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A STUDY OF THE DESERET TEST CENTER
TECHNICAL LIBRARY

Maury Wintle Schooff

United States
Naval Postgraduate School



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A STUDY OF THE DESERET TEST CENTER

TECHNICAL LIBRARY

by

Maury Wintle Schooff

April 1970

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A Study of the Deseret Test Center

Technical Library

by

Maury Wintle Schooff
Major, United States Army
B.S., Utah State University, 1959

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

From The

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ABSTRACT

The operations of the Deseret Test Center Technical Library, an element of the Information Analysis Branch, were examined. Measures of effectiveness for the Branch and Library were proposed and the advantages and disadvantages of having microform in the Library's holdings were discussed. The design, administration and results of a Technical Information Services Questionnaire were presented and selected questions from the Questionnaire were subjected to analysis using attitude scaling techniques. The growth of the Library's collection was modeled as a linear regression model and the number of years remaining until the Library reached capacity was determined. Holding policies for present holdings and future acquisitions were proposed to provide additional space for future growth. Considerations for equipment necessary to utilize the microform holdings were detailed and a distribution of microform readers was proposed based on the results of modeling reader use as a finite population, many server queueing problem.

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I. INTRODUCTION

This study is concerned with operations of the Technical Library at the Deseret Test Center, a research facility located in Utah. The material presented in this section will state the purpose of the study, define some terms peculiar to libraries, discuss the background of the organization being examined and briefly outline a previous library study.

A. PURPOSE OF THE STUDY

The purpose of this study was to analyze the operations of the Deseret Test Center Technical Library and to recommend policies and procedures that would insure that the library's holdings would continue to provide the patron with the level of service to which he has become accustomed. The problem underlying the stated purpose was to determine if inclusion of microfilm records in quantity to the library holdings would provide the patron with a level of service while providing the library with needed space for expansion.

B. DEFINITIONS OF TECHNICAL TERMS

Several terms, peculiar to libraries, will be used throughout this study and should be specifically defined to avoid confusion later.

These terms are:

Microform: (noun): a generic term referring to any miniaturized form containing microimages.

Microfilm: (noun): any transparent photographic film in roll, strip or scroll form containing negative or positive microreproductions of graphic records. Presently, both 16mm and 35mm film are being used.

Both are stored in the small casset cannisters common to 35mm photographic film with each casset containing one document. Longer strips are stored on reels that are 3 3/4 inches in diameter.

Microfiche: (noun): any transparent photographic film in flat form containing multiple negative or positive microreproductions of graphic records arranged in a grid pattern by rows. There are many sizes of microfiche but the one currently in use by the government is approximately four-by-six inches. The common format has up to 58 microimages, each image being one page of the original document, on the first fiche and up to 70 microimages on succeeding fiche.

Microform reader: (noun): a devise used to enlarge and to project a microimage onto a screen for viewing by the user. Some readers have the additional capability of producing a hard copy of any microimages. Readers with this capability are called microform reader/printers or reader/printers.

C. BACKGROUND

To understand the peculiarities of the library at Deseret Test Center, it is necessary to appreciate the history, the organization and the missions of the Center. This is accomplished below by first discussing briefly the history of DTC, its organization and some of its functions or missions. Next specifics of the Information Analysis Branch, the results of a library study previously conducted; and a discussion of the meaning of the so called "information explosion" will be presented.

1. History, Organization and Missions of DTC

Deseret Test Center was organized at Fort Douglas, Utah in May 1962 as a Class II activity under the jurisdiction of the Chief

Chemical Officer of the Army. In August 1962 with the disestablishment of the Office of the Chief Chemical Officer, the jurisdiction for DTC was transferred to the Army Material Command, where it remains today. A notable addition was made to the Center in July 1968 when Dugway Proving Grounds, a large test site located approximately ninety miles southeast of Fort Douglas, was merged with DTC. The organizational chart of the Center, as of March 1969, is shown as figure 1. Ref. 1

The main headquarters of the Center, located at Fort Douglas, consists of the command group and portions of each staff office. At Dugway Proving Grounds are the research and testing facilities as well as the remaining portion of each staff office. The physical separation of the two elements of the Center causes some difficulty in coordination and supervision. These problems are being overcome through transfer of responsibility and personnel.

The missions or functions of Deseret Test Center include:

a. Collection, analysis and correlation of chemical and biological (CB) test requirements submitted by the military services.

b. Preparation of CB test plans.

c. The planning, coordination, scheduling and conduct or support of CB tests.

d. Evaluation of test data, preparation and distribution of test reports.

e. Engaging in research, development, laboratory and field tests and investigations to support the functions of the command.

These activities cover such peripheral areas as meteorology, ecology, epidemiology and test technology.

f. Serving as the joint contact point for the collection, publication and maintenance of the CB Technical Source Book. [Ref. 1]

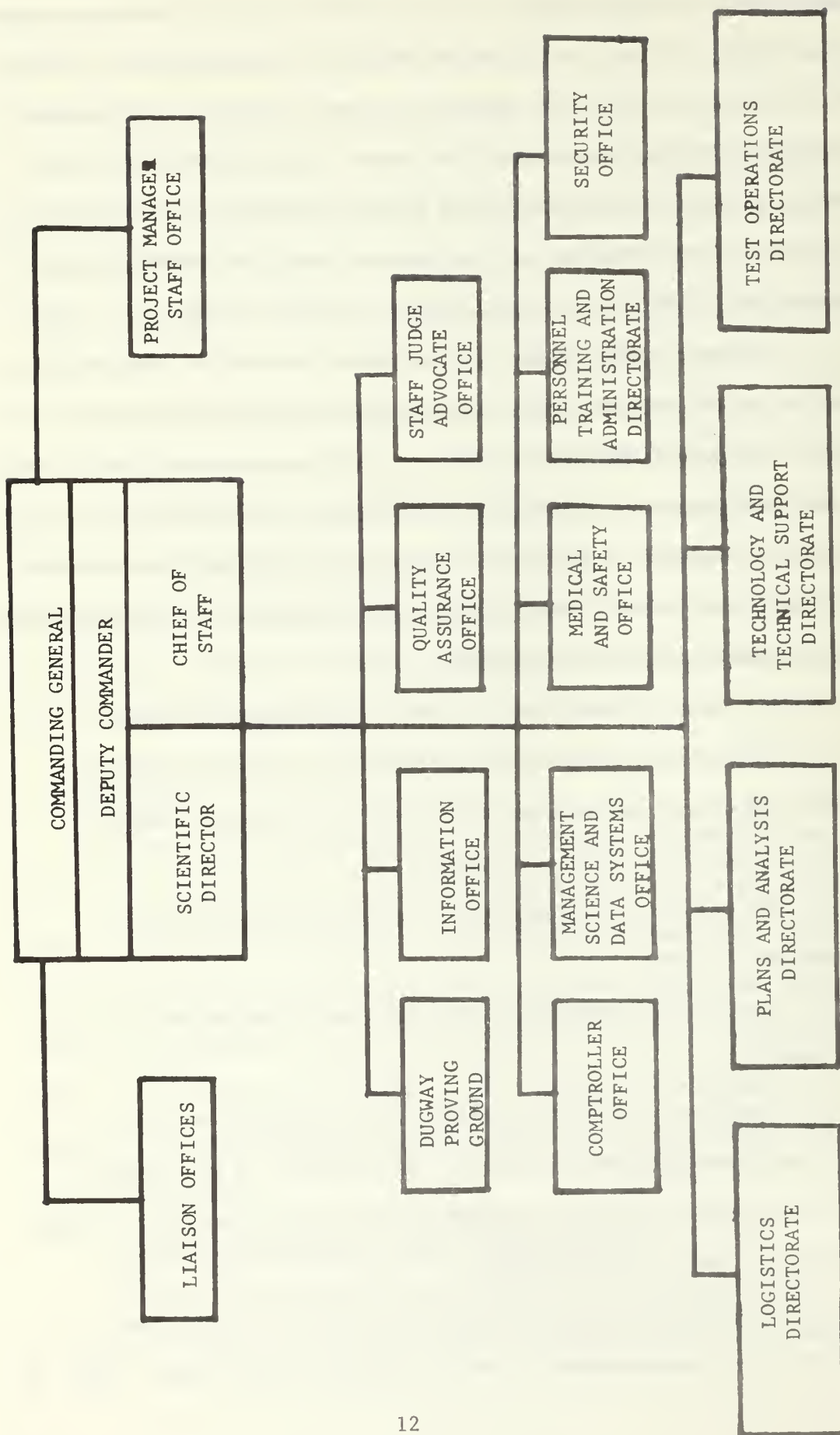


Figure 1

2. The Information Analysis Branch

The Information Analysis Branch, part of the Joint Contact Point Division of the Technology and Technical Support Directorate, is located both at Fort Douglas and at Dugway Proving Grounds. The functions of the branch are to:

- a. Receive and process requirements for CB technical information submitted by the CB community.
- b. Collect, screen and evaluate CB weapons and defense systems testing information generated by the CB community, Quadrapartite and other friendly countries and integrate the information into a dynamic technical data repository.
- c. Collect, screen and assess CB field testing information from intelligence sources.
- d. Determine the requirements for and provide an adequate storage and retrieval system for the dynamic technical data repository.
- e. Maintain liaison with the Defense Documentation Center and the CB community.
- f. Provide a technical library automated to facilitate ready location of information to support the dynamic technical data repository. [Ref 1]

The major concern of this thesis is with the last function - the maintainance of a technical library. Presently, the branch operates a small library facility at Fort Douglas and a larger facility at Dugway.

The facility at Fort Douglas consists mainly of classified and unclassified technical reports, test plans, and related material. There is a section set aside where current periodicals of the various

technical disciplines represented in the command are displayed; however no bound periodicals are retained. A small collection of technical books and military manuals has been established. The patrons, here, are mostly administrators or those who are concerned with either pure or applied research into the more basic sciences related to CB technology.

The Dugway facility has been established longer than the one at Fort Douglas and parallels more closely the traditional technical library. The collection here includes classified and unclassified technical reports, laboratory notebooks, current and bound periodicals, and a rather extensive collection of technical books. The Dugway patron is a scientist concerned with pure or applied research in the areas of chemistry, biology, ecology, epidemiology, meteorology, physiology, palenatology, geology, becteriology and other such areas.

There is interest at both locations for material located at the other facility. Resultantly, there is an interchange of material from one location to the other. This is accomplished by a courier service provided on a twice a day basis by the Personnel, Training and Administration Directorate. Material requested one day is generally received by the requesting facility the next day.

3. Previous Library Study

Anyone looking at the organization of the Information Analysis Branch with its two library facilities would suspect that there must be some duplication of effort as well as duplication of material. The next logical step would be to suggest combining the two facilities to produce a monetary savings. However, one must consider the distance factor as well as the monetary savings before drawing a firm conclusion on the propriety of maintaining two facilities.

In November 1968, the Commanding General of DTC directed that a study be conducted to determine where the consolidation of the two facilities should take place. This statement implied that consolidation of the two facilities was a foregone conclusion and not open to discussion.

The ad hoc committee appointed to accomodate the commander's request attacked the problem by interviewing those division chiefs who had an interest in the Technical Library and by interviewing individuals selected at random. Little is recorded concerning the nature and results of these interviews. Some data concerning the space availability at each facility, the size of each collection and other physical parameters was gathered. However, the study was careful to indicate that a decision cannot be made on these physical parameters alone.

