TECHNICAL REPORT
NATICK/TR-84/043

(12)

AD_____

STUDY OF THE CAPABILITY OF THE UNITED STATES TEXTILE AND APPAREL INDUSTRIES TO SUPPORT NATIONAL DEFENSE

VOLUME 1

BY
TONY D. BROOKS
AND
DOUGLAS C. ROGERS

KURT SALMON ASSOCIATES, INC
ATLANTA, GA 30361

JUNE 1983

UNITED STATES ARMY NATICK
RESEARCH & DEVELOPMENT CENTER
NATICK, MASSACHUSETTS 01760-5000

INDIVIDUAL PROTECTION LABORATORY

DISCLAIMER

THE VIEWS, OPINIONS AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHORS AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION UNLESS SO DESIGNATED BY OTHER DOCUMENTATION.

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

CITATION OF TRADE NAMES IN THIS REPORT DOES NOT CONSTITUTE AN OFFICIAL INDORSEMENT OR APPROVAL OF THE USE OF SUCH ITEMS.

DESTROY THIS REPORT WHEN NO LONGER NEEDED. DO NOT RETURN IT TO THE ORIGINATOR.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NATICK/TR-84/043 — 2. GOVT ACCESSION NO.: AD-A146663 — 3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): STUDY OF THE CAPABILITY OF THE UNITED STATES TEXTILE AND APPAREL INDUSTRIES TO SUPPORT NATIONAL DEFENSE, VOLUME 1	5. TYPE OF REPORT & PERIOD COVERED: Final Report, Oct 81 thru Jun 83
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): TONY D. BROOKE, DOUGLAS C. ROGERS	8. CONTRACT OR GRANT NUMBER(s): DAAK60-81-C-0153
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Kurt Salmon Associates, Inc., 400 Colony Square, Atlanta, GA 30361	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 1304257700050
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Research and Development Center, Individual Protection Laboratory (STRNC-I), Kansas Street, Natick, MA 01760-5019	12. REPORT DATE: June 1983
	13. NUMBER OF PAGES: 228
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:
16. DISTRIBUTION STATEMENT (of this Report): Approved for public release; unlimited distribution.	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):	
18. SUPPLEMENTARY NOTES: This report is Volume 1 of two volumes. The sub-title of Volume 2 is Appendix.	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number): Capability, Textile Industry, Apparel Industry, Armed Forces Requirements, Military Requirements, National Defense, Textiles, Clothing, Peacetime, Wartime.	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of this project is to determine the national defense requirements for textiles and clothing and the impact these requirements will have on the United States industrial capabilities in a peacetime or wartime environment. A further objective is to define the role Natick R&D Center should take to meet research and development requirements of the military services which are not expected to be met by the United States textile/apparel industry.

Volume 1 of the report indicates that, in general, sufficient capability exists

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

In both the textile and apparel industries to meet the mobilization requirements of the three unclassified scenarios in the report. However, several weaknesses were identified that could become critical, especially under full mobilization conditions. These weaknesses are:

- Sole source proprietary fibers;
- Very heavy duck fabrics used in tents, tarpaulins and vehicle upholstery;
- Foreign sole source chemicals related to fire, water, weather, and mildew resistance (FWWMR); infrared reflectance (IR); and colorfastness;
- Foreign source sewing needles.

Also, the report recommends that all DoD clothing and individual equipment research and development activities be consolidated at the Natick R&D Center.

Volume 2, Appendix, provides documentation information.

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

SUMMARY

The experience gained in providing clothing and individual equipment during the Second World War, the Korean war, and the Vietnam conflict has indicated that textiles and apparel are strategic commodities. In peacetime, however, procurement procedures and planning are not focused on responding to the needs of a mobilization. Budget limitations and the separate missions of the agencies involved in designing, testing, procurement, and delivery of clothing and individual equipment to the armed forces result in less than comprehensive planning for these items crucial to combat sustainability.

Mobilization scenarios emphasize planning of end-use items. However, the planning process does not extend upstream into the industrial chain responsible for delivering finished goods. The Individual Protection Laboratory at the U.S. Army Natick Research and Development Center commissioned this study to determine the capability of the textiles and apparel industries to meet projected national defense requirements. Approximately nine years ago, Dr. S. J. Kennedy prepared an analysis addressing this issue. This study expands upon Dr. Kennedy's work.

Although textiles represent a crucial commodity to sustaining the military in modern warfare, no previous attempt had been made to quantify, by basic textile group, the requirements to meet mobilization demands. Should a sudden demand occur due to a full or partial mobilization, indications of the magnitude of components needed to provide finished clothing and individual equipment exist only in the estimations provided in this report.

In general, based on the methodology employed by KSA, sufficient capability exists in both the textile and apparel industries to meet the mobilization requirements of the three unclassified scenarios in the report. However, several weaknesses were identified which could become critical, especially under full mobilization conditions. These weaknesses involve the following areas:

- Sole source proprietary fibers;
- Very heavy ducks used in tents, tarpaulins, and vehicle upholstery;
- Foreign sole source chemicals related to fire, water, weather, and mildew resistance (FWWMR); infrared reflectance (IR); and colorfastness;
- Foreign source sewing needles.

The peacetime demands for the clothing and individual equipment items covered in the study do not reflect a significant demand on the textile or apparel industrial base. Initiatives for comprehensive planning do not flow from the private sector and are not taking place within or among the five armed services.

