT ERRORS FOR MESSAGE SUBJECT AND MESSAGE TYPE CATEGORIES

| Code[a] | Message Categories | Number in Sample | Total Number of Errors | Percent (Weighted) Errors |
|---|---|---|---|---|
| | Subject | | | |
| A | Task Organization | 6 | 17 | 20% +[b] |
| B | Task Force | 3 | 14 | 33% + |
| C | FLT and Coord. Points | 0 | 0 | --- |
| D | CP and COM Locations | 5 | 8 | 11% |
| E | Boundary | 4 | 5 | 9% |
| F | Control Lines | 4 | 5 | 9% |
| G | Current Activity | 4 | 9 | 16% + |
| H | Planned Activity | 1 | 7 | 50% + |
| J | Unit Status | 5 | 8 | 11% |
| K | Front Line Trace | 2 | 4 | 14% |
| L | SITREP | 5 | 8 | 11% |
| M | Periodic Prep. at SITREP | 2 | 6 | 21% + |
| N | Pending Change | 3 | 4 | 10% |
| A | Relay | 0 | 0 | --- |
| | Sub-Total | 44 | 95 | |
| | Type | | | |
| 1 | Data Add | 2 | 7 | 25% + |
| 2 | Data Change | 9 | 22 | 17% + |
| 3 | Data Delete | 4 | 6 | 11% |
| 4 | Query | 11 | 14 | 9% |
| 5 | Special Process | 3 | 10 | 24% + |
| 6 | SRI Establish | 8 | 26 | 23% + |
| 7 | SRI Change | 7 | 4 | 4% |
| 0 | Relay | 0 | 0 | --- |
| | Sub-Total | 44 | 89 | |

[a] Code as used in this and the tables to follow is an abbreviated form of the Operator Communication Field Code given in Table 2. For example, UA1 is the code for a task organization data message in Table 1 while in this table A alone is used to designate task organization.

[b] Plus signs designate those message category responses with especially high error rates.

Table 4

MOST FREQUENT ERRONEOUS RESPONSES IN TERMS OF CONFUSION BETWEEN FORMATS AND LIKELIHOOD OF OCCURRENCE OF PARTICULAR CONFUSION[a]

| Code | Message Category | Number of messages in the sample | Number of errors | Percent error | Most frequent erroneous responses | Number of times this response was given | Confusion likelihood |
|---|---|---|---|---|---|---|---|
| H | Planned Activity | 1 | 7 | .50 | Relay | 4 | .57 |
| | | | | | Task Force | 3 | .43 |
| B | Task Force | 3 | 14 | .33 | Relay | 6 | .43 |
| | | | | | Task Organization | 4 | .29 |
| | | | | | Current Activity | 4 | .29 |
| 1 | Data Add | 2 | 7 | .25 | Relay | 3 | .43 |
| | | | | | Data Change | 2 | .29 |
| 5 | Special Process Request | 3 | 10 | .24 | Query | 5 | .50 |
| | | | | | SRI | 3 | .30 |
| 6 | SRI Establish | 8 | 26 | .23 | Query | 16 | .62 |
| M | Periodic Preparation of SITREP Special Process Request | 2 | 6 | .21 | SITREP | 6 | 1.00 |
| A | Task Organization | 6 | 17 | .20 | Relay | 5 | .29 |
| | | | | | Unit Status | 5 | .29 |
| | | | | | Task Force | 4 | .23 |
| 2 | Data Change | 9 | 22 | .17 | Relay | 10 | .45 |
| | | | | | Data Add | 8 | .36 |
| G | Current Activity | 4 | 9 | .16 | Unit Status | 3 | .33 |
| | | | | | Control Lines | 2 | .22 |

[a] Confusion likelihood values of less than 20 were arbitrarily omitted from the table, since they reveal only minimal impact in the transformation process.

