Technical Report 398

ASSESSMENT OF ABBREVIATION METHODS FOR AUTOMATED TACTICAL SYSTEMS

Franklin L. Moses and Lawrence M. Potash

HUMAN FACTORS TECHNICAL AREA

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Alternative methods of producing abbreviations of single words for use in automated military systems were empirically evaluated. Each of 50 enlisted men performed three tasks designed to assess five different abbreviation methods including two versions of truncation, two versions of contraction, and one procedure based on current Army practice. In the first four methods, abbreviation length was directly related to word length. In Task A, participants used a 10-point scale to rate preference for abbreviations for each of

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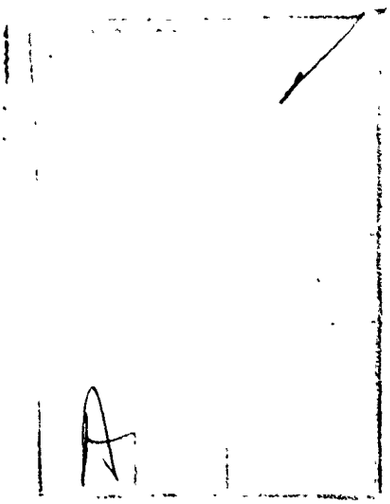
60 terms. Thirty of these terms were repeated in Task B; the other 30, in Task C. Task B required participants to decode 60 abbreviations into their original terms. Finally, Task C asked participants to encode (i.e., generate) a meaningful abbreviation for each of 60 terms. Results showed that abbreviations produced using simple truncation were consistently preferred, easily decoded, and frequently used for encoding terms. Scores for abbreviations from current Army practice were among the lowest except in Task C (encoding). Experience with abbreviations in Task A (preference) made decoding of identical abbreviations significantly easier in Task B, but did not affect the abbreviations encoded by participants in Task C. Simple truncation is the method suggested to produce good single word abbreviations quickly and to reduce the errors and the time requirements for user interactions with battlefield automated systems.



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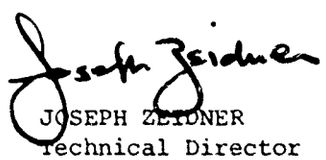
FOREWORD

The Human Factors Technical Area is concerned with improving man/machine systems to acquire, transmit, process, disseminate, and utilize information from the increasingly complex battlefield. The research is focused on the interface problems and interactions within command and control centers and is concerned with such areas as topographic products and procedures, tactical symbology, user-oriented systems, information management, staff operations and procedures, and sensor systems integration and utilization.

One area of special research interest involves the design and evaluation of procedures to increase efficiency and accuracy of user-computer interactions. Advances in user-approachable systems would reduce errors, increase input rates, and provide for well-structured outputs to help realize the potential benefits of automation for command and control applications. The present research evaluated alternative methods for creating abbreviations of military terms. It is part of a continuing effort to provide the command staff with efficient vocabularies, message structures, and "natural" language elements for interacting with battlefield automated systems. Such research suggests techniques and methods which can be incorporated into plans for Army-wide automated systems.

Research on characteristics of user-approachable systems is conducted as an in-house effort augmented by contracts with organizations selected for their specialized capabilities and facilities. These efforts are responsive to requirements of Army Project 2Q163743A774 and to special requirements of the U.S. Army Combined Arms Combat Development Activity, Fort Leavenworth, Kans. Special requirements are contained in Human Resource Need 78-149, "Interactive Procedures for Data Inputting, Organization, Retrieval and Purge."



JOSEPH ZEIDNER
Technical Director

ASSESSMENT OF ABBREVIATION METHODS FOR AUTOMATED TACTICAL SYSTEMS

BRIEF

Requirement:

To evaluate alternative methods for producing abbreviations of single words for use as data element codes in battlefield automated systems.

Procedure:

Each of 50 enlisted men (E4 and above) performed three tasks designed to assess five different abbreviation methods: two versions of truncation, two versions of contraction, and one procedure based on current Army practice. In the first four methods, abbreviation length was directly related to word length. For all research tasks, 120 single words and their Army abbreviations were selected from the 1977 Army Tactical Data Systems Standard Data Element Dictionary (DED) intended for use with automated systems.

In Task A, participants used a 10-point scale to rate preference for abbreviations for each of 60 terms. Thirty of these terms were repeated in Task B and the other 30 in Task C to determine if such minimal experience would influence results. Task B required participants to decode 60 abbreviations into their original terms. Task C asked participants to encode (i.e., generate) a meaningful abbreviation for each of 60 terms. Since the context of an abbreviation can provide clues about its meaning, half of the participants in Tasks B and C were told the DED category of each item presented.

Results:

Single word abbreviations produced using simple truncation were consistently preferred, easily decoded, and frequently used for encoding terms. Scores for abbreviations from the DED were among the lowest except in Task C (encoding). There was no clear-cut second-ranking method although both forms of contraction did well. Experience with abbreviations in Task A (preference) made decoding of identical abbreviations significantly easier in Task B, but did not affect the abbreviations encoded by participants in Task C. There was no effect on performance in Task B or in Task C of knowing the context (i.e., DED category) for items in the research.

Utilization of Findings:

Simple truncation is the suggested method for quickly producing single word abbreviations which are preferred and easily decodable. With this method, battlefield system designers should produce good data element codes. In addition, such abbreviations presumably should benefit users by reducing input time and errors in interactions with battlefield systems. Overall, the abbreviations produced by simple truncation are not intended to replace commonly accepted abbreviations and are not likely to be judged acceptable in all cases.

ASSESSMENT OF ABBREVIATION METHODS FOR AUTOMATED TACTICAL SYSTEMS

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ASSESSMENT OF ABBREVIATION METHODS FOR AUTOMATED TACTICAL SYSTEMS

The use of abbreviations as data element codes in battlefield automated systems reduces the amount of display area required for items and is expected to decrease input time and errors. However, the multitude of acronyms and abbreviations available in Army systems confuses users. A good abbreviation should be quickly and easily discriminated from other abbreviations in a particular system, and it should be easily decoded and remembered. In addition, it should be compatible with a variety of different system configurations to facilitate implementation. The present effort was designed to determine standard methods for creating abbreviations that have clear and immediate associations with their original words.

The design and evaluation of procedures for creating abbreviations is part of implementing the Army's program to standardize data elements and codes (AR 18-10). The fundamental purpose of this program is to facilitate integration of systems and direct computer-to-computer communications. One of the efforts at standardization is in Army Tactical Data Systems (ARTADS). A Standard Data Element Dictionary (DED) has been developed in the broad area of tactical command/control to reflect needs of the Tactical Operable Segment Tactical Operations System (TOS[2]) the All Source Analysis System (ASAS), and the Tactical Fire Control System (TACFIRE).[1] The 1977 DED was the source of terms for testing in the current research.