As a conclusion to the study, the committee recommended consolidating the resources of the two library facilities at Dugway; establishing a reading room at Fort Douglas; and expanding the mission of the Library. Little was said about the decision process that led to these conclusions. The general tone of the study was that of "Yes, Sir!". In other words, the committee was biased from the start toward consolidation and failed to investigate thoroughly those areas that might have countered a recommendation for consolidation.

After the report was submitted, there were lengthy rebuttals by those who felt that the decision to consolidate needed to be justified. These rebuttals, while slightly histrionic, are based on experience with operations of the Library and on the premise that the Library must be readily available to all patrons to truly be effective. They stress that the committee failed to consider certain library

improvements that were in progress and that were designed to overcome the patron's frequent objection that the system could not provide material on a timely basis.

In February 1969, after weighing the study against the rebuttals, the general directed that the two facilities be consolidated. This directive was interpreted by those responsible for its implementation to mean consolidation of certain administrative operations and responsibilities, not consolidation of holdings. [Ref. 2]

During June of 1969, there was some talk of physically consolidating the holdings of both facilities at Fort Douglas but this plan was abandoned.

For the purpose of this thesis, it will be assumed that the interpretation of the general's directive to consolidate was correct and thus there will be two library facilities in the command. It will be seen that without this assumption, this study would be meaningless since any recommendations for policies relating what to hold or retain in the library as well as predictions on space availability would be hollow and, possibly, conflicting depending on where the physical consolidation was to take place.

4. Special Considerations

What is the impact of the so called "information explosion" on a technical library? Certainly, the amount of information being published in the form of books, reports, periodicals and the like is increasing rapidly each year. This growth has not and should not alter the traditional characterization of a library as a highly organized, neatly ordered and systematically arranged collection of books, bound and loose periodicals, and reports. To the infrequent

patron to a library, the obvious change is that the librarian and his staff are not able to pinpoint the single item in the library's collection that answers the patron's specific question. Rather the staff must point the patron to an area of the library and allow him to dig and delve for his answer. An alternative to this method is for the library staff to conduct a bibliographic search of the collection using some automated means to determine those items of the collection that would satisfy the patron's needs.

Implied in what has just been stated is that the library must be a dynamic organization. No longer can the librarian be tied to archaic time-consuming procedures. The librarian must plan where all the newly acquired material is to be shelved and what open areas are to be eliminated to make room for more material while still maintaining the classical ordering of the library. But, of even more importance, is the problem of providing the patron with a level of service equivalent to that of the older, smaller facility where the librarian knew exactly where everything was.

Of course, all the innovations must be constrained either by the physical size of the library or by budget. Space soon becomes critical. When one considers that the Defense Documentation Center, the central facility of the Department of Defense for processing and distributing scientific and technical reports of Defense sponsored research, developments, test and evaluation efforts, process in excess of 50,000 new documents yearly, one quickly concludes that the librarian must have a dynamic program for storing the subject of these reports of concern to the supported facility. Additional space can be made available, when all shelves are filled, in three basic ways;

(1) by building a new and bigger facility; (2) by reducing the amount of reading rooms, aisle and work space; (3) by being a heretic to tradition and incorporating miniaturized or microformed records into the collection. The first alternative, a new facility, is generally out of the question because of cost factors. The second, reducing open spaces, provides a very short run solution to the problem and when all open spaces have been reduced to a minimum provides no solution. The last alternative, microform is not the panacea but does provide a major space savings. This will be discussed throughout this paper.

The information retrieval problem, providing the patron with the material that will satisfy his needs, is being solved through computer based bibliographic search systems. These systems provide the capability of matching a patron's area of interest, expressed as a combination of key words and Boolean operators, with those holdings in the library pertaining to the area of interest. Some systems provide only a list of the reports of interest while others go further and also provide an abstract of each reference. The object of these systems, then, is to relieve the librarian of knowing what is contained in each document in the library's holdings.

To answer the question posed at the beginning of this section, the impact of the information explosion is to force librarians to become innovators by appealing to their professional pride and the desire to provide the patron with the best possible service.

II. MEASURES OF EFFECTIVENESS FOR THE INFORMATION ANALYSIS BRANCH

It was noted earlier that the Technical Library at Deseret Test Center is an element of the Information Analysis Branch, Joint Contact Point Division, and thus, any standards of performance or measures of effectiveness for the library must be expressed in terms of the Branch, the lowest level of structure in the command.

When the research for this study was accomplished, in May and June 1969, there were no established measures of effectiveness for the Branch and, resultantly, no operating rules for the library. One of the initial actions taken during the research phase was to propose effectiveness measures for approval of the Branch chief in order to provide structure for the larger problem of optimizing holdings.

The product of the Information Analysis Branch is service to the patrons. Its real function is support of the scientists, engineers, and administrators who are directly involved with accomplishing the overall goals of DTC. The support provided by the Branch is timely and adequate information. It is realized that the scientist or engineer will use only that information readily available to him; that is to say, he will use whatever he can find quickly. This condition does not always lead to use of the best information but does emphasize the necessity of having a responsive information system to support the scientist or engineer. DTC has been moving toward a responsive system. In early 1969 they contracted with Planning Research Corporation to develop an in-house capability of producing a bibliography for those areas of interest to DTC research personnel. This system utilizes a thesaurus of more than 70,000 words and chemical compound names with an

initial bibliography of 10,000 documents in DTC Document Bank. This bank is being expanded to include the material at all research agencies with a mission that overlaps or relates to the DTC missions as well as to include material available through DDC. Further, it is planned to incorporate the contents of the Technical Abstracts Bulletin, the periodical published by DDC listing all new government related publications, that relate to DTC into the bank within a few days of its publication. When completely operational, this bibliographic search system will provide a tremendous assist to the Branch in supporting the patron with timely and adequate information.

At present, the Branch has established the unwritten policy of processing requests for information on the same day received. Requests may require ordering documents from DDC, obtaining bibliographic searches from DDC or Medical Literature Analysis and Retrieval System (MEDLARS), arranging interlibrary loans, or obtaining copies of periodical articles available from the University of Utah Library. This policy has resulted in increased library usage simply because patrons realize that they will get the information they need in a timely manner.

The measures of effectiveness listed below resulted from the modification of the initial measures submitted to the Information Analysis Branch Chief. Following each measure is a brief justification of that measure.

A. In-HOUSE BIBLIOGRAPHIC SEARCH

Within 24 hours of receipt of a request for a bibliographic search from a patron in DTC, the Information Analysis Branch will provide the patron with a bibliographic listing of all documents relating to the

patron's subject area that are in the DTC Document Bank. Additionally, the Technical Library will provide either the document or an abstract for 90% of the items in the bibliographic listing that are in the holdings of the DTC Technical Library. Emphasis will be on providing documents. Abstracts will be provided only when the document is not readily available.

Measure A reflects the bibliographic search capability being developed under contract by the Planning Research Corporation and which is designed to produce a bibliographic listing, using the in-house computer, of documents related to a patron's area of interest. The system was expected to be operational by September 1969. The 24 hour time factor reflects the anticipated computer schedule of one bibliographic search run daily. Additionally, very few short fuzed projects are received by the headquarters, thus the productive effort would not suffer because of a 24 hour delay in receiving the results of a search. With only one exception, the patrons surveyed felt that their productive effort would not be unfavorably affected by this 24 hour dealy. The 90% level for providing documents and abstracts to the patron is the upper bound on this service. Presently, a 50% level is probably the maximum attainable level since establishment of an abstract file has not been accomplished.

B. OUT-OF-HOUSE BIBLIOGRAPHIC SEARCH

If the results of an in-house bibliographic search are inadequate for the patron's needs, the patron will be provided a more detailed bibliography of documents in the holdings of either the Defense Documentation Center (DDC) or the Medical Literature Analysis and Retrival System (MEDLARS). Searches from DDC will be provided within six

working days and will include abstracts while a search from MEDLARS will be provided within ten working days. Those documents available locally will be provided, on request, within 24 hours. Other documents will be obtained through interlibrary loan, requisition from DDC or purchase from publisher and will be provided upon receipt at the Technical Library.

Measure B concerns bibliographic searches that would be made should a patron consider the in-house search inadequate for his needs. Certain specialized areas peripheral to the CB field will have only limited references in the document bank; thus to obtain an adequate bibliography for these areas, it may be necessary to utilize the resources of the Defense Documentation Center, DDC, at Alexandria, Virginia, or of the Medial Literature Analysis and Retrieval System, MEDLARS, with regional office at Denver, Colorado. The time delay for DDC reflects the usual airmail time between Salt Lake City and Alexandria with a day added for processing. The MEDLARS delay reflects the airmail time plus a processing delay of five days since MEDLARS makes searches only one day a week. The 24 hour delay for providing documents in the DTC Technical Library results from the time necessary to collect the documents from library storage. It is difficult to quantify the times that will be required to obtain materials from sources outside DTC.

C. PATRONS OUTSIDE DTC

For requests from patrons outside DTC, a bibliographic search of documents in DTC Document Bank will be accomplished within 24 hours and forwarded to the patron by airmail. It is the patron's responsibility to initiate action to acquire any document listed in the search.

Measure C concerns accomplishment of searches for patrons not in DTC, and considers the anticipated once-a-day batch processing of bibliographic searches by the computer facility.

D. HOLDING DOCTRINES

To assist the Joint Contact Point Division in accomplishing its CB focal point mission and to support the dynamic technical repository, the Technical Library will attempt to maximize the number of classified and unclassified documents, periodical subscriptions and books in its holdings in the fields of chemistry, biology, physiology, paleontology, medicine, geology, ecology, meteorology, microbiology, mycology, bacteriology, epidemiology, parasitology, virology, mathematics, statistics, physics, applied engineering, safety, and data processing as they relate to chemical and biological warfare in its broadest context. The holdings will include all documents and technical reports generated by DTC and will favor, heavily, documents resulting from government sponsored or government conducted research, development, test and evaluation efforts that relate to chemical and biological warfare. Pertinent abstracts of periodicals and defense produced or sponsored technical reports will also be provided. These requirements must be constrained by 3645 linear feet of storage space.

This measure is based on the functions of the Information Analysis Branch as outlined in Chapter 6 of DTC Pamphlet 10-1 with Change 1 and on discussions with the personnel of the Branch. It pertains directly to the purpose of this study and is consistent with the requirement established by Army Materiel Command that DTC serve as the focal point for CB information. The shelf space constraint is the actual shelf space now available at both facilities.

III. TRADEOFF CONSIDERATIONS BETWEEN MICROFORM AND HARD COPY

Since its inception, microform has been suggested as a logical replacement for hard copy in library collections and much has been recorded as to the pros and cons of such a replacement. Those librarians of the classical era consider such a suggestion as heresy. Others, whose esthetic sense overrides their common sense, object to microform because they cannot visualize themselves curled up in their favorite chair in front of the fire with a microform reader in their lap. One specific advocate of hard copy, Harold Wooster of the Air Force Office of Scientific Research, has gone so far as to propose development of what he calls a "cuddly microfiche reader." [Ref 3] His reader is given such characteristics as portable, personal, and, of course, cuddly. While his suggestions have merit, the approach tends to alienate readers desiring to critically evaluate the pros and cons of microform as a replacement for hard copy. What follows is, hopefully, a less emotional condensation and consolidation of the stated advantages and disadvantages of microform.