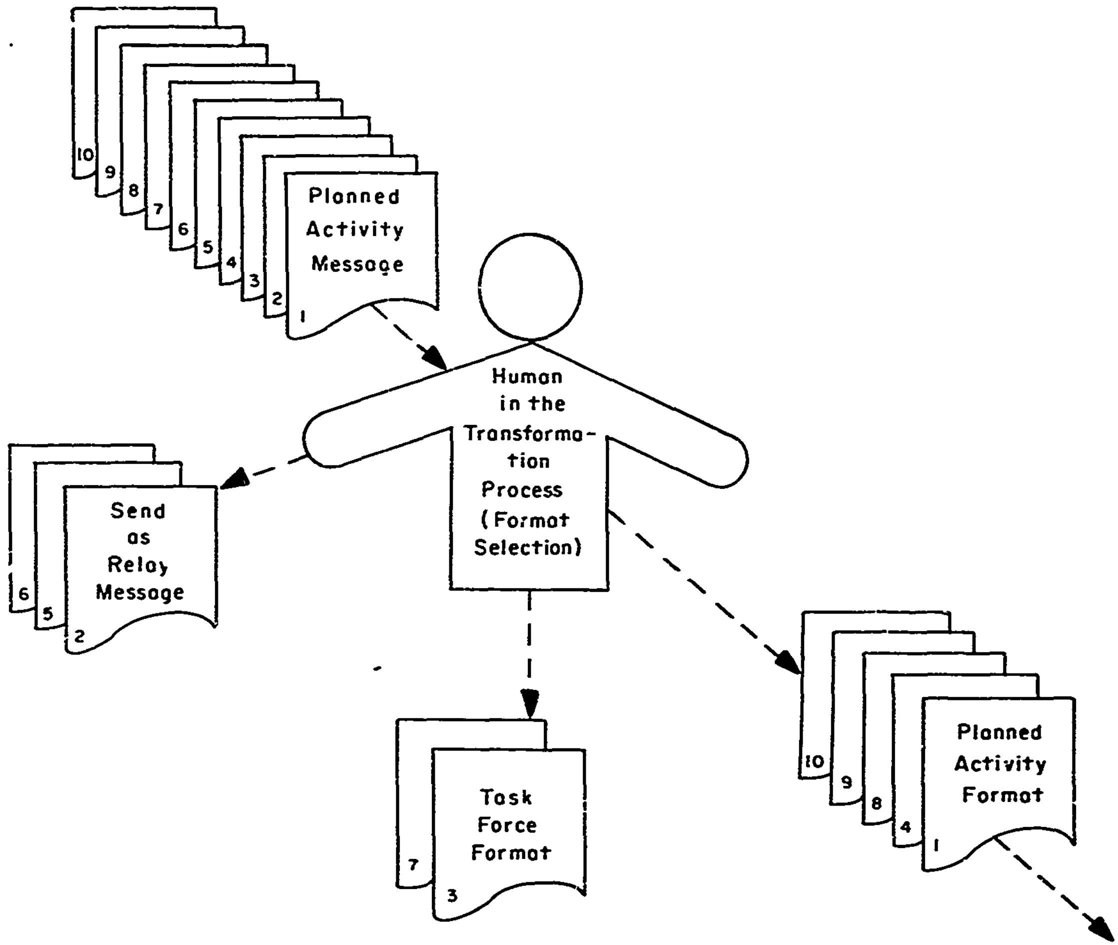


Figure 7. Illustrates a hypothetical sequence of ten "Planned Activity" messages being processed by a G3 staff action officer

*Of these ten messages, and based upon the data in Table 4, we could expect about half of the messages to be handled erroneously. Of those in error, approximately three--for example, messages No. 2, 5, and 6--would be sent out as relay messages. The staff action officer also would have attempted to compose two of these messages--e.g., 3 and 7--using a "Task Force" format worksheet.*

### Confusion of Message Content and Format Label

Several years ago, Chapanis[7] published a paper in which he called attention to a very large and important area of human factors which was then--and for that matter still is--almost entirely neglected. This area consists of the language and the words attached to the tools, machines, systems, and operations with which human factors personnel are concerned. Examples, illustrations, and data were cited to show that changes in the words used in man-machine systems may produce greater improvement in performance than do changes in the machine itself.

Evidence in the present data suggests that the human performance problems encountered in this TOS-tied transform process is yet one more instance of the difficulties individuals have with the words and language of man-machine systems. The problem uncovered here is one not generally encountered in laboratory research where stimulus materials are permitted to vary only with respect to well defined dimensions. Although in the current study the stimulus materials (messages) were said to vary with respect to the appropriate format category, it cannot be assumed that the resulting nominal scale (message format titles) reflects corresponding variability in the latent content of the messages themselves. The format categories and message content are never isomorphic; that is, while the format categories refer to well defined groups of items, the content often extends beyond the purpose implied by the title.