BACKGROUND

A variety of methods are available for constructing abbreviations, including use of acronyms, contractions, truncations, or some variation of these (Barrett & Grems, 1960; Bourne & Ford, 1961b; Luhn, 1958; Davidson, 1962; Hodge & Pennington, 1973). However, with but few exceptions (Hodge & Pennington, 1973; Nystrom & Givideh, 1978; Nawrocki, 1979), there is a lack of empirical data concerning methods that produce short forms for which both the short form designating a word or concept and the meaning are easily associated, learned, and remembered. For example, consider the range of differences among five abbreviations for the term reinforcing: RNF, REINF, RINFO, RNFRC, and RIFCG. The first reflects current Army practice, and the others represent two variations of truncation and two variations of contraction. Guidelines are needed for choosing among such alternatives.

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[1] A recent and intensive effort called the TRADOC Data Element Standardization Program was initiated in 1978 to develop standards for all tactical Battlefield Automated Systems (BAS).

Hodge and Pennington (1973) analyzed the ways people create abbreviations and their ability to correctly interpret abbreviations produced by others. Participants were asked to create abbreviations for words varying in length from four to nine letters and to reconstruct the original words from abbreviations previously produced by another group. Results showed that (a) the percentage of letters used in an abbreviation declined systematically with increasing word length, although the actual number of letters used showed a moderate increase; (b) truncation was used more often than contraction with the longer high frequency-of-usage words whereas the reverse tended to be the case for the low frequency-of-usage words of any length; and (c) the median number of different abbreviations increased systematically with word length. At a minimum, the research by Hodge and Pennington gave clues about the relationship among abbreviations, different word lengths, and frequency of usage.

Nystrom and Gividen (1978) investigated the ease of learning different types of codes used to categorize input messages in an automated system. Their results suggest that for message titles containing multiple words, the coding should be done with acronyms. In general, use of arbitrary letters or words should be avoided.

Nawrocki (1979) investigated the accuracy of interpreting abbreviations created with alternative abbreviation methods. He found no difference in the number of abbreviations correctly interpreted for a truncation method compared to a contraction procedure that removed vowels. However, such contractions led to considerably more spelling errors than were caused by truncation. Truncation produced significantly more grammatical errors where the endings or tense of words were incorrect. In terms of abbreviation lengths, procedures using fewer letters (i.e., greater "economy") resulted in poorer performance.

Clearly, a variety of suggestions exist for shortening single as well as multiple word items. However, no generalizable recommendation has emerged for methods which generate abbreviations that are preferred, easily decoded, and used with minimal learning. Some abbreviation rules may lead to forms which require constant looking up and, therefore, are harder to use than the original terms. Other rules may be appropriate for some items and not for others. For example, use of acronyms is highly desirable only when they are easily remembered and associated with the items represented. Typically, logically compelling arguments or personal choices are the primary basis for choosing among abbreviation methods. The present effort employed empirical measures to assist in choosing among alternative methods for abbreviations of single words

OBJECTIVE

The objective was to evaluate the effectiveness of five abbreviation methods using three evaluation criteria. The first criterion, preference, was used to assess general acceptance of different

abbreviation formats. Interpretation or decoding, the second criterion, was used to determine how well abbreviations produced by different methods actually suggest the terms they represent. The third criterion, encoding of abbreviations, determined which methods people naturally use to create abbreviations. In summary, the research goal was to identify abbreviation methods whose use with single words may gain easy acceptance and may increase speed and accuracy for interactions with tactical data bases.

METHOD

Participants

Participants were 50 military personnel (E4 and above) who had diverse backgrounds. They were assigned to the Military District of Washington, D.C., and participated in the experiment as a group.

Task

The experiment consisted of three tasks. In Task A, participants judged how well single word military terms were represented by abbreviations generated using five different methods. Task B required participants to reconstruct military terms from abbreviations produced by the same five methods used in Task A. Finally, in Task C, participants were instructed to generate an abbreviation for each military term presented.

Materials

Five different methods used for generating abbreviations in Tasks A and B were chosen from 12 possible candidate methods (Appendix A). The following methods were selected:

1. Data Element Dictionary (DED). Abbreviations taken directly from the DED represent current Army practice and provide comparisons for abbreviations produced by the other four methods.

2. Simple Truncation. Starting from the right end of the word, drop off letters until the required word size is obtained (Bourne & Ford, 1961a,b).

3. Truncation/Second Letter Out. Automatically eliminate the second character of the word counting from the left side. Then use simple truncation (Bourne & Ford, 1961a,b).

4. Contraction/Vowels Out. Keep the first character on the left, but remove vowels and H, W, or Y (from right to left) until the correct number of letters is reached. Supplement the

method with simple truncation if necessary (modified from Davidson, 1962).

5. Contraction/Frequent Letters Out. Keep the first character and eliminate letters from right to left on the basis of their frequency of occurrence in proper names until the desired abbreviation length is reached. Highest frequency letters are eliminated first (Bourne & Ford, 1961a,b).

Each of the five methods was used to abbreviate 120 single word terms (Appendix B) taken from the DED. Lengths of DED abbreviations had no consistent scheme; all other abbreviations were generated with lengths varying according to guidelines empirically generated by Hodge and Pennington (1973) as follows:

Number of Letters in Original Term	Number of Letters in Abbreviation
5	3
6-7	4
8 or more	5

The abbreviations taken from the DED sometimes had a prefix letter (e.g., "p" for personnel) so that an abbreviation could be even longer than the original term. Overall, the DED scheme was as follows:

Number of Letters in Original Term	Mean Number of Letters in Abbreviations	Range of Number of Letters in Abbreviations
5	3.5	1-6
6-7	4.5	1-6
8 or more	4.9	1-7

The total number of terms in each word-length category follows:

Number of Letters in Original Term	Number of Terms
5	2
6-7	21
8 or more	97

PROCEDURE

Participants were told that the research was aimed at evaluating various ways to abbreviate military terms. The relationship of such abbreviations to computerized information systems and the importance of having abbreviations that are easily recognized and interpreted was explained. Illustrations were given to show how some abbreviations are

not as good as others. Instructions emphasized that no special training was required for completion of the task and that no individual would be graded or evaluated. Participants read specific instructions (Appendix C) prior to working on each of the three parts of the research.

Task A: Preference

All participants in Task A used test materials containing the same 60 military terms. Each term was followed by five abbreviations generated using the five methods being evaluated. Participants were required to use an 11-point scale for rating how well the abbreviations represented a particular term. On the scale, "0" was defined as "unsatisfactory," and "10" was defined as "excellent." The presentation order of abbreviations for each military term was determined by use of a random number table.