A. ADVANTAGES OF MICROFORM

The primary advantage of microform over hard copy is the savings of shelf space resulting from exchanging a hard copy document that is an inch or more thick for a few sheets or a short strip of photographic film. For microfiche, physical measurements showed that, on the average, 33 technical reports could be stored in one inch of shelf or drawer space. Contrast this with measurements for hard copy technical reports where three feet of shelf or drawer space are required to store

about 120 reports. With microfiche, it might be possible to reduce the vertical space between shelves thus providing more shelves in a given vertical plane than for hard copy reports since the standard government fiche is four inches tall. Disregarding this possibility, and translating microfiche per inch to microfiche per foot, it would be possible to store over 1100 documents reduced to microfiche on a three foot shelf. For microfilm, short documents are usually stored individually in cassetts that are $1\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inches high. On a three foot long shelf that is 12 inches deep, with cassetts arranged one high and eight deep, 112 documents, approximately the same number as in hard copy, 120, could be stored. Considering the vertical distance between shelves is 12 inches as a minimum and piling cassetts on top of each other, 896 documents could be stored on a shelf. Longer documents in microform are wound usually on reels that are stored in boxes $3\frac{3}{4}$ inches square by $1\frac{1}{2}$ inches wide. Thus, on a shelf three feet long, 12 inches deep and 12 inches from the shelf above, 336 documents could be stored. This method of using reels is used only for the longer documents so comparison with an average of 120 hard copy documents occupying the same shelf space cannot be directly correlated. Regardless of the storage method, the saving is appreciable varying from the reduction of $\frac{1}{3}$ for reel type containers to $\frac{1}{10}$ for fiche.

A second advantage for using microform in government sponsored libraries is that copies of reports obtained as secondary distribution from DDC are provided free of cost to the requester while a charge of \$3.00 per document is levied for hard copies. For the DTC Library that requests an average of 30 reports monthly, the direct savings is \$90.00 which would nearly pay the purchase price of a good microform reader costing approximately \$100.00.

Microform also serves as a means of preserving rare materials and as a means of simply and economically reproducing this rare material. This advantage is secondary to an agency that sends copies of all reports to DDC but is a prime consideration in research facilities for storing laboratory notebooks, test data and the like.

Other advantages include simplification and cost reduction of mailing documents. For microfiche, this means putting a fiche in an envelope and mailing as opposed to wrapping a hard copy document. Also, microform saves the cost of binding loose periodicals or reports when these are to be retained. [Ref. 4, 5, 6, 7]

B. DISADVANTAGES OF MICROFORM

To the patron a disadvantage of microform is that only the title and some administrative information can be read with the unaided eye. This necessitates having microform readers readily available in all work areas so that a person desiring to review a microform can do so quickly and conveniently.

Implied in the disadvantage above is a second disadvantage, that of the initial cost of procuring a microform system. For the system to be accepted by the patrons, sufficient readers must be available to reduce user inconvenience. A better than average reader available through government supply channels costs about \$100.00.

The problem of remarking classified documents is always a problem to a library staff, but for documents on microform it is even more of a problem. For hard copy material, the usual procedure in downgrading is to mark out the classification marking at the top and bottom of each page and write in the new classification. There is no comparable way presently available to do this to microform documents. Generally, all

that is done is to remark the classification on the container and on the portion of the microform that is readable with the unaided eye.

Discussions of the advantages and disadvantages of microform written several years ago listed the problem of eye fatigue as a drawback to a microform system. This fatigue or eyestrain resulted from reading the white on black image of the microform reader. The newer readers have decreased this problem by using brighter illuminating devices and more responsive screens. Personal experience of using a reader nearly continuously for a full work day coupled with discussions with frequent users of microform readers indicates that the new readers have overcome this problem quite well. [Ref 4, 5, 6, 7]

C. DISCUSSION

To make a global comparison between the advantages and disadvantages of microform would be foolhardy since each library must weigh each factor according to their needs and problems.

To make a comparison for the DTC Library is less risky and, in fact, quite valueable. Space is a prime problem at DTC. A weeding program to eliminate seldom used material is of questionable value since the chemical-biological warfare field has been cyclic in the past. Material with a low demand today may suddenly become in great demand as the research cycle returns to that field. Couple this with the mission of being a repository for CB information and the magnitude of the amount of material that must be held by DTC becomes staggering. To store what must be obtained and what will be generated in years to come will require space. Consider also, that DTC is fairly young and has not received initial distribution of much of the material that it will need. Implied here is a cost of procuring this needed material.

The costs of purchasing hard copies at \$3.00 a copy soon becomes formidable. Applying the savings generated by obtaining microform to the purchase of microform readers results in a continually improving microform system and serves to counter the disadvantage of patron inconvenience. No handy solution is available to the reclassification problem. Despite this fact, the advantages of incorporating microform into the holdings of the DTC Library far outweigh any and all disadvantages.

IV. TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

During the initial design of this study, it was determined that information concerning the users familiarity with microform and his feelings toward the library would be helpful in order to determine and evaluate holding policies. To this end, a questionnaire was designed and distributed. The purposes of this Technical Information Services Questionnaire (TISQ) were to obtain an evaluation of DTC personnel toward microform, to ascertain the familiarity of the library patron with microform, to determine the current utilization pattern of some library services, and to record projected future library useages, assuming that some new systems were operational.

A. DESIGN OF THE QUESTIONNAIRE

The previous library study was examined in some detail prior to designing the questionnaire to determine if any of the stated purposes of the proposed questionnaire had been satisfactorily documented. This analysis revealed that the desired information was not available.

In designing the specific questions for the questionnaire, it was felt that subjective responses should be solicited concerning microform since this type of response would provide the responder greater freedom to express his opinion. Further, it would serve to reflect whether those patrons who have strong opinions for or against microform had vocalized their opinions to the extent that the less firmly opinioned patrons were influenced by the vocalizing. The value of the subjective response was anticipated to override the difficulties associated with objectively scoring questions of this type.

Objective type questions were considered best for the areas related to present and future library useage since the desire of the questions in these areas was to establish useage patterns and not obtain the opinions or feelings of the staff.

An initial questionnaire was prepared and discussed at length with members of the Information Analysis Branch and then sent to three members of the DTC staff who had some experience with the design and administration of questionnaires. These three respondants were asked to complete the questionnaire and then to comment on the wording of the questions and other areas that they felt pertinent.

Several valuable comments and suggestions resulted from these precursory respondants and were incorporated into a second draft questionnaire. During the discussion of this effort with the Information Analysis Branch, some idiosyncrasies of the command were identified that necessitated further revision of the questionnaire. The final questionnaire, figure 2, reflects all suggestions and modifications of the previous attempts.

B. ADMINISTRATION OF THE QUESTIONNAIRE

Two plans were considered for the distribution of the questionnaire to the command. The first was to survey a random sample of the staff personnel at both Fort Douglas and Dugway who had occasion to use the Technical Library. This alternative was rejected based on the small population less than 200 personnel, and on the inability to determine whether a staff member was at Dugway or at Fort Douglas.

The second plan, the one used, called for exhaustive distribution of the questionnaire to the extent of possibly supersaturation of the population. A total of 173 questionnaires were distributed on

TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

Your answers and comments to these questions concerning technical information services for DTC will assist in determining procedures for providing better service.

1. Microform Utilization

The term microform includes both roll-type microfilm (16m and 35m) and sheet-type microfiche. Two types of readers are available in the Command to enlarge the microfilms and microfiche to a readable size. These are a microform reader that enlarges and displays the image only and a microform reader/printer that enlarges, displays, and provides the reader with the option of making a hard copy of any page.

a. Are you familiar with microform and microform readers?

Yes _____ No _____

b. What is your opinion of having documents available in microform?

Professional Journals?

Technical Reports?

c. Assuming that adequate microform readers were available and easily accessible, would your productive effort be affected favorably or unfavorably as a result of using microform as opposed to hard copy documents or periodicals? Explain your rationale.

Figure 2

2. Present Utilization of the Library Services

a. Do you peruse or browse through current copies of technical periodicals in your field or related fields that are available in the library? Yes ___ No ___ If yes, are they read for

Background _____
Keeping current in field _____
Detailed study _____

b. Do you have occasion to refer to older technical periodicals? Yes ___ No ___ If yes, how often? Weekly _____
Monthly _____

Are they read for Background _____
Detailed study _____
Updating in field _____

c. Do you have occasion to use documents or books available thru the library? Yes ___ No ___ If yes, are they used for

Background _____
Updating in field _____
Detailed study _____

d. Would you prefer to use documents, books, and periodicals

At the library _____
At your desk _____

3. Future Utilization of Library Services

The Information Analysis Branch, Joint Contact Point Division, with the assistance of Planning Research Corporation, is developing an automated in-house information retrieval system that will be completely operational about 1 September 1969. This system, using automatic data processing techniques, will have the capability of producing a bibliographic listing of all documents in the DTC library which pertains to the area of interest of the requestor. The response time, dictated by the availability of the computer, is expected to be 24 hours or less.

a. When this system becomes operational, do you envision that your utilization of the library services will

Increase _____
Remain Constant _____
Decrease _____

Figure 2 continued

b. Would it be satisfactory if the documents contained in the bibliographic listing were provided to you in microform? (It is anticipated that sufficient microform readers will be available for you to review the documents in either your immediate work area or the library.)
Yes ___ No ___

Comments:

c. Would you prefer to review the microform documents

At the library _____
At your desk _____

4. Personal Background

Rank/Grade

Directorate

Division

Technical Speciality

Figure 2 continued

19 May 1969 during a sequence of personal visits to each division and branch chief's office. The purpose of the visit was to brief the chief on the study, to request his cooperation and to deliver sufficient copies of the questionnaire so that all branch members could respond. Extra copies of the questionnaire, beyond the number needed on the basis of one per library user, were provided to account for spoilage or loss.

At the time of the survey, DTC was undergoing several personnel changes, and thus, the exact number of personnel available for the survey was not obtainable. Total authorized strength, total assigned strength, and total present for duty figures were available. However, these figures included administrative and support personnel, those who do not have a reason to use the Technical Library facilities, as well as the research or scientific personnel.

To facilitate the processing of the questionnaire through the message center and to provide a brief explanation as to the purpose of the survey and to indicate that the completed questionnaire was to be returned to the Information Analysis Branch by 2 June 1969, a covering Disposition Form (DF), DA Form 2496, was attached to each questionnaire.

As the completed questionnaires were received, the covering DF was removed; the questionnaire was numbered in the sequence that it was received and was filed by division for later evaluation. Ninety-three questionnaires were completed and returned by the cut off date, 2 June 1969.

C. ELIMINATION OF BIAS

The possibility of bias being introduced into the survey was anticipated during the design phase and steps were taken then and in the execution phase to minimize the problem.

One bias that could possibly arise was that of a responder stating the opinions of his immediate superior. To reduce this area, the branch and division chiefs were requested not to comment about the survey, not to show extraordinary interest in the questionnaire, and not to review the completed forms.

To prevent the responder from feeling that his answers might someday return to haunt him, no names were requested on the completed questionnaire. Despite this measure, total anonymity cannot be guaranteed since the four pieces of personal information requested in question 4 could possibly be used to identify a responder.

A third possible bias that was considered was the influence of those with strong opinions on those with less firmly entrenched opinions. The short time allowed for responding to the questionnaire, 10 working days, was established to reduce this problem. It was felt that, with the normal workload levied on most research/scientific personnel, there would be little time for the vocal opinionated patron to influence others.

Lastly, the Information Analysis Branch and the administrative section of the Joint Contact Point Division were eliminated from the survey to avoid the inclusion of bias from those responsible for the operation of the library facilities.