The problem of format selection is one of recognizing the correspondence between the significant characteristics of a message and the purpose of one of the message formats. Since the purpose of each format is more complex than its title would indicate, attempting to match key items in the message content with format title alone is not sufficient. Yet this strategy appears to be the one used by the subjects in many instances, as illustrated by comparing the content of selected stimulus messages with the types of error reflected in Table 4. The only "Planned Activity" message in the stimulus set was as follows:

> A TASK FORCE NAMED TF-TEST IS TO MINE APPROACHES
> TO BRIDGE, THEN MOVE FORWARD TO SOUTH OF AREA
> NEAR MISSION X. START TIME OF THE OPERATION IS
> Ø8ØØ ZULU ON 16 AUGUST 1967, AND END TIME IS Ø8ØØ
> 17 AUGUST 1967. THE UNIT SENDING THIS UNCLASSIFIED
> MESSAGE IS THE THIRD ARMORED DIVISION AT TOC.

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[7] Chapanis, A. Words, words, words. Human Factors, 1965, 7, 1-17.

The message content suggests that the simplest explanation for confusion of the "Planned Activity" message with the "Task Force" response is that the single Planned Activity message dealt with the planned activity of a task force. The opening statement is "A TASK FORCE NAMED TF-TEST IS TO ..., etc." This explanation gains further support by examining the errors for the four Current Activity messages, none of which contained the term "Task Force." None of the errors for these messages resulted in a Task Force response.

The errors for the three Task Force messages can be explained similarly. Three of the four erroneous "Task Organization" responses were to the only message which had the word "organize" as part of its content. Likewise, three of the four erroneous "Current Activity" responses occurred to the only message which specifically discussed an activity, a river crossing.

These errors, and others like them, indicate that subjects were often misled by an irrelevant correspondence between message content and message category titles. Since the titles are not completely descriptive of the purpose of various message formats, additional familiarity with the purpose of each format through a carefully structured training program is required if errors are to be reduced. Alternatively, a set of mnemonic descriptions for message titles which draws attention to the relevant differences in the purpose of the various message formats could act to reduce error. Such an approach would require further experimentation to develop discriminably different titles associated with a low error rate.

### Type-Subject vs Subject-Type Procedure

As just mentioned, a carefully structured training program could conceivably reduce the number of errors in the field. The present results yield some suggestions regarding this training. The suggestions were reinforced by statements made by some of the subjects in the study.

Post-experimental discussions with the subjects suggested that the process of choosing a format began with the choice of a message type, followed by the choice of a message subject from those available for the type of message chosen. To determine how this "type-subject hypothesis" describes the data, expected values were computed for each response format listed in Table 1 or Figure 4, and these were correlated with the observed error rate for each response.

The expected values were calculated under the assumption that erroneous responses were made at random within the constraints of the model; that is, the total sample of error response was distributed evenly among the 8 message types and the errors of each type were distributed evenly among the various message subjects within the type. For example, the total number of errors was 132, an expected value of 16.5 for each message type.[8] Since there were eight subjects associated with the query type message, the expected error value of each (e.g., UA4, UD4 etc.) would be 2.06 $\left(\frac{16.5}{8}\right)$. Likewise, since the Data-Add message type had only two message subjects, the expected error value for erroneous UA1 and UB1 format responses would be 8.25.

The correlation between expected and observed errors using the type-subject hypothesis was r = .86. To determine whether the hypothesis was in fact better than its converse (the subject-type hypothesis), a correlation coefficient was similarly comput d on the assumption that subjects chose message subjects first and then chose a message type from those available for that subject.[9] Expected values for message subjects were therefore 9.43 $\left(\frac{132}{14}\right)$. Since there were 4 types of message available for the message subject, "Control Lines," the format responses of UF2, UF4, UF6, and UF7 all have expected values 2.41 $\left(\frac{9.43}{4}\right)$.