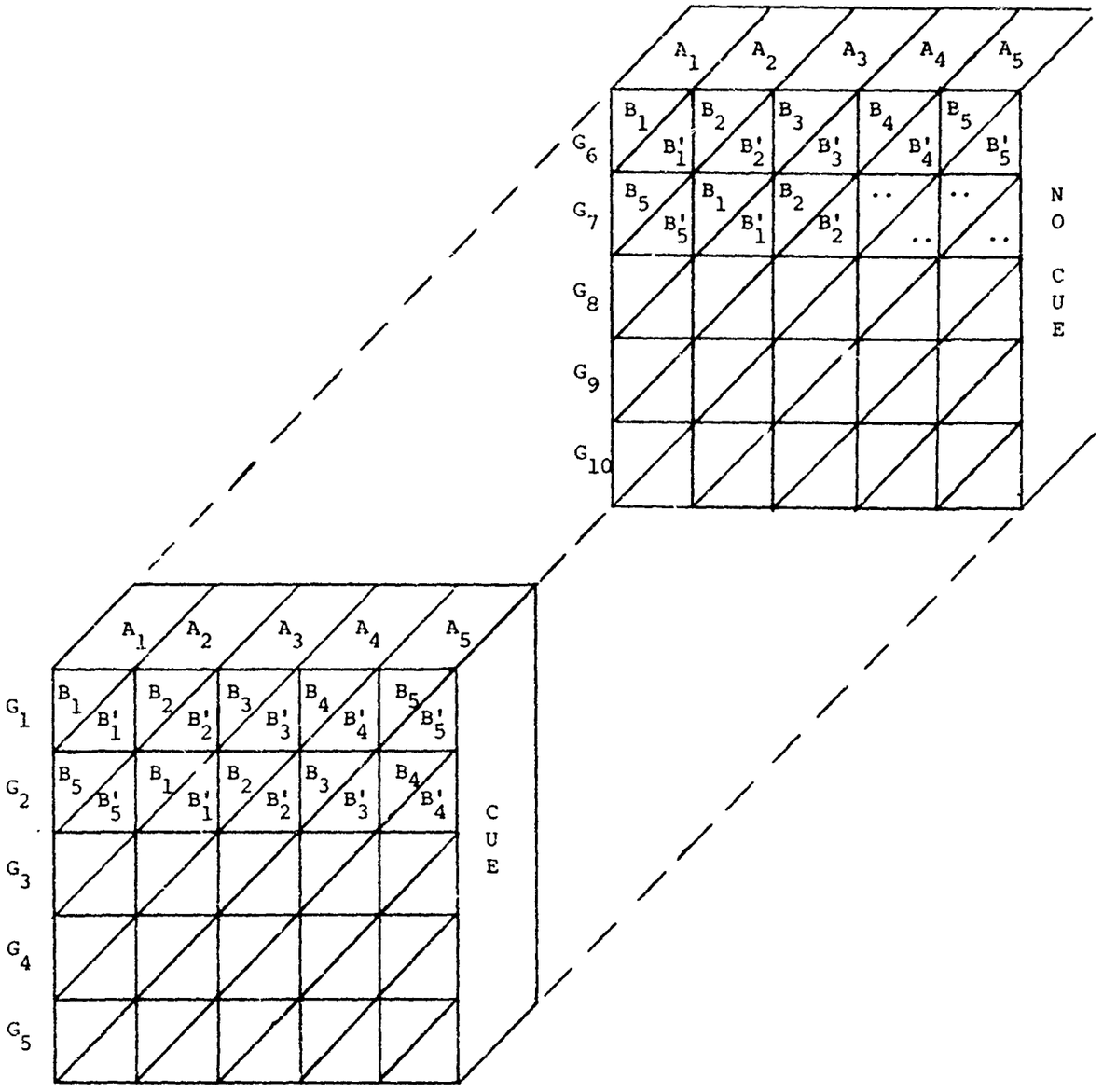
Task B: Decoding

In this part of the research, participants were presented with 60 abbreviations generated using the five methods and were instructed to write the original term for each of the abbreviations. Thirty of the abbreviations were for terms used in Task A; the other 30 abbreviations were for new terms (experience condition, previously seen versus not previously seen). Each abbreviation represented a different term.

All participants did not see the same 60 abbreviations. For a given participant, each of the five abbreviation methods was used on a different block of 12 terms, 6 terms previously seen and 6 new ones. By using five groups of participants, all possible combinations of the five blocks of 12 terms using the five abbreviation methods were represented. Abbreviations representing the terms were randomly assigned to the 60 positions so that abbreviations from a particular method would be scattered and a "position effect" minimized. The same random order was used for all groups. For 25 participants (5 per group), each abbreviation was accompanied by a cue to help in reconstructing the original term (cue condition). Cues consisted of military categories for terms as specified in the DED (for example, the cue support mission accompanied RNF, the abbreviation for reinforcing). In a parallel condition, the remaining 25 participants had the same sets of abbreviations but had no accompanying cues. The research design for Task B was a modified Latin Square design (Figure 1).

Task C: Encoding

All participants in Task C were presented with 60 terms and were instructed to generate one "best" abbreviation for each term. The length of the abbreviation had to be three or more letters but less than the total number of letters in the term being abbreviated. Thirty



A = Abbreviation techniques
G = Groups of five participants
B = Abbreviated terms previously seen (blocks of six)
B' = Abbreviated terms not previously seen (blocks of six)

Figure 1. Modified Latin Square design for Task B (decoding abbreviations)

of the terms had previously been used only in Task A; the remaining 30 terms had not been presented previously (experience condition). As in Task B, the military categories for terms were specified for half of the participants but not for the other half (cue condition).

RESULTS

The effectiveness of abbreviation procedures was assessed in three ways: preference, decoding, and encoding measures. Since a different research design was used for each of the three experimental tasks, the results are presented most clearly in separate sections.

Task A

Preferences expressed in the form of numerical ratings were analyzed using a one-way analysis of variance (ANOVA) with the five abbreviation techniques as the main effect and participants as a replication factor. There was a statistically significant difference ($p < .01$) among ratings for the different techniques (Appendix D). A Neuman-Keuls test of means showed that abbreviations produced by simple truncation and by contraction with vowels removed were preferred over abbreviations produced by all other techniques (Table 1). The DED abbreviations and truncation/second letter out were statistically less acceptable than any other method.

Table 1

Preference Ratings for the Five Abbreviation Methods

Mean rating	Method
5.46	Contraction/vowels out
5.10	Simple truncation
4.25	Contraction/frequent letters out
3.48	Truncation/second letter out
3.12	DED

Note. Means which are significantly different from each other, $p < .01$, are not bracketed together.

Task B

The number of abbreviations correctly decoded in Task B was determined using both liberal and strict scoring criteria. With liberal scoring, some of the decoded terms which were counted as correct had spelling errors or different endings from the intended terms. Decoded terms counted as correct under strict scoring criteria were error free.

A five-factor ANOVA (based on the modified Latin Square design) applied to liberal scores showed statistically significant differences ($p < .01$) for abbreviation method, for experience with abbreviations (seen, not previously seen), and among blocks of abbreviations (Table D-2). The block factor is not of interest because of the counterbalanced research design. Only two of the significant interactions merit mention. The Experience x Method interaction may suggest that the relative decodability of abbreviations created by different methods varied with experience. The Experience x Residual x Cue effect, while significant, was too small to be useful in data interpretation.

Mean scores (Table 2) showed that previously seen abbreviations ($\overline{X} = 4.30$) were more accurately decoded than abbreviations not previously seen ($\overline{X} = 3.72$). Using the Neuman-Keuls test, the mean scores for abbreviation methods were compared for differences. Simple truncation scored best in six of eight comparisons. It was better than all other methods for not-previously-experienced abbreviations. For terms experienced earlier in the research, simple truncation scored better than DED abbreviations and contraction/frequent letters out.

A five-factor ANOVA, parallel to the one just discussed, was applied to data scored by strict criteria (Table D-3). Only some of the minor interactions differed from the earlier analysis using liberal scoring criteria. A Neuman-Keuls test of mean scores (Table 3) for the five abbreviation methods indicated that simple truncation and contraction/frequent letters out were better than most of the other methods for items not previously experienced. Once again, the DED abbreviations tended to be the worst technique overall. The small range of scores resulting from strict scoring perhaps limited the number of statistically significant findings.