D. SCORING THE COMPLETED QUESTIONNAIRES

The scoring of the survey was done in two phases; tabulation of the responses to the objective questions in parts 2 and 3, and evaluation of the four subjective questions in part 1. The methods used to accomplish the first phase were trivial and will not be discussed.

The scoring of the four questions in part 1 dealing with microform utilization was more difficult. The initial step was to read all the responses in order to identify some patterns that could be used to categorize the responses. This reading identified the four categories of favorable, undecided, unfavorable and no answer. A more careful second reading was then undertaken to classify each response into one of the four categories. Comments such as "O.K., Good, Yes, Of value," were construed to mean a favorable response while comments like "No, Worthless, Cumbersome" were taken as implying an unfavorable response. Those responders who discussed the pros and cons of the issue being questioned without identifying their feelings were classed as undecided. Those whose comments avoided the question or who put no response were classed as no answer.

E. RESULTS OF THE SURVEY

Figure 3 gives the numbering system used in Tables I and II. Table I lists the responses by division and directorate while table II presents the responses for all responders. All the tabulations exclude the initial three questionnaires and all percentage values are calculated on the number of personnel responding since the exact number of DTC personnel having occasion to utilize either of the Technical Library facilities was not available. Where percentages do not sum to 100 for

TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

Your answers and comments to these questions concerning technical information services for DTC will assist in determining procedures for providing better service.

1. Microform Utilization

The term microform includes both roll-type microfilm (16m and 35m) and sheet-type microfiche. Two types of readers are available in the Command to enlarge the microfilms and microfiche to a readable size. These are a microform reader that enlarges and displays the image only and a microform reader/printer that enlarges, displays, and provides the reader with the option of making a hard copy of any page.

a. Are you familiar with microform and microform readers?

Yes 1 No 2

b. What is your opinion of having documents available in microform?

- 3 Favor
- 4 Undecided
- 5 Opposed
- 6 No response

Professional Journals?

- 7 Favor
- 8 Undecided
- 9 Opposed
- 10 No response

Technical Reports?

- 11 Favor
- 12 Undecided
- 13 Opposed
- 14 No response

c. Assuming that adequate microform readers were available and easily accessible, would your productive effort be effected favorably or unfavorably as a result of using microform as opposed to hard copy documents or periodicals? Explain your rationale.

- 15 Favor
- 16 Undecided
- 17 Opposed
- 18 No response

Figure 3 Numbering System for Questionnaire

2. Present Utilization of the Library Services

a. Do your peruse or browse through current copies of technical periodicals in your field or related fields that are available in the library? Yes 19 No 20 If yes, are they read for

Background	<u>21</u>
Keeping current in field	<u>22</u>
Detailed study	<u>23</u>

b. Do you have occasion to refer to older technical periodicals? Yes 24 No 25 If yes, how often? Weekly 26 Monthly 27

Are they read for	Background	<u>28</u>
	Detailed study	<u>29</u>
	Updating in field	<u>30</u>

c. Do you have occasion to use documents or books available thru the library? Yes 31 No 32 If yes, are they used for

Background	<u>33</u>
Updating in field	<u>34</u>
Detailed study	<u>35</u>

d. Would you prefer to use documents, books, and periodicals

At the library	<u>36</u>
At your desk	<u>37</u>

3. Future Utilization of Library Services

The Information Analysis Branch, Joint Contact Point Division, with the assistance of Planning Research Corporation, is developing an automated in-house information retrieval system that will be completely operational about 1 September 1969. This sytem, using automatic data processing techniques, will have the capability of producing a bibliographic listing of all documents in the DTC library which pertains to the area of interest of the requestor. The response time, dictated by the availability of the computer, is expected to be 24 hours or less.

a. When this sytem becomes operational, do you envision that your utilization of the library services will

Increase	<u>38</u>
Remain constant	<u>39</u>
Decrease	<u>40</u>

Figure 3 continued

b. Would it be satisfactory if the documents contained in the bibliographic listing were provided to you in microform? (It is anticipated that sufficient microform readers will be available for you to review the documents in either your immediate work area or the library.)
Yes 41 No 42

Comments:

c. Would you prefer to review the microform documents

At the library	<u>43</u>
At your desk	<u>44</u>

4. Personal Background

Rank/Grade

Directorate

Division

Technical Speciality

Figure 3 continued

a question, the difference reflects those who did not respond to the question. Responses to some questions will sum to more than 100 since multiple responses were permitted.

F. ANALYSIS OF RESULTS

Several significant results of the survey become obvious when tables I and II have been studied. First, of particular interest is the large percentage of respondents who failed to provide distinguishable or meaningful replies to the four subjective areas on question 1. Responses 6, 10, 14 and 18 reflect this "No Response" category and the average for these four responses is approximately 26%. The implication, here, is two fold; either the respondents were not willing to expend the time necessary to answer the questionnaire in depth, or the interrogatives were not worded correctly to invoke a definitive response. It does not appear possible to identify which of these implications produced the high percentage of no responses.

The results of question 1 concerning microform utilization supported some preconceived conclusions of the Information Analysis Branch. More than three out of four responders were familiar with microform. This was as expected since the Library had been procuring and distributing microform and ancillary equipment for more than a year prior to the study. The responses to the questions concerning what types of material should be in microform also supported the staff's intuition. Technical reports and documents, materials primarily used for detailed study, were considered to be acceptable in microform to the majority of those responding; while periodicals, which are used both for detailed study and frequently for browsing or casual review, were not acceptable in microform. These results will be utilized later in this study to propose holding policies.

TABLE I

PERCENT RESPONSES TO TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

PLANS AND ANALYSIS DIRECTORATE

Response Number	Edit Svc	Mat Test	Bio Sys	Rsh & Anl	Chem Sys	Total
1	100.0	54.5	62.5	100.0	70.0	71.4
2	0.0	36.4	37.5	0.0	30.0	28.6
3	100.0	54.5	50.0	100.0	60.0	60.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	18.2	0.0	0.0	10.0	8.6
6	100.0	27.2	50.0	0.0	30.0	31.4
7	100.0	27.2	37.5	50.0	50.0	40.0
8	0.0	0.0	0.0	25.0	10.0	6.7
9	100.0	27.2	25.0	25.0	20.0	25.7
10	0.0	45.4	37.5	0.0	20.0	28.6
11	100.0	45.4	50.0	100.0	60.0	60.0
12	0.0	9.1	0.0	0.0	0.0	2.9
13	0.0	9.1	12.5	0.0	20.0	11.4
14	0.0	36.4	37.5	0.0	20.0	25.7
15	0.0	36.4	50.0	50.0	10.0	28.6
16	100.0	36.4	25.0	50.0	50.0	42.9
17	0.0	9.1	0.0	0.0	0.0	2.9
18	0.0	18.2	25.0	25.0	40.0	25.7
19	100.0	100.0	75.0	75.0	90.0	85.7
20	0.0	0.0	25.0	25.0	10.0	14.3
21	0.0	81.8	75.0	50.0	50.0	62.9
22	50.0	100.0	50.0	50.0	70.0	71.4
23	0.0	54.4	25.0	0.0	10.0	25.7
24	50.0	100.0	87.5	50.0	60.0	80.0
25	50.0	0.0	0.0	50.0	30.0	17.1
26	0.0	0.0	0.0	0.0	10.0	2.9
27	50.0	90.9	75.0	50.0	50.0	68.6
28	50.0	72.7	62.5	50.0	40.0	57.1
29	0.0	90.0	50.0	25.0	30.0	51.4
30	0.0	45.4	12.5	50.0	10.0	25.7

TABLE I CONTINUED

PERCENT RESPONSES TO TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

PLANS AND ANALYSIS DIRECTORATE

Response Number	Edit Svc	Mat Test	Bio Sys	Rsh & Anl	Chem Sys	Total
31	100.0	100.0	100.0	100.0	100.0	100.0
32	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	90.0	87.5	75.0	100.0	85.7
34	0.0	63.6	62.5	100.0	60.0	62.9
35	50.0	90.9	100.0	100.0	80.0	82.9
36	0.0	36.4	0.0	25.0	10.0	17.1
37	100.0	72.7	75.0	75.0	90.0	80.0
38	50.0	36.4	75.0	75.0	60.0	60.0
39	50.0	45.4	25.0	25.0	40.0	40.0
40	0.0	0.0	0.0	0.0	0.0	0.0
41	50.0	72.7	87.5	100.0	90.0	82.9
42	0.0	9.1	12.5	0.0	0.0	5.7
43	0.0	36.4	12.5	25.0	20.0	22.8
44	100.0	45.4	75.0	50.0	70.0	62.9

TABLE I Continued

PERCENT RESPONSES TO TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

Response Number	Test Operations	Medical & Safety	Tech and Technological Support Directorate				
			Chem	Metro	JCP	Bio	Total
1	90.0	75.0	72.7	100.0	80.0	80.0	81.1
2	10.0	25.0	27.3	0.0	20.0	20.0	18.9
3	60.0	41.7	72.7	50.0	30.0	90.0	62.2
4	10.0	0.0	0.0	16.7	0.0	10.0	5.4
5	0.0	25.0	0.0	16.7	30.0	0.0	10.8
6	30.0	33.3	27.3	16.7	40.0	0.0	21.6
7	30.0	16.7	36.4	33.3	20.0	80.0	43.2
8	0.0	0.0	9.1	16.7	0.0	0.0	5.4
9	30.0	50.0	36.4	16.7	70.0	10.0	35.1
10	40.0	33.3	18.2	33.3	10.0	10.0	16.2
11	80.0	33.3	72.7	33.3	50.0	70.0	59.4
12	0.0	0.0	0.0	16.7	0.0	10.0	5.4
13	0.0	25.0	18.2	16.7	40.0	0.0	18.9
14	20.0	41.7	9.1	33.3	10.0	20.0	16.2
15	30.0	8.3	18.2	50.0	20.0	40.0	29.7
16	50.0	41.7	36.4	16.7	20.0	20.0	24.3
17	0.0	33.3	9.1	0.0	0.0	10.0	5.4
18	10.0	16.7	36.4	33.3	60.0	30.0	40.5
19	90.0	91.7	90.9	100.0	100.0	100.0	97.3
20	10.0	8.3	9.1	0.0	0.0	0.0	2.7
21	70.0	67.7	72.7	83.3	70.0	60.0	70.3
22	60.0	75.0	81.8	100.0	100.0	90.0	89.2
23	20.0	67.7	63.6	50.0	10.0	50.0	43.2
24	50.0	91.7	100.0	100.0	80.0	100.0	94.6
25	40.0	8.3	0.0	0.0	20.0	0.0	5.4
26	0.0	41.7	54.5	50.0	0.0	10.0	27.0
27	50.0	50.0	54.5	50.0	80.0	80.0	67.6
28	50.0	67.7	81.8	50.0	70.0	80.0	73.0
29	20.0	0.0	81.9	100.0	30.0	50.0	62.2
30	20.0	33.3	36.4	33.3	50.0	20.0	35.1
31	80.0	100.0	100.0	100.0	80.0	100.0	94.6
32	20.0	0.0	0.0	0.0	10.0	0.0	2.7
33	70.0	83.3	81.8	100.0	60.0	80.0	78.4
34	40.0	58.3	54.5	83.3	50.0	40.0	54.0
35	30.0	83.3	90.9	100.0	60.0	60.0	75.7
36	10.0	0.0	9.1	0.0	10.0	10.0	8.1
37	90.0	100.0	63.6	83.3	90.0	90.0	81.1