The correlation coefficient obtained for the subject-type hypothesis was .62, which was less than the coefficient of .86 obtained using the type-subject hypothesis.

The implication of these data for structuring a training program is straight-forward: Emphasis should be on teaching the potential user the unique aspects, as well as properties and characteristics of, the type of message transaction required, and only limited coverage need be given the message subject characteristics. The basis for this conclusion is simply that a "user" in the field, when faced with the task of choosing a format, will most likely select a message type first, and then the message subject.

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[8] The total of 132 errors represents the total number of incorrect responses made by Ss. This number is somewhat less than the sum of message subjects (95) and message type (89) errors because several of these errors occurred as joint events, i.e., the subject responded with both the incorrect type and incorrect subject to the same message.

[9] The critical reader may be puzzled at this point, noticing that some message formats serve purposes of two message subjects. This is true of formats UA4, UA6, UA7, UG4, UG6 and UG7. The UG4 format, for example, is a query message for both current and planned activity. Computation of expected values for the subject-type hypothesis considered these dual roles by first postulating the existence of a separate format for the second subject of each of these, i.e., UB4, UB6, UB7, UH4, UH6 and UH7. Expected values were calculated as described in the text, but since the identical response was required for current or planned activity and Task Organization and Task Force Query and SRI messages, the expected values of UA4 and UB4, UA6 and UA7, etc., were summed to produce one expected value for each format in the response set which served a dual role.

## Relay Message Error

One other type of error merits comment. The data in Table 4 show that, overall, the most frequent erroneous response was in selecting a "Relay" message format. The relay message is used to communicate plain text remarks--statements in normal English language--between the staff users of the TOS. When used, the message performs a communication function only: it has no effect on the TOS data base and it does not interface with other TOS messages. It is, in effect, a catch-all category and was included in our response set for that very reason. Consequently, there was no item in the stimulus set specifically requiring a Relay Message format (see Figure 6). Many of the personnel involved in the TOS development (including a number of the subjects in the present experiment) have speculated that the relay message will be "overworked" in TOS. The present data tend to bear them out.

# CONCLUSIONS

The primary objective of the study was to produce normative data concerning user performance levels. Overall, the users in the experiment operated at about a 22 percent error rate. On the average, it took them about 50 seconds per message to select a format. Certain message-format combinations contributed more to user confusion than did others; for example, a situation requiring a Planned Activity format resulted in an error about 50% of the time, while situations concerned with "Boundary" or "Control Line" formats resulted in few errors. A detailed analysis of message content revealed that individuals are often misled by irrelevant correspondence between message content and message category titles, since the titles are not completely descriptive of the purpose of the various message formats. It also was found that the selection of the Relay Message format (a plain text communication which utilizes TOS equipment but does not interact with the TOS data base) was the most frequent erroneous response made over all the message categories.

The results point out a number of considerations. First, the error results. Even in situations where messages are simple and require only a single format, a relatively high error rate in format selection can be anticipated. This anticipated high error rate must be qualified, since the subjects in the present study were not formally trained in format selection. The degree of reduction in error rate as a consequence of special training is yet to be determined. In operational settings, this problem of error rate will be compounded by the concomitant screening, translation (input and output), and error-correction requirements which also will beset the user. Second, the time results. The time involved in selecting a format, considered in relation to the message load to be expected in peak periods, indicates that at certain times the staff action officer will be quickly overloaded. This situation, too, will be compounded by the fact that for some messages multiple formats will be required, increasing selection time. Third, the indicated confusion between class of message and format selection. Messages in certain classes will result in errors more often than others. Overall, the most likely error is that data will be sent as Relay Messages when, in fact, they should have been input into TOS to enrich the data base.

In the present study, concern was with a "simulated" G3 staff action officer trying to match an incoming message with one of 44 possible formats in one functional area (Friendly Unit Information). When the present TOS goes into the field, three other first priority functional areas (Enemy Situation, Nuclear Fire Support, and Effects of Enemy Nuclear Strikes) will be added, and there will be approximately 140 formats to match to incoming messages. It has been hypothesized that the total number of different formats in TOS will exceed 500 if all planned additional functional areas are introduced into the system. Consequently, transform process problems should be addressed now before they reach major proportions.