Task C

Abbreviations produced by participants were scored for correspondence with abbreviations produced by the five methods used in earlier tasks. A two-way ANOVA (Table D-4) showed significant differences among the five methods ($p < .01$) and a significant Methods x Experience interaction effect ($p < .01$). Data were collapsed across the cue/no cue condition since no noticeable differences occurred. Similarly, no differences in scores resulted from the use of liberal versus strict scoring criteria defined in Task B's results. Table 4 shows mean scores

Table 2

Correctly Decoded Abbreviations for Each of Five Methods (Liberal Scoring)

Previously seen items		Not previously seen items	
Method	Mean and percentage decoded	Method	Mean and percentage decoded
Simple truncation	4.66 (78%)	Simple truncation	3.38 (56%)
Truncation/second letter out	4.54 (76%)	Contraction/ frequent letters out	2.73 (45%)
Contraction/ vowels out	4.36 (73%)	Truncation/second letter out	2.58 (43%)
Contraction/ frequent letters out	4.14 (69%)	DED	2.54 (42%)
DED	3.82 (64%)	Contraction/ vowels out	2.40 (40%)
Column mean	4.30	Column mean	2.72

Note. Means which are significantly different, $p < .05$, from each other are not bracketed together.

Table 3

Correctly Decoded Abbreviations for Each of Five Methods (Strict Scoring)

Previously seen items		Not previously seen items	
Method	Mean and percentage decoded	Method	Mean and percentage decoded
Contraction/ frequent letters out	3.60 (60%)	Simple truncation	2.08 (35%)
Contraction/ vowels out	3.58 (60%)	Contraction/ frequent letters out	2.02 (34%)
Truncation/second letter out	3.46 (58%)	Truncation/second letter out	1.64 (27%)
Simple truncation	3.18 (53%)	Contraction/ vowels out	1.54 (26%)
DED	2.86 (48%)	DED	1.50 (25%)
Column mean	3.34	Column mean	1.76

Note. Means which are significantly different, $p < .05$, from each other are not bracketed together.

Table 4

Participant-Produced Abbreviations That Matched Abbreviations Produced by Each of the Five Methods

Previously seen items		Not previously seen items	
Method	Mean and percentage of matches	Method	Mean and percentage of matches
Simple truncation	2.42 (40%)	DED	3.14 (52%)
Contraction/ vowels out	2.34 (39%)	Simple truncation	2.80 (47%)
DED	2.30 (38%)	Contraction/ vowels out	1.38 (23%)
Contraction/ frequent letters out	1.02 (17%)	Contraction/ frequent letters out	1.02 (17%)
Truncation/second letter out	.22 (04%)	Truncation/second letter out	.08 (01%)
Column mean	1.66	Column mean	1.68

Note. Means which are significantly different, $p < .05$, from each other are not bracketed together.

for the five abbreviation methods and the two experience conditions. A Neuman-Keuls test for differences among mean scores showed that participants most frequently generated abbreviations which matched those produced by the DED or the simple truncation method. For previously seen terms, the contraction/vowels out method also was frequently matched. Overall, the DED approach scored well in Task C, but not in the two earlier tasks.

DISCUSSION

The results of this research strongly support simple truncation to efficiently produce a high percentage of acceptable abbreviations for use as data element codes in battlefield automated systems. In contrast, the use of abbreviations from the 1977 ARTADS Data Element Dictionary received very weak support. Participants not only preferred abbreviations produced by simple truncation, but they decoded such abbreviations more accurately than those produced by other methods. Abbreviations from the DED were less preferred and less accurately decoded than abbreviations generated by other methods. Even in the encoding task, when participants frequently generated DED abbreviations, simple truncation provided a comparable score. Clearly, simple truncation is an effective abbreviation method. However, its utility should not totally exclude the use of alternative methods or the influence of user experience on choosing abbreviations.

Alternative Abbreviations

One way to interpret the research data is to consider how abbreviations produced by alternative methods could affect the accuracy of information transfer. Task B, which required decoding, indicates how many errors users are likely to make in understanding different abbreviations. For example, 14% more errors are likely with abbreviations from the DED than with those produced by simple truncation. No method unambiguously ranks second in error reduction. However, abbreviations from the DED may cause as many as 9% more errors than abbreviations produced by contraction/vowels out and 12% more errors than abbreviations generated by truncation/second letter out. These values fluctuate for different tasks, but give some meaning to the range of performance differences from using different abbreviation methods.

Some of the abbreviations produced by simple truncation will be considered unreasonable by system designers and users. Although simple truncation did well most consistently under research conditions, its absolute success could have been better. The best results occurred in decoding (Task B), where 78% of the abbreviations produced by simple truncation were decoded correctly. Other abbreviations could be improved by avoiding simple truncation. When word endings such as "ed" and "ing" are important, for example, Nawrocki (1979) found that truncation produces many ending errors compared to contraction. Sometimes,

traditional and familiar abbreviations from the DED may be best choices. There is no substitute for good judgment in using alternative methods as supplements to simple truncation for improving the overall quality of a set of abbreviations. Reasonable alternatives would be both forms of contraction, which scored well and are good competitors for simple truncation. However, simple truncation should be accepted as the best initial approach for creating most abbreviations.

The support for simple truncation in the current research is reasonably compatible with other findings. Nawrocki's (1979) research showed that truncation produced many good abbreviations, but did not differ substantially from contraction using vowel removal. Bourne and Ford (1961b) recommended simple truncation as a good method, although they suggested that it might be improved by omitting the second letter with its "weak discriminating power." The suggestion was tested explicitly in the current research (i.e., truncation/second letter out) and did not produce better results than simple truncation. Finally, Hodge and Pennington (1973) found that participants favored simple truncation for abbreviating longer words (more than seven letters) corresponding to word lengths used in the current work.

Thus, according to Hodge and Pennington (1973), length of terms is a potentially important factor in choosing an appropriate abbreviation method. In the present experiment, the majority of terms tested (81%) were more than seven letters long. Longer terms were selected in part because they discriminate well among alternative abbreviation methods. In addition, abbreviations are most important in long words because they represent meaningful and obvious saving in the number of letters used. Finding a good abbreviation method, such as simple truncation, for longer terms as well as for some shorter ones, should solve many abbreviation problems.

User Experience

Users benefit from abbreviations which are easy to remember. Therefore, one aspect of the research looked at the effect of experience on results. The learnability of abbreviations is addressed indirectly by preference judgments (Task A). Abbreviations which are preferred are likely to be easier to remember. On a 10-point scale, abbreviations from the DED were about 2 points less popular than abbreviations produced by simple truncation and contraction/vowels out. User opinion should be considered in selecting abbreviations because it can affect system acceptability.

In a more direct test of experience, abbreviations previously seen in the preference test (Task A) were decoded in Task B more accurately than those which were not previously seen. An interesting finding was that experience improved decoding scores for simple truncation, but not as much as it improved scores for other abbreviation

methods. Even limited experience with abbreviations produced by different methods seems to reduce their statistical difference in a decoding task.