TABLE I Continued

PERCENT RESPONSES TO TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

Responses Number	Test Operations	Medical & Safety	Tech and Technological Support Directorate				
			Chem	Metro	JCP	Bio	Total
38	30.0	67.7	54.5	83.3	50.0	60.0	59.4
39	70.0	33.3	36.4	16.7	40.0	40.0	35.1
40	0.0	0.0	9.1	0.0	0.0	0.0	2.7
41	80.0	58.3	90.9	50.0	80.0	100.0	83.8
42	10.0	41.7	9.1	50.0	10.0	0.0	13.5
43	10.0	8.3	27.3	16.7	10.0	10.0	16.2
44	60.0	83.3	63.6	83.3	80.0	90.0	78.4

TABLE II

TOTAL TABULATED RESULTS OF TECHNICAL INFORMATION SERVICES QUESTIONNAIRE

Response Number	Percent Response	Response Number	Percent Response
1	77.6	24	82.9
2	22.4	25	13.3
3	58.5	26	17.0
4	3.1	27	63.8
5	10.6	28	63.8
6	27.6	29	52.1
7	37.2	30	29.7
8	4.2	31	95.8
9	32.9	32	3.1
10	25.5	33	80.8
11	58.5	34	56.3
12	3.1	35	76.5
13	14.8	36	9.5
14	23.4	37	84.0
15	26.6	38	57.4
16	36.1	39	40.4
17	7.4	40	1.1
18	29.7	41	78.7
19	91.4	42	14.8
20	8.5	43	17.0
21	67.0	44	71.2
22	77.6		
23	37.7		

While the large number of undecided responses to question 1-C concerning the effect of microform on productive effort prohibits a definitive evaluation of the question, it is interesting to note that less than 10% of those responding anticipated a decrease in their productive effort. Prior to the study, it was felt that many more library patrons were opposed to microform and would express their opposition by indicating a decrease in productive effort.

Responses to question 2-B, frequency of reference to older periodicals, proved to be a surprise. Over 82% of those responding indicated that they had occasion to refer to older periodicals. Of this group, 64% indicated that they referred to the older periodicals on a monthly basis. This situation indicates an additional area that should be investigated; namely, which of the 281 periodicals received by DTC should be retained in order to best serve those patrons who would frequently consult them.

The responses to questions 2-D and 3-C pertaining to the preferred use location for library material were as expected, heavily in favor of the patron's desk. It is interesting to note that 84% responded "desk" to question 2-D under present utilization, while only 71% responded "desk" under future utilization.

The implementation of bibliographic search capability by the Library will produce an increase in library utilization for 57% of the responders while only 1.1%, one person, anticipates a decrease. The significant result of question 3 is that 79% of the responders felt that receiving the reports identified by the bibliographic search in microform would be satisfactory. Coupling this response with the response to question 1-B provides an endorsement by the patron for the inclusion of microform in Library holdings.

G. SPECIAL CONSIDERATION OF SELECTED QUESTIONS

The three parts of question 1-B and question 1-C required that the responder record his subjective opinion to the interrogatory statement. Since subjective responses do not lend themselves to direct interpretation or to comparison either between responders or among groups of responders, the techniques of attitude scaling have been developed and used in the soft sciences, sociology, psychology, to provide a means of comparing subjective responses.

For the subjective questions in the Technical Information Services Questionnaire an attitude scale was constructed using the Method of Summated Ratings. This method was selected from the four most common techniques because it did not require a panel of experts to classify the questions into categories of favorability. For the technique employed, all questions are considered favorable to the overall objective of having microform holdings in the DTC Technical Library.

Each question was subdivided into the same four categories that were used in the tabulation of the Questionnaire as discussed above. The normalized scores were calculated and rounded to the nearest integer. Table III gives these normalized values.

TABLE III
NORMALIZED SCORES FOR SUMMATED RATING ANALYSIS

Question	Response			
	No Comment	Disagree	Uncertain	Agree
1 b 1	0	1	1	2
1 b 2	0	1	1	2
1 b 3	0	1	1	2
1 c	0	1	1	2

The normalized values were then applied to returned questionnaires in order to obtain the distribution of raw scores presented in Table IV.

TABLE IV
DISTRIBUTION OF SCORES FROM SUMMATED RATING ANALYSIS

Score	Frequency	Score	Frequency	Score	Frequency
8	14	5	13	2	7
7	9	4	10	1	7
6	19	3	8	0	6

To obtain a more meaningful scale, the raw scores were transformed into T scores using the relation $T = 50 + 10 \left(\frac{X - \bar{X}}{S} \right)$ where X is the raw score, \bar{X} is the mean of all raw scores, and S is the standard deviation of raw scores. The T statistic which has mean 50 and standard deviation 10 is frequently used to provide a standard interpretation of scores free from differences in means and standard deviations. Ref 8
These results of the transformation of scores are presented in Table V.

TABLE V
FREQUENCY OF T SCORES

Raw Score	T Value	Frequency	Raw Score	T Value	Frequency	Raw Score	T Value	Frequency
8	65.99	14	5	50.52	13	2	35.04	7
7	60.84	9	4	45.36	10	1	29.88	7
6	55.68	19	3	40.20	8	0	24.72	6

It can be seen that there are more scores in Table V above the mean than below it. The T values are tightly grouped above the mean and are spread more below the mean. A zone 1.6 standard deviations above the mean includes all high scores while the zone to include all low scores

must be 2.3 standard deviations below the mean. Thus, it can be concluded that the responders to the Technical Information Services Questionnaire tended to be more favorable to microform than an average group would be.

During the development of the attitude scale mentioned above, the question arose as to whether the four questions being considered really lent themselves to attitude scaling. To test this concept, a scalogram was constructed using techniques reported by Edwards. [Ref. 8] The purpose of the scalogram was to determine the coefficient of reproducibility which represents the degree of accuracy with which the responses to the statements being scaled can be reproduced from the total scores alone. Coefficients of 0.90 or greater are generally accepted as meaning that attitude scaling techniques can be freely applied to the questions.

The coefficient of reproducibility was calculated by determining an ideal pattern for each possible score, determining the number of variations from the idealized pattern for each responder, and summing the variations or errors for each responder to obtain the total number of errors. Table VI summarizes the idealized pattern for each possible score. Analysis of the ninety-three completed questionnaires using the idealized patterns of Table VI resulted in a total of 130 errors. The coefficient of reproducibility, R, was calculated as $R = 1 - \frac{E}{TR}$ where E is the total number of errors and TR is the total number of responses. For the Technical Information Services Questionnaire, the coefficient of reproducibility was calculated to be $0.651 = 1 - \frac{130}{372}$. This value is well below the 0.90 level and implies that the questions under consideration do not readily lend themselves to attitude scaling.

TABLE VI

IDEALIZED PATTERNS FOR SCALOGRAM ANALYSIS

Total Score	Question Number			
	1	2	3	4
	Ideal Responses			
12	3	3	3	3
11	3	3	3	2
10	3	2	3	2
9	3	1	3	2
8	3	1	2	2
7	2	1	2	2
6	2	1	1	2
5	1	1	1	2
4	1	1	1	1
3	1	1	1	0
2	0	1	1	0
1	0	0	1	0
0	0	0	0	0

V. ANALYSIS OF PRESENT HOLDINGS AND GROWTH CONSIDERATIONS

The problem of housing a rapidly growing collection of material is a problem in the DTC Library as it is in most established libraries. Today the present areas are marginally satisfactory but will be unsatisfactory in the near future unless actions are taken to reduce the physical size of the holdings. This section discusses the space available at the two facilities, estimation of the present holdings, projection of acquisition rates, and the impact of projected acquisition rates on available space.

A. SPACE AVAILABILITY

The two facilities of the DTC Library have only limited amounts of space available for housing the library collection. Table VII summarizes, by designated use, the shelf space in linear feet available, presently occupied and for expansion. It should be noted that space for expansion

TABLE VII
LINEAR FEET OF SHELF SPACE BY USE AND FACILITY

	Occupied	Expansion	Total
Bound Periodicals			1470
Dugway	1320*	150	1470
DTC	0	0	0
Books			807
Dugway	618	120	738
DTC	66	3	69
Documents & Reports			1680
Classified			560
Dugway	384	16	400
DTC	152	8	160
Unclassified			1120
Dugway	501	467	968
DTC	138	14	152

*Includes 450 linear feet used for current periodicals

is severely limited at the DTC facility. The eight feet available for classified expansion are a safe that presently houses microfiche and microfilm. However, the vault that accounts for the remaining classified area has, in addition to having all shelves filled, several stacks of material piled on the floor that are too large for the safe.

At Dugway, the classified material is housed in 48 safes that are kept in a secure room. There is no floor space left in the room for additional safes and no plans to improve another area to the level required for designation as a secure room. This facility is not as cramped for space as is the DTC facility.

B. ESTIMATE OF PRESENT HOLDINGS

During the initial phases of this study, it was felt that obtaining an exact estimate of the size of the library holdings was of supreme importance. To this end a sampling program was developed that was to utilize the library's two card files, one at each facility, and was to proceed as follows: arrange all cards in a file drawer neatly; using the adjustable slide in the drawer compact the cards until no further compaction was possible; measure the total length of cards in the drawer; select a one inch sample of cards from the front, the middle, and the rear of the drawer; count the number of cards in the sample. By averaging the count from all the samples an estimate of the number of cards in an inch of drawer space was to be obtained. Application of this estimate to the total number of inches of cards was to produce an estimate of the total size of the collection.

The plan was applied to the DTC facility and the measurements taken. However, when the plan was applied to the Dugway facility, unanticipated complications arose that made the plan useless. It had been assumed that

both facilities had the same policy with regard to card files. This was a poor assumption since at Dugway the only acquisitions that are entered into the card file are those acquisitions with provided reference cards or those for which reference cards can be obtained from the Library of Congress. At DTC, cards are prepared or obtained for all acquisitions. Additionally, the Dugway facility does extensive cross referencing of those materials filed while the other facility does no cross referencing.

Based on these complications, the plan was scrapped. In the search for an alternate method of obtaining the total collection size, the importance of this value degenerated until, in the final analysis, it was determined that it would make no contribution to the goals of the study.

C. PROJECTED ACQUISITIONS

The value of being able to estimate the future acquisitions of a library is of recognizable consequence and would be of value in planning future space requirements, estimating manpower expenditures, and determining budget levels.

To obtain a basis for predicting future acquisitions at DTC, it was necessary to employ two techniques to obtain the yearly acquisitions for the DTC library. Since only limited information was available for the years prior to 1967, data was collected for 1967, 1968 and for the first 125 days of 1969.

For the DTC facility, the technique employed took advantage of the card file. A physical count was made of all cards in the card file recording by year the number of classified reports, unclassified reports and books acquired. During the counting process it was noted that some cards, less than 1%, had no dates and the other cards had only the date

of publication, and not the publication and the acquisition dates. Those cards with no date were not counted while those with only a publication date were assumed to have been received during the year of publication. The validity of the latter assumption was ascertained during discussions with the librarian at the DTC facility. His experience was that the number of acquisitions increased in December due to the policy of some originating agencies to publish as many reports as possible prior to submission of the annual historical report. Since for books the assumption is not as valid, the number of books acquired in a year was checked against purchase orders to identify those older books obtained in the years of interest.

The technique used at the Dugway facility was, of necessity, different. Here, the periodical Technical Library Bulletin was used. This Bulletin lists all the acquisitions of the DPG facility since the publication of the last bulletin. Beginning in 1969 the acquisitions of both facilities are listed in the Bulletin with an indicator to identify those acquired at each facility. The procedure was to physically count the number of acquisitions of each type by year being certain to exclude those received by the DTC facility during 1969.