One task that should be undertaken is that of scrutinizing existing formats to determine if the absolute number can be reduced. Considerable overlap in content exists among the present formats. Certain formats could conceivably be combined because of this communality. Even if the present "people problem" was not a consideration, the sheer cost and logistic problems involved in printing, transporting, and field storage of so large a number of different forms dictate a critical review of requirements.

Considering the normative performance data developed in the study, and in light of the logistic considerations, the question of need for format selection as an off-line step in the transform process is raised. Viewed simply from the standpoint of data through-put, this step in the operation is redundant. The staff action officer fills out a format worksheet. He then hands it to the UIOD operator. The UIOD operator, in turn, calls up on his display the same format and enters the identical information into the system. Toward eliminating this redundancy in the operation (which inflates system process time and introduces another potential source of system error), an empirical test of the feasibility of on-line composition should be undertaken. Should this approach prove feasible, it would not only improve system performance but would also reduce the manpower requirements of the TOS.

While the procedures described above might reduce data through-put time as well as eliminate a step where error can creep into the system, there remains the question of how to resolve user confusion resulting from irrelevant correspondence between message content and TOS message category titles. As a short-term approach, training which focuses on the definitive purpose of each format seems reasonable. The efficacy of this approach, however, remains to be demonstrated.

This aspect of the transform process in TOS will probably be with us, in one guise or another, for some time to come. Studies at the practical working level (for example, a determination of the possible facilitating--or debilitating--effects of on-line composition in the transform operation) need to be supplemented by studies at a more fundamental level. Many changes between the "experimental" and the "ultimate" TOS can be anticipated. Therefore, in order to recommend what should be done in the future to enhance performance, a deeper understanding of the fundamental process involved is required. In short, the research should involve tasks which are analogous to, if not exactly equivalent to, TOS operations as presently envisioned. Conceptualizing the task in the abstract will permit free manipulation of important variables in a way that is precluded in practical experiments. The latter normally reduce to demonstrations of the efficiency of new approaches formulated by extrapolating from fundamental research. In this case, there is a lack of appropriate fundamental research which can be brought to bear on TOS-type problems.

## APPENDIXES

APPENDIX A

## CONTINUATION OF STAFF ACTION OFFICER'S TRANSLATION PROCESS IN THE TRANSFORM OPERATION

Our hypothetical staff action officer had just been handed the following unclassified message from the G3 at Seventh Army Main:

> "I WANT TO KNOW IMMEDIATELY ALL U. S. COMBAT UNITS SUBORDINATE TO V CORPS, OF DIVISION ECHELON OR LESS, WHICH HAVE MORE THAN 80 PERCENT TOE PERSONNEL AND MORE THAN 70 PERCENT COMBAT EFFECTIVENESS. ADDITIONALLY, THESE UNITS MUST HAVE AT LEAST 700 PERSONNEL."

Using the Unit Status Query Message Worksheet, the staff action officer transformed the above message into a language that the TOS computer understands and will accept. Shown in Figure A-1 is the completed Unit Status Query Worksheet that the staff action officer would hand to his UIOD (User Input/Output Device) operator. Let us examine each of the entries to determine how he transformed the basic message into an acceptable "User/Computer Language."

PRECEDENCE: A reply to the message was requested "immediately," thus the "I" entry.

HARDCOPY: The "Y" indicates that the Staff Action Officer requested a printed copy of the message for his record purposes.

ORIGIN: The originator of the message is the G3, Seventh Army Main. Therefore, the staff action officer's originator code is "CMG3."

SECURITY: The security of the message was unclassified, or "UNCLAS."

PERSONNEL: The number of personnel stated in the basic message was "at least 700." The entry for this, found in the Rational Operator (R-O) list of his glossary, was "NOLESS." The number (A-N) 700 is entered in the spaces following the slash.

PERS-PCT: The message specified "more than 80 percent TOE personnel." The Relational Operator (R-O) list in his glossary was used to supply the entry "MORE." The number "80" is the percent of TOE entry inserted after the slash.

CBT-EFFECT: The message stated "more than 70 percent combat effectiveness." "MORE" and "70" were entered in the same manner as above.