No specific effects of research experience were found on encoding in Task C, which required the creation of abbreviations. However, the high scores for DED abbreviations in only this task may be due to the military background of all participants. Participants may have relied on such "common" abbreviations when they were easier to create than potentially better alternatives. The only fair conclusion from the results is that DED abbreviations may be easily created. However, their preference ratings (Task A) and decoding scores (Task B) are inferior to other methods. Further work should be done to clarify the role that prior experience and training can have in determining efficient abbreviations for both single- and multiple-word terms.

SUMMARY AND CONCLUSIONS

Simple truncation is an easy-to-use method that generates a high proportion of consistently preferred and easily decodable abbreviations for single words. This method should benefit system designers by reducing the time needed to produce many good abbreviations for use as data element codes. Such abbreviations presumably should benefit users by reducing input time and errors in interactions with battlefield systems. However, the abbreviations produced by simple truncation are not intended to replace commonly accepted abbreviations and are not likely to be judged acceptable in all cases.

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APPENDIX A

SUMMARY OF ABBREVIATION METHODS

Eleven abbreviation methods were identified by an extensive literature search. A twelfth method was simply the set of existing abbreviations in the 1977 ARTADS Data Element Dictionary (DED). Four of the 11 non-DED methods have been defined in the main report. The other seven follow.

Contraction/Frequent Letters in Subject Words Out. Keep the first character and eliminate letters from right to left on the basis of their frequency of occurrence in subject words until the desired abbreviation length is reached. Highest frequency letters are eliminated first (Bourne & Ford, 1961a,b).

Contraction/Frequent Letters in Written English Out. Same method as above based on written English and different frequency tables (Barrett & Grems, 1960).

Contraction/Letters Out by Position Frequency in Subject Words. Same method as above based on the frequency of letter use by position (Bourne & Ford, 1961a,b).

Contraction/Letters Out by Position Frequency in Proper Names. Same method as above using proper names (Bourne & Ford, 1961a,b).

Contraction/Letters Out by Frequency and Redundancy. Keep the first letter, and from right to left eliminate all U's following Q's; then eliminate the second letter of double consonants followed by the second letter of double vowels. Further eliminate letters one at a time based on a frequency scale (Barrett & Grems, 1960) until the desired abbreviation length is achieved.

Contraction/Letters Out Using Bigram Rankings for Proper Names. Keep the first character and eliminate letters based on the frequency with which they occur in adjacent letter pairs (bigrams) for proper names. The letter on the right of a pair always is eliminated and in the case of bigrams with identical frequencies, the rightmost pair is considered first. For example, using a table of "Bigram Rankings for a Composite Sample of Proper Names" (Bourne & Ford, 1961a), the word ablation has the following ranks:

169	276	29	94	130	273	34	12
A	B	L	A	T	I	O	N	space

A score for each letter is derived by adding ranks for the two bigrams associated with letters to produce:

A	B	L	A	T	I	O	N	space
445	305	123	224	403	307	46		

By removing letters with the lowest numbers (highest frequency) the sample abbreviation becomes "ABLIO."

Contraction/Letters Out Using Bigram Rankings for Subject Words. Same method as above based on a bigram table for subject words (Bourne & Ford, 1961a).

A major factor in selecting methods for comparison with the DED was that they should produce different abbreviations for more than 50% of the items abbreviated. This constraint was essential since the candidate terms for abbreviation were limited to those presented in the DED. The constraint also meant that any two methods having extensive overlap could, in a practical sense, be represented by only one of the methods.

Two samples of one-word terms from the DED (N = 23; N = 89) were initially used to assess the amount of overlap among the 11 methods and the DED abbreviations. Five methods were eliminated because they produced more than 70% overlap. The remaining six methods plus the DED abbreviations were evaluated using a sample (N = 120) of one-word terms from the DED. Only 21% of the resulting abbreviations were unique. Two more methods were eliminated because they produced identical abbreviations for more than 50% of the tested terms. An evaluation yielded only 41% overlap among the five remaining methods. These five methods were used in the research in conjunction with a selection of 120 terms from the DED.

APPENDIX B

RESEARCH TERMS RANDOMIZED FOR TESTING FROM THE ARTADS STANDARD DATA ELEMENT DICTIONARY

Military term	Category
Telegraph	Communication/electronic equipment
Detonated	Activity
Rowboat	Vehicle
Airfield	Terrain
Probable	Evaluation of accuracy
Loudspeaker	Communication/electronic equipment
Aviation	Staff element or function
Telephone	Communication/electronic equipment
Organization	Staff element or function
Point	Area (type of)
Veterinary	Unit organization type (special)
Sprayed	Activity
Demolition	Disposition
Responsibility	Disposition
Contact	Activity
Observed	Activity
Finance	Unit organization type (special)
Surrendered	Activity
Carbine	Weapon (type of)
Restricted	Disposition
Screening	Deployment
Destroyed	Activity
Artillery	Staff element or function
Attack	Mission
Weather	Staff element or function
Rifleman	Personnel
Unconventional	Disposition
Repatriate	Personnel
Jamming	Activity
Ordnance	Unit organization type (principle)
Advance	Activity
Saboteur	Personnel
Pipeline	Terrain
Suspected	Activity
Unclassified	Security
Propaganda	Report or document
Approach	Activity
Checkpoint	Disposition
Emplacement	Terrain
Reinforcing	Support mission
Helicopter	Vehicle
Tractor	Vehicle
Switchboard	Communication/electronic equipment

Military term	Category
Microwave	Communication/electronic equipment
Special	Deployment
Translator	Collection agency
Photographic	Communication/electronic equipment
Bulldozer	Vehicle
Troops	Personnel
Infantry	Unit organization type (principle)
Withdraw	Activity
Disengage	Activity
Shotgun	Weapon (type of)
Motorcycle	Vehicle
Missionary	Personnel
Terrorized	Activity
Outgoing	Activity
Brambles	Vegetation area type
Enlisted	Personnel
Infrared	Communication/electronic equipment
Mountainous	Terrain
Helipad	Terrain
Confidential	Security classification
Captured	Activity
Depression	Terrain
Orchard	Vegetation area type
Beachhead	Disposition
Airplane	Vehicle
Shooting	Activity
Surgeon	Staff element or function
Newspaper	Report or document
Defector	Personnel
Incoming	Activity
Chaplain	Staff element or function
Security	Staff element or function
Attached	Assignment status
Vineyard	Vegetation area type
Plantation	Vegetation area type
Crashed	Activity
Church	Terrain
Strafing	Activity
Objective	Disposition
Positioned	Activity
Partisan	Personnel
Fortification	Terrain
Waterfall	Terrain
Amphibious	Vehicle
Aeromedical	Unit organization type (special)
Intercepted	Activity
Ambulance	Vehicle
Infiltrate	Activity
Automatic	Weapon (type of)
Improbable	Evaluation of accuracy