The results of the count at each facility for the years 1967 and 1968 and the first 125 days of 1969 together with a projection of the total acquisitions for 1969 are tabulated in table VIII. The projection figures were calculated using the values for the first 125 days and by assuming that the projected value Y was obtained from $Y = \frac{365}{125} X$ where X is the physical count of acquisitions of a type to 15 May 1969. The validity of the constant acquisition rate assumption is based both on a comparison of the number of listings in each

TABLE VIII
ACQUISITIONS BY YEAR, FACILITY, AND TYPE MATERIAL

YEAR Facility	1967			1968			1969			Projected for year						
	Clas	Uncl	Bks	Total	Clas	Uncl	Bks	Total	Clas	Uncl	Bks	Total				
Dugway	486	580	73	1139	443	818	183	1444	224	330	44	598	654	963	128	1745
DTC	639	453	20	1112	581	359	30	970	291	127	16	434	849	373	46	1268
Total	1125	1033	93	2251	1127	1177	213	2414	515	457	60	1032	1503	1336	174	3013

Technical Library Bulletin for a one month period and on comments of the Librarians that the number of new items obtained in any month is about constant except for an increased load in December that is countered by decrease in the January load.

Knowing the past yearly acquisitions, the problem was to determine a suitable model for predicting future yearly acquisitions. The remarks of W. N. Locke of Massachusetts Institute of Technology during a panel discussion on libraries and computers at the 1969 Spring Joint Computer conference gave some direction of an area of search for an appropriate model. Mr. Locke said, "... (the) outpouring of written words is going up ten percent a year..." [Ref. 9] The implication drawn from this statement was that a linear relation would satisfactorily model the growth of library acquisitions.

The model selected was a linear regression model having the statistical form $Y = A + BX + E$ where Y is the number of volumes acquired in years X , A and B are parameters and E is the correction for error. The method of least squares was used to obtain estimates of the parameters A and B . The assumptions made for the model were that the Y 's, for a given X , are independent and have normal distribution with mean $A + BX$ and common variance. Additionally, it was assumed that the failure of the model to fit the observations exactly is solely a function of errors. [Ref. 10]

The application of the model to the yearly acquisition values for the DTC Library resulted in the values of A and B in Table IX. Additionally, this table also contains the correlation coefficient, R , for each of the twelve cases studied. For the analysis, the year was

TABLE IX

RESULTS OF LINEAR REGRESSION ANALYSIS

Material Type Facility	Books			Unclassified Reports			Classified Reports			Total		
	A	B	R	A	B	R	A	B	R	A	B	R
Dugway	73	28	.5000	404	191	.9903	360	84	.7534	837	303	1.000
DTC	6	13	.9912	475	-40	.7887	480	105	.7447	961	78	.5233
Combined	66	51	.7829	879	151	.9996	873	189	.8649	1798	381	.9500

transformed to a smaller value using the relationship $YU = YA - 1966$ where YU was the value of the year used in the linear model and YA was the actual year value.

The summarized results of the linear analysis generated two areas that bear discussion. The first is the calculated negative value of B for unclassified reports at DTC. This was a surprise since it is generally accepted that the amount of printed material is on the increase and since the value of the same parameter for Dugway Facility was positive. From Table VIII it can be seen that there was an appreciable decrease in the number of reports in this class received in 1967 (453) to the number received in 1968 (359). Also, the projected number of unclassified reports to be received in 1969 (373) is much less than the 1967 level and only slightly larger than the 1968 level. When the method of least squares was applied to this data, the deviation from a best fit line for the 1967 value was so large that it overrode the deviations for 1968 and 1969 producing a projected decrease in the acquisition rate. While statistically this parameter estimate is valid, it must be considered with caution in analysis until more data can be obtained to refute or confirm the estimate.

The second area is the correlation coefficients. Note that all coefficients are above 0.5 and that five values are above 0.90. Since only three data points were used for each of the twelve regressions, it is surprising that the correlation coefficients are so high. It would be an easy and, possibly, logical extension of the study to conclude that these values serve to verify the model. However, such a conclusion would be misleading. A more reasonable conclusion is that the correlation coefficients are encouraging and indicate that more data should be obtained to assist in verifying the model.

Due partly to the small number of data points in the linear regression model, three samples for each case, the standard error of estimation for each category (Table X) was quite large. This value, calculated by dividing the sum of the squares about regression by $N-2$, where N is the sample size, can be used to establish confidence limits on the various parameters of the model. For this study, the establishment of confidence limits is futile due to the large standard error of estimation and the small sample size. To illustrate this claim, consider the category classified reports for the Dugway facility. The standard error of estimation, SE, is 103.7.

TABLE X
STANDARD ERROR OF ESTIMATION

	Books	Unclassified Reports	Classified Reports	Total
Dugway	67.4	38.0	103.7	1.7
DTC	2.4	44.1	133.1	179.6
Combined	56.7	6.12	155.1	177.2

To translate this value to the estimated standard deviation of a predicted Y value for a given S value, the relation used is

$$SY = (SE) \sqrt{1 + \frac{1}{N} + \frac{(X - \bar{X})^2}{\sum_{i=1}^3 X_i^2}}$$

where X is the value of interest, \bar{X} is the average of the X_i 's used in the prediction and N is the sample size. For the problem in question for 1970, year 4,

$$SY = (103.7) \sqrt{1 + \frac{1}{3} + \frac{((4 - 6)^2)}{14}} = 228.1$$

To get the upper 100 (1 - α) percent confidence limit on Y the relationship used is $YU = YE + SY (t \left[\frac{(1 + B)}{2}, n - 2 \right])$

where YE is the estimate from the linear regression model, $B = 1 - \alpha$ and t is the value from Student's t distribution with n - 2 degrees of freedom. For the example being considered, for $\alpha = 0.10$, the corresponding t value is 6.314. Applying this to the SY produces a value of 1820 which is nearly four times as large as the value of YE, 496.

D. EFFECT OF PROJECTED ACQUISITIONS ON SPACE AVAILABILITY

The utilization of the estimated number of volumes to be received by the Technical Library was to determine when the space presently unoccupied at each facility would become filled. To make this determination, it was necessary to obtain an estimate of the average number of books, reports or documents that occupy a length of shelf space. This estimate was obtained by physically counting the number of volumes on each full three foot shelf at both facilities and the mean and standard deviation calculated (Table XI). It is obvious from this table that

the probability that the number of books and the number of classified or unclassified reports occupying three feet of shelf space came from the same population is fairly small and thus books must be considered separately from reports when determining the utilization of available space.

TABLE XI
MEANS AND STANDARD DEVIATIONS OF THE NUMBER OF VOLUMES
OCCUPYING THREE LINEAR FEET OF SHELF SPACE

Facility	Books		Unclass. Reports		Classified Reports	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Dugway	30.7	5.9	142.8	32.2	97.9	33.3
DTC	30.5	5.4	189.1	21.5	101.9	30.2

It is not readily apparent from the table whether or not the number of classified reports and the number of unclassified reports came from the same population. To test this conjecture, the Mann-Whitney U test was applied to the data used to calculate the values of Table XI. This nonparametric test was chosen over parametric tests because the assumption of a distribution for the number of reports occupying three linear feet of shelf space appeared too restrictive. The hypothesis that the sample of classified reports and the sample of unclassified reports came from the same population was rejected at the 0.05 level of significance. [Ref. 11] Thus each type of report must be considered separately when considering available shelf space.

To determine how many years of growth the library had until all shelving areas were filled, the number of volumes, N, that could be shelved in the space available was calculated for the categories of books, classified reports and unclassified reports using $N = \frac{SP}{3} (\bar{X})$

where SP was the linear feet of space available and \bar{X} was the mean number of volumes that could occupy a three foot shelf.

Next, the number of years needed to acquire the value of N for each category was determined by applying the linear model $Y_i = A + BX_i$, $X_i = 4, 5, \dots$ where X_i was allowed to take on increasing value until the sum of the Y_i 's exceeded N for the category being studied. The results of these calculations can be found in Table XII.

No attempt was made to calculate values of \bar{X} that would be of greater confidence since, as previously mentioned, the application of confidence calculations to the estimates of Y would be futile due to the large values of the standard error of estimation and to the small sample size. It can be seen that the critical area at Dugway is classified reports while DTC has criticality in both books and classified reports.

TABLE XII
EFFECT OF ACQUISITION RATES ON SPACE AVAILABILITY

	Books		Unclassified Reports		Classified Reports	
	No. of Vols. to Capacity	Yrs. needed to acquire	No. of Vols. to Capacity	Yrs. needed to acquire	No. of Vols. to Capacity	Yrs. needed to acquire
Dugway	1230	<6	12152	<7	522	<1
DTC	30	<1	983	<4	272	<1

E. PERIODICAL AND ABSTRACT COLLECTION

To this point little has been said about the periodical and abstract holdings of the Technical Library. The exclusion of this topic has been intentional since periodicals and abstracts are handled differently than other material in the Library operation.

Presently, only the Dugway facility shelves bound copies of periodicals. The DTC facility maintains a rack for current periodicals and for retention of all issues in the current volume. This means that periodicals are held in unbound form for approximately a year before they are sent to the Dugway facility for storage or are eliminated from the collection.

The two facilities subscribe to 281 periodicals of which 43 are received by both facilities. These periodicals range from the light, general interest military publication to the more scholarly publications of the numerous technical societies. The decision to bind and retain a particular publication is rather arbitrary and is based more on the money available for binding than on the future needs of the patrons for the publication. Thus, several journals were bound for one or two years when funds were plentiful and then, when funds became limited, were eliminated from binding and from retention as loose copies. Some publications with extremely limited interest have been bound in both lean and fat fund years. The Library Journal, a publication concerning library procedures and operations, is an example of this situation, and would be of interest to only those eight or ten persons working in the Information Analysis Branch.

The arbitrary binding policy makes the determination of growth rates and prediction of space required to house periodicals in the future extremely difficult. In 1967, 320 volumes were bound and in 1968, 411 volumes were bound at a cost of nearly \$1,600.00. The approved budget for 1969 included slightly more than \$1,400.00 for binding of approximately 400 volumes while the budget request for 1970 solicited \$1,600.00 to bind an estimated 400 volumes. Assuming that a

bound volume of periodicals is the same size, on the average, as a book, the space available for periodicals should last more than five years at the present rate of binding.

As was mentioned previously during the analysis of the Technical Information Services Questionnaire, serious consideration should be given to conducting a study to determine which of the 281 periodicals are of most interest to the patrons in order to establish policies relative to which periodicals to bind and retain. This study should also consider the possibility of obtaining microfilm copies of periodicals for retention as opposed to binding hard copies. Ninety-four of the periodicals currently being received are available on microfilm for both back and current volumes. Additionally seven others have current volumes available. The cost of a yearly volume varies from \$53.00 to \$3.00 with the average being about \$12.00. This cost appears high at first glance when compared with the estimated average price of \$4.00 for binding a yearly volume. However, if microfilm were to be selected over binding, the number of copies of each periodical could be reduced since it would no longer be necessary to receive one copy which is set aside strictly for binding.

The Library's collection of abstracts relating to the technical areas encompassed in the CB field is complete and is being increased yearly through subscriptions to the most important abstracting services. The shelving problem for abstracts is not acute at the present time. Predictions of growth are difficult because of the ever expanding abstracting services being provided. Abstracts do use up large amounts of shelf space. The Library's collection of Chemical Abstracts dates back to 1920 and occupies 75 linear feet of shelf space.