U J 4 FRIENDLY UNIT INFORMATION

PRECEDENCE I ! HARDCOPY Y ! (UNIT STATUS QUERY)

ORIGIN ! /CMG3; SCTY ! /UNCLAS;

/R-O/A-N; PERS /NOLESS/ 700; /R-O/PCT-OF-TOE; PERS-PCT / MORE / 80;

/R-O/A-N; TANKS / / ; /R-O/PCT-OF-TOE; TANKS-PCT / / ;

/R-O/A-N; WHEEL-VEH / / ; /R-O/PCT-OF-TOE; WH-VEH-PCT / / ;

/R-O/A-N; TRACK-VEH / / ; /R-O/PCT-OF-TOE; TR-VEH-PCT / / ;

/R-O/A-N; ARTY / / ; /R-O/PCT-OF-TOE; ARTY-PCT / / ;

/R-O/A-N; MISSILES / / ; /R-O/PCT-OF-TOE; MSI-PCT / / ;

/R-O/A-N; ACFT / / ; /R-O/PCT-OF-TOE; ACFT-PCT / / ;

/R-O/PCT CBT-EFFECT /MORE / 70;

/ID OR SWBD-DSGTR; UNIT / ;

/R-O/ECHELON; ECHELON /NOMORE / DIV ; /UNIT-TYPE/ TYPE / ;

BRANCH / ; CATEGORY / CBT ; NATION /US;

/ASGU OR AYCHD-MISSION; SUBOR-TYPE / / ;

SUBOR-TO / 5-CORPS ;

TIME-FRAME / FROM / /TO / ;

/DATA MSG ORIGINATOR; ENTERED-BY / ; /R-O/SCTY-LEVEL; CLASSIFIED / / ;

Figure A-1. Sample of a completed Unit Status Query worksheet

ECHELON: The only echelons requested for the output message were "division or less." The two entries for echelon, therefore, were "NOMORE" and "DIV."

CATEGORY: The message specified "combat" units; therefore, "CBT" was chosen from his glossary.

NATION: Only "US" units were requested.

SUBOR-TO: The message indicated that only units "subordinate to V Corps" were to be reported. The entry "5-CORPS" therefore was made.

Thus, the original free-English text was transformed into a computer-acceptable language. As noted earlier, the language required is most precise, e.g., the SUBORD-TO entry, "5-CORPS," must be written exactly as shown, including the arabic numeral and the dash (-), or the computer will reject the message.

APPENDIX B INSTRUCTIONS FOR STANDARD AND JOB-AID GROUPS

INSTRUCTIONS (Standard Group)

You are all aware of the numerous formats which exist for inputting information into TOS. Choosing a correct format for a message must be accomplished quickly and correctly for TOS to have a real benefit to the user. We have asked for your help today in order to gather information which might help us determine what types of problems an action officer might have choosing a correct format.

We have prepared a set of canned situation descriptions which are similar to those which might be expected in the G3 Friendly Unit Information Area. We would like you to read each situation description, choose a format which is most appropriate for TOS to handle the problem described, and write that format code in the space provided on the situation sheet. Since each situation represents an isolated and independent case, it should not be considered in relation to other situations.

After completing your answer, read the next situation description and do not refer again to situations previously scored. Since the number of situations to be scored is greater than the number of formats to choose from, it is obvious that some formats must be used more than once. Also, since each of you has a situation description set which was randomly compiled, it may be that some of you will find that some message formats need not be used at all.

In addition to recording your answers regarding which format you selected for each message, we want to find out how long it took you to select formats for all of the messages you have. This will be done by keeping track of when you start the first message and when you have selected the format for the last message. Therefore, you must let us know as soon as you finish. Finally, after each format is selected you are asked to rate how certain you are that you have selected the proper format.

In addition to the set of situation descriptions which you will be given, you now have a list of message formats from which you are to choose the appropriate formats for each situation. This list provides the three-character format codes which you should use for scoring your answers. Every situation in the set given you has, among the formats listed, one which is most appropriate.

INSTRUCTIONS (Job-Aid Group)

You are all aware of the numerous formats which exist for inputting information into TOS. Choosing a correct format for a message must be accomplished quickly and correctly for TOS to have a real benefit to the user. We have asked for your help today in order to gather information which might help us determine what types of problems an action officer might have choosing a correct format.