Military term	Category
Roadblock	Terrain
Neutralized	Activity
Reconnaissance	Unit organization type (special)
Reported	Activity
Battery	Communication/electronic equipment
Guerilla	Personnel
Teletype	Communication/electronic equipment
Powerline	Terrain
Sighted	Activity
Rectangle	Area (type of)
Generator	Communication/electronic equipment
Sailboat	Vehicle
Agent	Personnel
Cavalry	Unit organization type (special)
Antitank	Weapon (type of)
Unreliable	Evaluation of reliability
Counterattack	Activity
Administrative	Unit organization type (principle)
Penetrating	Activity
Strongpoint	Disposition
Chemical	Unit organization type (principle)
Troposcatter	Communication/electronic equipment
Television	Communication/electronic equipment
Cemetery	Terrain
Compressor	Vehicle
Concentrate	Activity
Envelope	Activity

APPENDIX C

INSTRUCTIONS TO PARTICIPANTS

Part I

(Preference Ratings: Task A)

In Part I, we are trying to find out how well you like different abbreviations. Please look at the example shown below:

Data item	Abbreviations	Unsatisfactory										Excellent
Personnel	PRSNL	0	1	2	3	4	5	6	7	8	(9)	10
	PEOEL	0	1	(2)	3	4	5	6	7	8	9	10
	PESEL	0	1	2	3	4	5	6	7	8	9	10
	PERSN	0	1	2	3	4	5	6	7	8	9	10
	PSONL	0	1	2	3	4	5	6	7	8	9	10

Notice the Data Item and then the list of five different abbreviations. Each of the five abbreviations is followed by a 0 to 10 scale. The Data Item is always the word that is represented by the five abbreviations next to it. YOUR TASK IS TO TELL US HOW GOOD EACH ABBREVIATION IS FOR ITS ITEM. In deciding how good an abbreviation is, ask yourself: "How clearly does the abbreviation represent (i.e., suggest) the data item?" In Example No. 1 above, we think that the abbreviation PRSNL is much better than the abbreviation PEOEL for the word personnel. The scale next to each possibility is used to rate its "goodness." The two ends of the scale are labeled 0 (unsatisfactory) and 10 (excellent) so that you know what the scale means. There are no right or wrong answers on these scales--only your opinions! Two abbreviations in the example have been rated to show you how the system works. Obviously, the 2 rating for the abbreviation PEOEL says that the rater considers it to be a very poor abbreviation; in contrast; the 9 rating for the abbreviation PRSNL shows that he thinks that it's a very good abbreviation. Circling a "0" would show that the abbreviation is completely unsatisfactory and a "10" is the best possible goodness rating that can be given. The "5" rating is the middle point--the choice which means that an abbreviation is neither good nor bad--it's in between. The other numbers are used to show how much you like an abbreviation (6,7, 8,9) or how poor you think it is (1,2,3,4). The rating for each abbreviation is up to you.

Before you work the rest of Example No. 1, here are some suggestions: Start out by trying to find an abbreviation that you really like and one that you really do not like for a particular data item. You may not always have strong feelings, but this typically is a good approach. Rate each of these abbreviations. Then, go on to the three that are left to be rated. Do not be concerned if several abbreviations seem equally good (or bad) to you. If that is the case, just circle the same number on the scale for them. When you are done with a group of five abbreviations, please check to see that each scale number reflects how good an abbreviation is compared to others in that group. If you want to change a rating, ERASE THE CIRCLE AROUND THE OLD CHOICE AND CIRCLE THE NEW CHOICE. Now, please go on and do Example No. 2 below. If there are any questions, PLEASE RAISE YOUR HAND.

Data item	Abbreviations										
threaten		Unsatisfactory									Excellent
	THREE	0	1	2	3	4	5	6	7	8	9	10
	TEAEN	0	1	2	3	4	5	6	7	8	9	10
	THRTN	0	1	2	3	4	5	6	7	8	9	10
	TEATN	0	1	2	3	4	5	6	7	8	9	10
	TREAN	0	1	2	3	4	5	6	7	8	9	10

AT THIS POINT YOU SHOULD HAVE CIRCLED FIVE NUMBERS, ONE FOR EACH OF THE ABBREVIATIONS. Ask questions by raising your hand during the task if you have any problems.

Now, rate each of the data items in Part I of the booklet. Then, go on to Part II and finally Part III. Each part has its own instructions. Remember, if you have any questions, don't hesitate to ask.

Part II

(Decoding: Task B--Cue Condition)

In this part of the research we are trying to determine how well the different abbreviations suggest the data items that they represent. An example of the materials that you will be using for this part of the study is shown below:

Abbreviation	Category	Corresponding item
APL	Fruit	

In this example the abbreviation is "APL." You are to decide what the original data item was and print it in the blocks on the right hand side of the page beneath the heading "Corresponding item." The word beneath the heading "Category" describes the type of thing or group of items that the abbreviation is part of. In this example "Fruit" means that the original data item was some kind of fruit. If you thought that the original data item was "apple" (that is that APL stands for "apple") you would print "apple" in the space provided beneath the heading "Corresponding item" and your answer would look like this:

Abbreviation	Category	Corresponding item
APL	Fruit	apple

If you don't "really know" what the original data item was then take a guess. You might be right! For each abbreviation in Part II, please write the corresponding data item. Remember that all of the items in your task will be related to military use. (Note: You will have seen some of the items earlier.) IF THERE ARE ANY QUESTIONS, PLEASE RAISE YOUR HAND. IF YOU HAVE NO QUESTIONS NOW, PLEASE TURN THE PAGE AND START.

(Decoding: Task B--No Cue Condition)

In this part of the research we are trying to determine how well different abbreviations suggest the data items that they represent. An example of the materials that you will be using for this part of the study is shown below:

Abbreviation	Corresponding item
APL	

In this example the abbreviation is "APL." You are to decide what the original data item was and print it in the blocks on the right hand side of the page beneath the heading "Corresponding item." In this example, if you thought that the original data item was "apple" (that is that APL stands for "apple") you would print "apple" in the space provided beneath the heading "Corresponding item" and your answer would look like this:

Abbreviation	Corresponding item
APL	apple

If you don't "really know" what the original data item was then take a guess. You might be right! For each abbreviation in Part II, please write the corresponding data item. Remember that all of the items in your task will be related to military use. (Note: You will have seen some of the items earlier.) IF THERE ARE ANY QUESTIONS, PLEASE RAISE YOUR HAND. IF YOU HAVE NO QUESTIONS NOW, PLEASE TURN THE PAGE AND START.

Part III

(Encoding: Task C--Cue Condition)

In the third and last part of this research, we want you to tell us how you would abbreviate the data items. An example of the materials that you will be using is shown below.

Data item	Category	Corresponding abbreviation
apple	Fruit	

The word that you are to abbreviate is beneath the heading "Data item." In this example, the data item to be abbreviated is "apple." As in part II, the word beneath the heading "Category" describes the type of thing or group of items that this particular item is part of. In this example the data item represents a fruit. You are to make up an abbreviation for the data item and write it in the string of blocks beneath the heading "Corresponding abbreviation." In this example, if you chose to abbreviate "apple" using APL your answer would look like this:

Data item	Category	Corresponding abbreviation
apple	Fruit	APL

In making up your abbreviations please keep the following rules in mind:

1. Your abbreviations must be 3 or more letters long.

2. Your abbreviation can be as long as you want it to be except that you must use less letters than the number of letters in the whole word.