This one publication requires nearly two and one half feet to house a current year's publication.

To be effective and of value to the patron, abstracts must be in a form that allows the patron to be able to turn to the index and identify material of interest, to quickly turn to this material and to return again to the index. Abstracts in microform do not provide this capability and, thus, to be of most value to the patron, abstracts should be retained in hard copy and policies should be established to provide the space needed for abstracts.

VI. HOLDING POLICIES

If space is to be available to house future acquisitions, policies must be established that indicate what material is to be retained and in what form this material is to be added to the collection. These holding policies should complement the usual weeding and screening policies routine to all libraries. Since the needs of the DTC Technical Library are different from those of other technical libraries, the holding policies that are proposed reflect the Library's mission, the cyclic nature of the CB field and apply to either facility.

A. POLICIES RELATING TO PRESENT HOLDINGS

For material already in the Technical Library's collection, these holding policies are proposed:

With the exception of DTC generated or sponsored work, a single copy of area studies and other reports containing maps, blueprints, involved structural drawings, or numerous oversized pages or photographs should be retained as hard copy. Two copies of DTC material should be retained.

A single copy of all reports, except DTC reports, should be retained. When available from Defense Documentation Center, microform copies of these reports should be obtained and, upon receipt, the hard copy should be destroyed. Two hard copies of DTC reports should be maintained if the Library is to continue to be the Command repository. Otherwise, retain one hard copy of each DTC report.

Eliminate multiple copies of books that have not been circulated in more than eighteen months.

Periodicals that are of little interest to the patrons should be eliminated.

Abstracts should be retained as hard copy.

B. POLICIES RELATING TO FUTURE ACQUISITION

The proposed holding policies for future acquisitions are:

For reports received as direct distribution in hard copies, initiate action to obtain from DDC a microform copy of all reports that are not DTC originated or sponsored and that do not have numerous maps, oversized pages, photographs or blueprint-like figures. Route the hard copy as part of the Selective Dissemination of Information System and destroy the hard copy when the microform copy has been received. For DTC reports, retain two hard copies. For other reports, retain one hard copy.

Reports received as secondary distribution should be retained in microform.

Books should be retained in single copy except for those that are considered reference material or for which heavy demand is anticipated. Sufficient copies of books in the exceptional category should be retained to satisfy patron demands.

Periodicals that are in high demand should be bound and retained as hard copy.

Abstracts should be bound and retained as hard copy.

C. DISCUSSION OF PROPOSED HOLDING POLICIES

The holding policies proposed above are not the only possible policies and would not, if fully implemented, lead to the maximum collection. Rather they reflect the thinking of the Library staff,

the cyclic nature of the CB field, the tone of classical library procedure, the patron's needs and the mission of a library in relation to DDC.

The propriety of retaining only one copy of most reports might be questioned. Considering that it takes on the average only seven days to receive an order from DDC, the necessity of having multiple copies is minimized. Since few projects at DTC are short fuzed, this seven day waiting period is tolerable. Additionally, the one copy policy is in keeping with the measures of effectiveness for the Library proposed earlier.

The policies concerning periodicals should be considered stop gap measures until a study can be conducted to determine what periodicals should be retained on a continuing basis.

These policies are not sacrosanct nor are they static. As needs and technology change, the policies must also change.

For implementation of the policies, future acquisitions can be implemented as a whole while those for present holdings must be implemented in increments if routine library operations are to continue. At both facilities the initial action should be implementation of the policy for classified reports. The second step should be implementation of the same policy to the unclassified reports. The third action at the Dugway facility should be the policy on periodicals while at the other facility, the book policy should be implemented. These steps attack the areas in order of their criticality.

D. IMPACT OF HOLDING POLICIES ON SPACE AVAILABILITY

It can be anticipated that complete implementation of the proposed holding policies will require several months to accomplish and that

accomplishment will free a great deal of shelf space for future acquisitions.

To evaluate the magnitude of this increase in available space, consider the acquisitions for the year 1968 (Table VIII). Assume that all duplicate copies have been eliminated and that less than 1% of all reports received are DTC generated and less than 5% of all reports contain maps, detailed drawings or numerous photographs. Table XIII presents the space required to house the 1968 acquisitions entirely as hard copy and then after application of the proposed holding policies. The amount of space needed to house the entire year's acquisitions for both facilities is reduced by utilization of the holding policies to 0.38 of the amount needed without the holding policies. As mentioned previously, the critical area at both facilities is classified holdings. Utilizing the holding policies, the amount of shelf space needed at the DTC facility to house the 1968 classified acquisitions is reduced to 0.11 of that required for all hard copy holdings while at the Dugway facility the figure is 0.10.

TABLE XIII
SPACE REQUIRED TO HOUSE 1968 ACQUISITIONS
IN LINEAR FEET

	Without Holding Policies				With Holding Policies			
	Clas	Uncl	Books	Total	Clas	Uncl	Books	Total
Dugway	13.6	17.3	18.3	49.2	1.3	2.3	18.3	21.9
DTC	14.6	5.6	3.0	23.2	1.7	1.2	3.0	5.9

The space savings resulting from implementation of the proposed holding policies are appreciable. Extrapolating the values above to the future growth, it can be safely conjectured that the proposed holdings

will give the library an additional ten years of growth in all areas except the book, periodical and abstract collections.

E. IMPACT OF HOLDING POLICIES ON PATRONS

It can be anticipated that implementation of the proposed holding policies will result in consternation and lamentations to some of the Library patrons. This vocal group will be a minority as indicated by the results of the Technical Information Services Questionnaire. Recall that 59% of those responding to the questionnaire favored having documents and reports on microform. When queried as to the effect on productive effort of having reports and documents available in microform, assuming that adequate readers were available, only 7% anticipated a decrease in productive effort.

To reduce the discontent that could result from acceptance of the holding policies, a program should be developed to educate library patrons about microform. Included in this program should be a discussion of the limited storage space available at each facility, a demonstration on how to use each type of reader and reader/printer in the Command, a statement of policy for making hard copy from microform and other information that would serve to gain the support of the patron. Coupling this program with implementation of the bibliographic search program or the selective dissemination of information program would better utilize the time of the patron and would avoid undue interruption of the patron's routine.

VII. EQUIPMENT CONSIDERATIONS

Considering that the advantages of microform outweigh the disadvantages; that DDC provides users with microform copies of reports at no cost to the user; and that appreciable amounts of space are saved utilizing microform, the unexpressed conclusion of this study must be that microform must be included in the holdings of the Desert Test Center Technical Library in ever increasing amounts. This inclusion requires that special equipment be provided for both the library and the patron in order to facilitate the use of the microform. Presented in the colloquy that follows are considerations concerning an in-house capability of producing and reproducing microforms and concerning the selection and distribution of microform readers and reader/printers.

A. IN-HOUSE MICROFORM PRODUCTION AND REPRODUCTION

During the initial phases of this study, it was learned that purchase of a step-repeating microfiche camera was being considered. This camera was to be used to reduce material presently in the Library collection to microfiche. The decision hinged on the availability of money and on allocation of additional floor space to house the camera and ancillary equipment. While these two factors are important, they do not represent the entire decision process and do not provide an alternative process for obtaining microforms.

The task of microforming a set of records can be accomplished by either purchasing the equipment required or by contracting with a commercial microform production firm. The advantages of the first

method include use of library staff personnel who are familiar with the records; accomplishment of small jobs quickly and reasonably; immediate availability of records throughout the process; and circumvention of the problems related to transferring classified material from location to location.

On the other hand, the contractorial method requires no capital investment; does not tie up critical floor space; is faster for large jobs since those doing the filming do not have to do routine library work; and will probably result in a better quality product. [Ref. 12]

Specifically, for the DTC Technical Library, the purchase of a camera seems to be uneconomical. The capital outlay for an adequate camera would be about \$3,000.00 to which must be added the cost of training an operator and remodeling an existing space to provide adequate ventilation, lighting conditions and electrical load. Also, the mission of DDC, to supply microform free of cost, opposes this outlay of capital. If the portion of the material selected for microfilming and available from DDC were removed, the remaining portion would be very small consisting of extremely old documents and of documents whose origin is outside the U. S. Government. This small portion could be retained easily as hard copy or could be reduced to microfilm by a contractor for less cost than possible through in-house methods.

There are several machines available on the market to reproduce copies of microfiche. The average cost of a machine is about \$1,000.00. Considering that the majority of fiche in the Library were or would be obtained from DDC, the need for a reproducer is non-existent since additional copies could be ordered from DDC at no cost. Granted there is a delay of from five to seven days from ordering to receipt, but as

the measures of effectiveness indicate, this delay would not be detrimental to the patron's productive effort.

B. MICROFORM READERS AND READER/PRINTERS

The question of whether to have microform readers and reader/printers was answered when microform was introduced into the library system. For the DTC Technical Library, the questions of which type of and how many readers and reader/printers to purchase need answers.

There is a virtual potpourri of readers and reader/printers available. They vary in cost for a reader from about \$15.00 to as much as \$350.00 with an average price of \$100.00, and for a reader/printer from \$1,000.00 to \$1,400.00 with an average price of \$1,200.00. The size range is as wild with some as large as console television sets and some small enough to fit in the pocket. The cuddly reader proposed by Wooster [Ref. 3] has not been developed but portable readers are available that can be tossed in a briefcase and used while traveling or in bed during periods of restlessness.

The Defense Documentation Center reprinted in 1968 a survey of 23 microform readers and three reader/printers which lists 16 characteristics of the machines but which makes no attempt to evaluate the performance of the machines. [Ref. 13]

In July of 1968, the Redstone Scientific Information Center published a report containing a general evaluation of the 11 microfiche readers and two reader/printers available to Redstone. [Ref. 14] The readers are classified as portable and nonportable and the one from each class that best met the needs of the Center was designated as the "best buy". The reader/printer that best met the needs was also identified. Since the needs of the Redstone Center parallel quite

closely the needs of the DTC Technical Library, the readers and reader/printer identified as best buys would also be sound investments for DTC.

If it were desired to conduct a study to compare newer readers and reader/printers, a check list developed by DDC could be used. [Ref. 13] This Buyer's Guide for Microfilm Reader Evaluation provides a method for subjectively evaluating physical and operating factors of several machines and then generating a comparative score for each machine by assigning rankings to the subjective evaluations.

The problem of the distribution of readers within a command is not as well documented. The ideal would be for each patron to have a good reader available at his desk or work area but the cost of such a policy would be prohibitive. The portable pocket sized readers are inexpensive but are not suited for heavy work or for prolonged viewing.

To provide some insight into the distribution question, the use of readers within a command was modeled as a queueing system using the classic machine interference problem as the basis of the model. This model considers the utilization of one or more microform readers to provide service to a finite number of patrons. In the classical model, readers are called servicemen and patrons are called broken machines. [Ref. 15] Poisson arrivals and exponential service times were assumed due to the lack of historical data from which other distributions could be determined. The system was further assumed to be a first-in-first-out system with no priorities and the time reference was redefined so that the periods of time when patrons would not be working were eliminated.