We have prepared a set of canned situation descriptions which are similar to those which might be expected in the G3 Friendly Unit Information Area. We would like you to read each situation description, choose a format which is most appropriate for TOS to handle the problem described, and write that format code in the space provided on the situation sheet. Since each situation represents an isolated and independent case, it should not be considered in relation to other situations.

After completing your answer, read the next situation description and do not refer again to situations previously scored. Since the number of situations to be scored is greater than the number of formats to choose from, it is obvious that some formats must be used more than once. Also, since each of you has a situation description set which was randomly compiled, it may be that some of you will find that some message formats need not be used at all.

In addition to recording your answers regarding which format you selected for each message, we want to find out how long it took you to select formats for all the messages you have. This will be done by keeping track of when you start to format the first message and when you have selected the format for the last message. Therefore, you must let us know as soon as you finish. Finally, after each format is selected, you are asked to rate how certain you are that you have selected the proper format.

In addition to the set of situation descriptions which you will be given, you now have a decision chart which will assist you to find the correct format. The chart is arranged to indicate the correct format code, given that you know the type of message you need to send and the subject content of the message.

After reading a situation description, begin at the top of the chart and answer the question, "What do you want to do?" Then look at the column which contains your answer to this question, e.g., modify the data base. Two columns ask the additional question, "How?" You could query the data base more than once by establishing an SRI or changing an existing one. Also, you can modify the data base by adding data, deleting data, or changing data.

Once you have established the correct column, find the row which indicates the subject of the message you wish to send. The intersection of the row and column gives the correct format code.

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13. ABSTRACT

Under ~~BESRL's~~ COMMAND SYSTEMS program, specific aspects of information presentation, processing, and utilization in command and control systems are examined with respect to the requirements for and capabilities of handling and presenting information to human users of the system. The present study was conducted ~~by BESRL's Command Systems Field-Branch~~ in Europe to examine systematically human factors problems related to error rate, processing time, and confidence in message format selection. A second objective was to evaluate a newly devised job aid for use in selecting appropriate formats. The experimental TOS, being developed and evaluated as part of an Army-wide program (ADSAF), utilizes over 40 different message formats from among which G3 staff action officers have to determine the appropriate format or formats to use with each set of incoming data. Of concern in this study were the human factors problems involved in transforming free-English G3 message texts into rigidly defined format in preparation for user interaction with the TOS. In the experiment, 47 simple messages were given to 14 individuals familiar with TOS or G3 operations, or both. Half the men (job-aid group) used an aid devised by the BESRL investigators, and half (standard group) used a "menu" type listing of available formats in performing the required task of selecting an appropriate format for each message. Time taken to complete the task and also degree of confidence in the selection made were recorded. Findings showed a mean time of approximately 50 seconds for message reading and format selection. Average error rate in format selection was 22%. No significant difference was obtained in performance with the job aid over that with the "menu" type listing. Messages of different types and subject matter differed in error rate of format selection. Mean expressed certitude of correctness in format selection was almost the same for both groups. Time and error rate data, together with

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13. ABSTRACT - Continued

other factors such as screening for applicability to TOS, correction of errors, and translating more complex tests led to the conclusion that the transformation process is potentially a major problem in the experimental TOS. Results provided baseline data for comparative study of future performance and suggested some approaches to training and alternative methods for the transform process.

| KEY WORDS | LINK A ROLE | LINK A WT | LINK B ROLE | LINK B WT | LINK C ROLE | LINK C WT |
|---|---|---|---|---|---|---|
| *Tactical Operations System (TOS) | | | | | | |
| Automated TOS | | | | | | |
| *Message formats | | | | | | |
| *Job aids | | | | | | |
| *Transform process | | | | | | |
| *Transform operations | | | | | | |
| Automatic data processing (ADP) system | | | | | | |
| Information processor | | | | | | |
| *Command information processing systems | | | | | | |
| Decision making | | | | | | |
| Screening | | | | | | |
| *Military information systems | | | | | | |
| Data flow | | | | | | |
| Transformation | | | | | | |
| *Formatting | | | | | | |
| Translating | | | | | | |
| User/computer language | | | | | | |
| Response patterns | | | | | | |
| Certitude judgment | | | | | | |