3. You are to try to use the minimum number of letters possible (conciseness)--but not less than 3 letters--while at the same time trying to maximize the degree to which the abbreviation suggests the data item it represents (meaningfulness).

For each data item in Part III please write your choice for the corresponding abbreviation. Remember that all of the items in your task will be related to military use. (Note: You will have seen some of the items earlier.) IF THERE ARE ANY QUESTIONS PLEASE RAISE YOUR HAND. IF YOU HAVE NO QUESTIONS, PLEASE TURN THE PAGE AND START.--DON'T FORGET RULES 1, 2, and 3 ABOVE!!!

NOTE TO READER: Instructions for the "No Cue Condition" were identical except that the "Category" did not appear.

APPENDIX D

ANALYSIS OF VARIANCE TABLES

Table D-1

Analysis of Variance for Acceptability Ratings of Abbreviation Methods

Source of variation	df	MS	F	p
Between participants	49	4.5453		
Within participants				
Methods	4	50.6180	65.9260	.01
Residual	196	0.7678		
Total	249			

Table D-2

Analysis of Variance for Number of Abbreviations Correctly Decoded Using Liberal Scoring

Source of variation	df	MS	F	p
Between participants				
Cues	1	8.7120	1.66	NS
Groups	4	3.1670	0.60	NS
Cues x Groups	4	2.7970	0.53	NS
Error 1	40	5.2340		
Within participants				
Methods	4	9.9120	11.06	.01
Blocks of Words	4	8.3270	9.29	.01
Residual	12	1.3836	1.54	NS
Methods x Cues	4	0.6520	0.73	NS
Blocks of Words x Cues	4	4.7570	5.31	.01
Residual x Cues	12	0.7803	0.87	NS
Error 2	160	0.8965		
Experience	1	313.6320	178.14	.01
Experience x Cues	1	1.8000	1.02	NS
Experience x Groups	4	13.5570	7.70	.01
Experience x Cues x Groups	4	1.3350	0.76	NS
Error 3	40	1.7606		
Experience x Methods	4	3.0520	3.44	.025
Experience x Blocks of Words	4	11.4070	12.85	.01
Experience x Residual	12	1.1586	1.31	NS
Experience x Methods x Cues	4	1.2200	1.37	NS
Experience x Blocks of Words x Cues	4	6.9050	7.78	.01
Experience x Residual x Cues	12	2.3050	2.59	.01
Error 4	160	0.8875		
Total	499			

Table D-3

Analysis of Variance for Number of Abbreviations Correctly Decoded Using Strict Scoring

Source of variation	df	MS	F	p
Between participants				
Cues	1	6.5000	1.35	NS
Groups	4	3.1750	0.66	NS
Cues x Groups	4	2.8525	0.59	NS
Error 1	40	4.8160		
Within participants				
Methods	4	5.2750	5.33	.01
Blocks of Words	4	8.4450	8.53	.01
Residual	12	0.9933	1.00	NS
Methods x Cues	4	1.0925	1.10	NS
Blocks of Words x Cues	4	0.6225	0.63	NS
Residual x Cues	12	0.4316	0.44	NS
Error 2	160	0.9897		
Experience	1	312.0500	144.74	.01
Experience x Cues	1	11.2500	0.58	NS
Experience x Groups	4	4.0250	1.87	NS
Experience x Cues x Groups	4	1.1650	0.54	NS
Error 3	40	2.1560		
Experience x Methods	4	3.4250	3.52	.01
Experience x Blocks of Words	4	26.2250	26.91	.01
Experience x Residual	12	1.5833	1.62	NS
Experience x Methods x Cues	4	0.4450	0.46	NS
Experience x Blocks of Words x Cues	4	5.3450	5.48	.01
Experience x Residual x Cues	12	0.7066	0.72	NS
Error 4	160	0.9747		
Total	499			

Table D-4

Analysis of Variance for Number of Abbreviations That Conform to Abbreviations Produced by the Five Methods

Source of variation	df	MS	F	p
Between participants	49	2.62		
Within participants				
Methods	4	116.40	42.85	.01
Error 1	196	2.72		
Experience	1	0.39	0.43	NS
Error 2	49	0.90		
Methods x Experience	4	11.26	9.62	.01
Error 3	196	1.17		
Total	499			