With these assumptions, it was possible to obtain closed form equations for the expected waiting time in queue for a person delayed, W_q . The equations used were:

$$P_0 = \frac{1}{1 + \sum_{n=1}^{c-1} \binom{m}{n} (c\rho)^n + \sum_{n=c}^m \frac{n!}{c! c^{n-c}} \binom{m}{n} (c\rho)^n}$$

$$P_n = \begin{cases} P_0 (c\rho)^n \binom{m}{n} & 0 \leq n < c \\ P_0 (c\rho)^n \binom{m}{n} \frac{n!}{c! c^{n-c}} & c \leq n \leq m \end{cases}$$

$$\rho = \frac{\lambda}{c\mu}$$

$$W_q = \frac{1}{\lambda} \sum_{n=c+1}^m (n-c) P_n$$

where P_0 is the steady-state probability that there are no patrons waiting or being served, P_n is the steady-state probability that there are n patrons waiting and being served, m is the number of patrons, c is the number of readers, λ is the service rate, and μ is the arrival rate. [Ref. 15]

The model was applied to 48 ratios of service to arrival rate for two, three, and four readers and five, ten, 15 and 20 patrons using an IBM 360 computer to perform the calculations. Results of this applications are record in Table XIV. To provide more generality to the analysis, the value of μ , the arrival rate, was made one for each ratio thus providing many possible ratios for each λ and μ . For example, consider the case where λ and μ both equal one. The ratio of λ/μ is also equal to one. The wait in queue resulting from this

case for a given m and c can be applied to any case where λ equals μ , for example $\lambda = \mu = 0.25$, $\lambda = \mu = 2.0$.

A side comment on computer procedure is in order. The IBM 360 has a limited capacity for integer numbers. It was found that 14 factorial was the largest factorial that the machine could handle. In order to consider sections of 15 and 20 patrons, it was necessary to use floating point numbers for the factorial values and thus the factorial of the numbers from 0 to 20 were input to the computer rather than being computed within the machine. To determine if any significant difference was being generated by using floating point numbers, a second program was run using the exact integer values of the factorials from 0 to 14 and the value of 14 factorial for the remaining values. Comparing the two runs showed no difference in the values for the probability of any wait for 5 patrons, differences in the fifth decimal place for the ratios of λ to μ of less than one for ten patrons and differences of the fourth and fifth decimal places for comparable values for 15 patrons. It was not possible to make meaningful comparisons for 20 patrons. The conclusion of this study was that there was no significant effect on the results of the study resulting from the use of floating point numbers.

The results of the model were applied to the Deseret Test Center situation in order to determine the number of readers that should be obtained for each staff section. The minimum level of service considered was eight hours. In other words, if a patron had to wait more than eight hours to use a machine, his productive effort would be negatively affected. On this basis, staff sections with five or less patrons should be allotted one reader, sections with five to ten

TABLE XIV

EXPECTED WAITING TIMES, IN HOURS, FOR DELAYS IN QUEUE

Service Rate	Arrival Rate	Readers	Patrons			
			5	10	15	20
0.25	1.00	2	0.47	5.83	20.53	40.01
0.33	1.00	2	0.66	7.37	21.07	36.18
0.50	1.00	2	0.98	8.11	18.00	28.00
0.67	1.00	2	1.16	7.51	14.99	22.49
0.75	1.00	2	1.21	7.12	13.78	20.44
1.00	1.00	2	1.26	6.00	11.00	16.00
1.25	1.00	2	1.23	5.12	9.12	13.12
1.33	1.00	2	1.21	4.88	8.64	12.40
1.50	1.00	2	1.16	4.44	7.78	11.11
1.67	1.00	2	1.11	4.07	7.07	10.06
1.75	1.00	2	1.09	3.92	6.78	9.63
2.00	1.00	2	1.01	3.50	6.00	8.50
2.50	1.00	2	0.88	2.88	4.88	6.88
3.00	1.00	2	0.78	2.44	4.11	5.78
3.50	1.00	2	0.69	2.12	3.55	4.98
4.00	1.00	2	0.63	1.87	3.12	4.37
0.25	1.00	3	0.04	1.30	7.24	21.10
0.33	1.00	3	0.07	2.11	10.25	24.04
0.50	1.00	3	0.14	3.48	12.05	22.00
0.67	1.00	3	0.21	4.07	11.25	18.74
0.75	1.00	3	0.24	4.16	10.67	17.33
1.00	1.00	3	0.32	4.02	9.00	14.00
1.25	1.00	3	0.36	3.59	7.68	11.68
1.33	1.00	3	0.37	3.57	7.33	11.09
1.50	1.00	3	0.39	3.33	6.67	10.00
1.67	1.00	3	0.40	3.12	6.11	9.10
1.75	1.00	3	0.40	3.02	5.88	8.73
2.00	1.00	3	0.40	2.75	5.25	7.75
2.50	1.00	3	0.39	2.32	4.32	6.32
3.00	1.00	3	0.37	2.00	3.67	5.33
3.50	1.00	3	0.35	1.76	3.18	4.61
4.00	1.00	3	0.33	1.56	2.81	4.06
0.25	1.00	4	—	0.25	2.13	11.22
0.33	1.00	4	—	0.50	3.85	14.08
0.50	1.00	4	0.01	1.14	6.71	16.07
0.67	1.00	4	0.02	1.70	7.58	15.00
0.75	1.00	4	0.02	1.91	7.59	14.22
1.00	1.00	4	0.04	2.25	7.00	12.00
1.25	1.00	4	0.05	2.31	6.24	10.24
1.33	1.00	4	0.06	2.30	6.01	9.77
1.50	1.00	4	0.06	2.25	5.56	8.89

TABLE XIV Continued

EXPECTED WAITING TIMES, IN HOURS, FOR DELAYS IN QUEUE

Service Rate	Arrival Rate	Readers	Patrons			
			5	10	15	20
1.67	1.00	4	0.07	2.17	5.15	8.15
1.75	1.00	4	0.07	2.13	4.98	7.84
2.00	1.00	4	0.08	2.00	4.50	7.00
2.50	1.00	4	0.09	1.76	3.76	5.76
3.00	1.00	4	0.09	1.56	3.22	4.89
3.50	1.00	4	0.09	1.39	2.82	4.24
4.00	1.00	4	0.09	1.25	2.50	3.75

patrons should receive two readers, ten to 15 patrons should require four readers, while sections with 15 to 20 patrons should require four or more readers. If the section size is disregarded, an adequate distribution of one reader for every four patrons would insure that patrons would not have to wait more than eight hours in over 75% of the cases examined. Table XV summarizes the application of the above formulas to the DTC sections and increments the introduction of readers into the command.

The distribution of reader/printers throughout the command must be restricted to prevent the unauthorized reproduction of classified material and to prevent a patron from arbitrarily making hard copies of all microform documents in his possession. The reasoning for the first problem is obvious but the second bears explanation. The average sized document distributed by DDC contains between 70 and 80 pages. [Ref. 16] At present, it costs about 11 cents to make a copy of a page from a microform or more than \$7.70 per document. This cost is greater than the \$3.00 cost of obtaining a hard copy directly from DDC. The distribution of reader/printers within DTC should be restricted to one for each library facility and one for each of the four directorates.

TABLE XV

DISTRIBUTION OF MICROFORM READERS

Office	Present	Phase I	Phase II	Total
Plans and Analysis Directorate				
Liaison Office (S)	0	0	0	0
Technical Publications (S)	0	0	0	0
Biological Systems (S)	0	1	1	2
Chemical Systems (S)	0	1	1	2
Material Test (D)	0	1	1	2
Requirements Analysis (S)	0	1	1	2
Technology & Tech Support Directorate				
Biological Division (D)	0	1	1	2
Chemical Division (D)	1	1	0	2
Joint Contact Point				
Biological Operations Research(S)	1	0	1	2
Chemical Operations Research(S)	0	1	1	2
Informational Analysis (S)	1	1	0	2
Informational Analysis (D)	1	0	0	1
Meteorological Division (S)	0	0	1	1
Meteorological Division (D)	0	1	0	1
Test Operations Directorate				
Administrative Office (D)	0	1	0	1
Instrument Division (S)	0	1	0	1
Range Instrumentation Division	0	0	0	0
Test Division (D)	0	0	0	0
Medical and Safety Office				
Ecology and Epidemiology (D)	0	2	1	3
Medical Division (S)	0	1	0	1
Safety Division (S)	0	0	1	1
TOTAL	4	14	10	28

Note: Each library facility presently has one reader/printer

(S) : Fort Douglas
(D) : Dugway

VII. SUMMARY

This paper began with a discussion of the organization and missions of Deseret Test Center, of the Information Analysis Branch and of the Technical Library. Further, comments were made concerning a previous library study. These two areas of background information served as the foundation for the rest of the study.

Measures of effectiveness for the Information Analysis Branch were proposed that reflected the missions of DTC and the role of the Technical Library, an element of the Information Analysis Branch, in the accomplishment of the DTC missions. The measures established levels of service that were considered attainable to those responsible for the Library's operations and that would meet the needs of the patron.

The relative merits of maintaining a library collection in microform were compared with the disadvantages of this type of holding. In view of the increasing number of reports and other printed material being received by the Library and of the large savings of space resulting from replacing hard copy holdings with microform, it was concluded that the few inconveniences to the patron from microform holdings were far outweighed by the advantages of including microform in the Library's holdings.

The design, administration and results of the Technical Information Services Questionnaire, whose purposes were to determine the attitudes of patrons of the Technical Library toward microform and to determine some patron use patterns, were presented. Results of the Questionnaire indicated that most of the Technical Library's patrons were familiar with microform; that the patrons would be satisfied to

have reports and documents in microform but opposed having periodicals in this form; and that they preferred to use the library material at their desks rather than in the Library. Selected subjective response questions were analyzed using the attitude scaling technique of the Method of Summated Ratings. This analysis revealed that the majority of library patrons favored having microform in the Library's collection. To determine how amenable the selected questions were to attitude scaling, a scalogram analysis was performed that indicated that the questions were not well suited for attitude scaling.

The growth of the Library was modeled as a linear regression model in order to determine how many years were needed to reach the capacity of the Library's shelf space. Application of this model was made to the three categories of material - books, classified reports, and unclassified reports - for each facility of the DTC Library. The results were that while space would be available for limited growth of unclassified reports and books, the classified storage areas would reach capacity in less than one year.

Holding policies were proposed that would provide shelf space for future growth. The separate policies presented for present holdings and future acquisitions were to be applied to both facilities and reflected the missions of the Library while considering the importance of service to the patron. Implementation of the proposed policies would result in substantial availability of shelf space.

Lastly, considerations for equipment necessary to utilize the microform holdings were presented. The purchase of a step-repeating microform camera was considered uneconomical as was the purchase of a microfiche reproducer. The problem of determining the number of

microform readers needed for each staff section was attacked by modeling the use of readers with a finite population, many server queueing model similiar to the classical machine interference problem. Utilizing the results of the model, a distribution of readers to the DTC staff sections was proposed.

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<p>The operations of the Deseret Test Center Technical Library, an element of the Information Analysis Branch, were examined. Measures of effectiveness for the Branch and Library were proposed and the advantages and disadvantages of having microform in the Library's holdings were discussed. The design, administration and results of a Technical Information Services Questionnaire were presented and selected questions from the Questionnaire were subjected to analysis using attitude scaling techniques. The growth of the Library's collection was modeled as a linear regression model and the number of years remaining until the Library reached capacity was determined. Holding policies for present holdings and future acquisitions were proposed to provide additional space for future growth. Considerations for equipment necessary to utilize the microform holdings were detailed and a distribution of microform readers was proposed based on the results of modeling reader use as a finite population, many server queueing problem.</p>			

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Microfilm						
Library						
Attitude Scaling						
Measures of Effectiveness						
Library Growth						

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