DISTRIBUTION

ARI Distribution List

4 OASD (M&RA)
2 HQDA (DAMI CSZ)
1 HQDA (DAPE PDR)
1 HQDA (DAMA AR)
1 HQDA (DAPE HRE PO)
1 HQDA (SGRD ID)
1 HQDA (DAMI DOT C)
1 HQDA (DAPC PMZ A)
1 HQDA (DACH PPZ A)
1 HQDA (DAPE HRE)
1 HQDA (DAPE MPO C)
1 HQDA (DAPE DW)
1 HQDA (DAPE MRE)
1 HQDA (DAPE CPS)
1 HQDA (DAFD MFA)
1 HQDA (DARD ARS P)
1 HQDA (DAPC PAS A)
1 HQDA (DAMA OR)
1 HQDA (DAMO RQR)
1 HQDA (DASG)
1 HQDA (DA IG PI)
1 Chief Consult Div (DA OTSG) Adelphi MD
1 Mil Asst Hum Res (ODDR&E OAD (E&LS)
1 HQ USARAL APO Seattle ATTN ARAGP-R
1 HQ First Army ATTN AFKA OI TI
2 HQ Fifth Army Ft Sam Houston
1 Dir Army Stf Studies Ofc ATTN OAVCSA (DSP)
1 Ofc Chief of Stf Studies Ofc
1 DCSPER ATTN CPS OCP
1 The Army Lib Pentagon ATTN RSB Chief
1 The Army Lib Pentagon ATTN ANRAL
1 Ofc Asst Sec of the Army (R&D)
1 Tech Support Ofc OJCS
1 USASA, Arlington ATTN IARD T
1 USA Rsch Ofc Durham, ATTN Life Sciences Dir
2 USARIEM Natick ATTN SGRD UE CA
1 USALEC Ft Clayton ATTN ATTC MO A
1 USAIMA Ft Bragg ATTN ATSU CTD OM
1 USAIMA Ft Bragg ATTN Marquat Lib
1 US WAC Ctr & Sch Ft McClellan, ATTN Lib
1 US WAC Ctr & Sch, Ft McClellan ATTN Trng Dir
1 USA Quartermaster Sch Ft Lee ATTN ATSM TE
1 Intelligence Material Dev Ofc EWL, Ft Holabird
1 USA SE Signal Sch Ft Gordon ATTN ATSO EA
1 USA Chaplain Ctr & Sch Ft Hamilton ATTN ATSC TE RD
1 USATSCH Ft Eustis ATTN Educ Advisor
1 USA War College Carlisle Barracks ATTN Lib
2 WRAIR, Neuropsychiatry Div
1 DLI, SDA Monterey
1 USA Concept Anal Agcy Bethesda, ATTN MOCA MR
1 USA Concept Anal Agcy Bethesda, ATTN MOCA JF
1 USA Arctic Test Ctr, APO Seattle, ATTN STE AC PL MI
1 USA Arctic Test Ctr, APO Seattle, ATTN AMSTE TL TS
1 USA Armament Cmd Redstone Arsenal, ATTN ATSK-TEM
1 USA Armament Cmd, Rock Island, ATTN AMSAR TDC
1 FAA NAFEC Atlantic City, ATTN Library
1 FAA NAFEC, Atlantic City, ATTN: Human Engr Br
1 FAA Aeronautical Ctr, Oklahoma City, ATTN AAC 44D
2 USA Fld Arty Sch, Ft Sill, ATTN Library
1 USA Armor Sch, Ft Knox, ATTN Library
1 USA Armor Sch, Ft Knox, ATTN ATSB DI E
1 USA Armor Sch, Ft Knox, ATTN ATSB DT TP
1 USA Armor Sch, Ft Knox, ATTN ATSB CD AD
2 HQUSACDEC Ft Ord, ATTN Library
1 HQUSACDEC, Ft Ord ATTN ATEC EX F Hum Factors
2 USAEEC Ft Benjamin Harrison ATTN Library
1 USAPACDC, Ft Benjamin Harrison ATTN ATCP HR
1 USA Comm Elect Sch Ft Monmouth ATTN ATSN EA
1 USAEC Ft Monmouth ATTN AMSEL CT HDP
1 USAEC, Ft Monmouth ATTN AMSEL PA P
1 USAEC, Ft Monmouth ATTN AMSEL SI CR
1 USAEC, Ft Monmouth ATTN C, Facl Dev Br
1 USA Materials Sys Anal Agcy Aberdeen ATTN AMXSY P
1 Edgewood Arsenal Aberdeen ATTN SAREA BL H
1 USA Ord Ctr & Sch Aberdeen, ATTN: ATSL TEM C
2 USA Hum Engr Lab Aberdeen ATTN Library/Dir
1 USA Combat Arms Trng Bd, Ft Benning ATTN Ad Supervisor
1 USA Infantry Hum Rsch Unit, Ft Benning, ATTN Chief
1 USA Infantry Bd, Ft Benning, ATTN STEBC TE T
1 USASMA Ft Bliss ATTN: ATSS LRC
1 USA Air Def Sch Ft Bliss, ATTN ATSA CTD MF
1 USA Air Def Sch Ft Bliss, ATTN Tech Lib
1 USA Air Def Bd Ft Bliss ATTN FILES
1 USA Air Def Bd Ft Bliss, ATTN STEBD PO
1 USA Cmd & General Stf College Ft Leavenworth, ATTN Lib
1 USA Cmd & General Stf College Ft Leavenworth ATTN ATSW-SE L
1 USA Cmd & General Stf College Ft Leavenworth ATTN Ed Advisor
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth ATTN DepCdr
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: CCS
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCASA
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN ATCACO-E
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACC-CI
1 USAECOM Night Vision Lab, Ft Belvoir ATTN AMSEL-NV-SD
3 USA Computer Sys Cmd, Ft Belvoir, ATTN Tech Library
1 USAMERDC Ft Belvoir ATTN STSFB DQ
1 USA Engr Sch Ft Belvoir, ATTN Library
1 USA Topographic Lab Ft Belvoir ATTN ETL TD-S
1 USA Topographic Lab Ft Belvoir ATTN STINFO Center
1 USA Topographic Lab Ft Belvoir, ATTN ETL GSL
2 USA Intelligence Ctr & Sch Ft Huachuca, ATTN CTD MS
1 USA Intelligence Ctr & Sch, Ft Huachuca ATTN ATS C-D-MS
1 USA Intelligence Ctr & Sch Ft Huachuca ATTN ATSI-TE
1 USA Intelligence Ctr & Sch, Ft Huachuca ATTN ATSI TEX GS
1 USA Intelligence Ctr & Sch, Ft Huachuca ATTN ATSI CTS-OR
1 USA Intelligence Ctr & Sch Ft Huachuca, ATTN ATSI-CTD DT
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI CTD CS
1 USA Intelligence Ctr & Sch Ft Huachuca ATTN DAS/SRD
1 USA Intelligence Ctr & Sch Ft Huachuca ATTN ATSI TEM
1 USA Intelligence Ctr & Sch Ft Huachuca, ATTN Library
1 CDR HQ Ft Huachuca ATTN Tech Ref Ctr
2 CDR, USA Electronic Prvg Grd ATTN STEEP MT S
1 HQ, TCATA, ATTN Tech Library
1 HQ, TCATA, ATTN ATCAT OP Q, Ft Hood
1 USA Recruiting Cmd, Ft Sheridan, ATTN USARCPM P
1 Senior Army Adv, USAFAGOD/TAC, Elgin AF Aux Fld No 9
1 HQ, USARPAC, DCSPER, APO SF 96558, ATTN: GPPE SE
1 Stimson Lib, Academy of Health Sciences, Ft Sam Houston
1 Marine Corps Inst, ATTN: Dean MCI
1 HQ, USMC, Commandant, ATTN Code MTMT
1 HQ, USMC, Commandant, ATTN Code MPI 20 28
2 USCG Academy New London, ATTN Admis-Off
2 USCG Academy, New London, ATTN Library
1 USCG Training Ctr, NY, ATTN CO
1 USCG Training Ctr, NY, ATTN Educ Svc Ofc
1 USCG, Psychol Res Br, DC, ATTN GP 1/62
1 HQ Mid Range Br, MC Det, Quantico, ATTN PS&S Div

1 US Marine Corps Liaison Ofc, AMC, Alexandria, ATTN: AMCGS-F
1 USATRADOC, Ft Monroe, ATTN ATRO-ED
6 USATRADOC, Ft Monroe, ATTN: ATPR AD
1 USATRADOC, Ft Monroe, ATTN: ATTS-EA
1 USA Forces Cmd, St McPherson, ATTN Library
2 USA Aviation Test Bd, Ft Rucker, ATTN: STEBG-PO
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN Library
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Educ Advisor
1 USA Aviation Sch, Ft Rucker, ATTN PO Drawer O
1 HQUSA Aviation Sys Cmd, St Louis, ATTN: AMSAV-ZDR
2 USA Aviation Sys Test Act, Edwards AFB, ATTN SAVTE-F
1 USA Air Def Sch, Ft Bliss, ATTN ATSA TEM
1 USA Air Mobility Rsch & Dev Lab, Moffett Fld, ATTN: SAVDL AS
1 USA Aviation Sch, Res Trng Mgt, Ft Rucker, ATTN: ATST-T-RTM
1 USA Aviation Sch, CO, Ft Rucker, ATTN ATST-D-A
1 HQ, DARCOM, Alexandria, ATTN AMXCD-TI
1 HQ, DARCOM, Alexandria, ATTN CDR
1 US Military Academy, West Point, ATTN Serials Unit
1 US Military Academy, West Point, ATTN: Ofc of Milt Ldrshp
1 US Military Academy, West Point, ATTN: MAOR
1 USA Standardization Gp, UK, FPO NY, ATTN MASE-GC
1 Ofc of Naval Rsch, Arlington, ATTN Code 452
3 Ofc of Naval Rsch, Arlington, ATTN Code 458
1 Ofc of Naval Rsch, Arlington, ATTN: Code 450
1 Ofc of Naval Rsch, Arlington, ATTN Code 441
1 Naval Aerospc Med Res Lab Pensacola, ATTN Acous Sch Div
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