The small base supplying military apparel does not have much additional capacity to bring on line in a mobilization. This lack of capacity is a function of the restrictions of the procurement system and impacts the response time. Changes in procurement regulations would be required to expand the base of experience in the apparel industry.

As the length of time between conceptual design of a clothing or an equipment item and its distribution to troops can be many years, maintenance of close contact between industry and the military is essential. The present system impedes an active interaction between product research and development and private industry. Product improvements are slowed due to multiple agency involvement. Private industry interest in peacetime procurement is reduced by the lack of coordination among agencies and little incentive to become involved in a product prior to fielding.

Part of comprehensive planning would include a defined relationship between performance of the mission of an end-use item and the technical specifications for that product. Prior knowledge of what may be relaxed in the specifications without imperiling the mission allows producers to project capabilities to respond in a mobilization.

Overall, industry research and development does not focus on military needs. Rather the Natick Research and Development Center (NRDC) represents the major resource in this area. Given the NRDC resources and experience base, it is the logical choice for a central coordinating agency of all DoD clothing and equipment research and development with control to maximize resource utilization benefits.

This study recommends actions be taken that:

1. Identify and quantify textile demands needed in national defense, expanding planning to include the industrial chain beyond end-use items;

2. Utilize industry expertise and product knowledge in the design of clothing and equipment items;

3. Focus on changes in the areas of product development and product improvement to increase industry participation and utilization of state-of-the-art materials and processes;

4. Expand the participation of the industrial base in peacetime procurement;

5. Reduce duplication in specifications, research and development facilities, and comparable items which dilute the impact of the limited budgets committed to clothing and individual equipment.

This document will perhaps best serve as a foundation for additional work to measure accurately textile and apparel mobilization requirements and orchestrate military and industrial base requirements. There is a long way yet to go to consider our logistical system for Clothing and Individual Equipment (CIE) adequate for sustainability in mobilization.

FOREWORD

This report brings together a great deal of information which will be useful for reference purposes, as a basis for dialogue between representatives of Government and industry, and as a point of departure for future projects on various aspects of this subject.

The reader should understand that the generally favorable conclusion regarding the present capability of the United States textile and apparel industries to meet military requirements must be viewed in light of the methodology employed in this study. For example, the study did not consider requirements for dress uniforms in a full mobilization condition, although policy may require the use of such uniforms under any mobilization condition. Also, the report suggests that specifications for special military fabrics might be relaxed under mobilization conditions to allow the substitution of more readily available materials in military items. While some compromises of this nature may have to be made, they can be expected to affect adversely the performance of the items, including the degree of protection provided the individual soldier. Therefore, the time required for the industry to increase capacity to produce the specification fabrics in sufficient quantity to avoid substitutions is a major concern. These and other areas remain for future studies to define fully the capability of these industries to meet the specific requirements of the military services.

EDWARD F. LEVELL
Acting Director
Individual Protection Laboratory
U.S. Army Natick Research &
Development Center

PREFACE

This study illustrates the variables involved in analyzing military textile and apparel requirements for mobilization. The study addresses the multiple issues of procurement, planning, sourcing, logistical constraints, industrial base response, and research and development in the context of the strategic nature of textile and apparel. This is not a technical document to describe any particular process of either the textile or apparel industry, though we are significantly indebted to numerous individuals, agencies, and organizations in both industrial and government areas of technical assistance.

Kurt Salmon Associates, Inc. (KSA) received a contract award from the Directorate for Procurement, Army Natick Research and Development Laboratories (now U.S. Army Natick Research and Development Center) to perform the Study of the Capability of the United States Textile and Apparel Industries to meet Armed Forces Requirements in Support of National Defense. Volume 2 in this series, NATICK/TR-84/044, provides documentation information. The contract approval for this study was awarded 30 September, 1981 with a contract number DAAK60-81-C-0153. The project officer was Laurance Coffin.

TABLE OF CONTENTS

Volume 1

TABLE OF CONTENTS
Volume 1
(Continued)

TABLE OF CONTENTS
Volume 1
(Continued)

TABLE OF CONTENTS
Volume 1
(Continued)

TABLE OF CONTENTS
Volume 2

TABLE OF CONTENTS
Volume 2
(Continued)

LIST OF FIGURES

LIST OF FIGURES
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

STUDY OF THE CAPABILITY OF THE UNITED STATES TEXTILE AND APPAREL INDUSTRIES TO SUPPORT NATIONAL DEFENSE

I. INTRODUCTION

A. Background

The United States Army Research and Development Laboratories (NLABS)* was formed in 1954 for the purpose of sustaining, protecting and increasing the capabilities of our defense forces to function in natural environments and meet battlefield threats. Improved environmental survivability involves continuous application of technology, and battlefield threats require both constant alteration of existing products and development of new equipment, shelter, and clothing items.

The primary mission of NLABS is to furnish the Army, and in many cases the other Military Services, solutions to military needs. Specific projects are commodity-oriented but the development of a new or improved product may include basic, exploratory, or advanced research and engineering investigations.

The NLABS meets the requirements of military users in the areas of:

- Rations and food services
- Individual protection
- Organizational facilities
- Basic research as needed.

The research and development is conducted in various technological fields such as life sciences, physical sciences, and behavioral sciences; in mechanical and other branches of engineering; and in several advanced technologies, such as food and textiles; and other materials area technologies.

The official NLABS mission statement contains these major responsibilities:[1]

- Accomplish research and development in the physical and biological sciences and engineering to meet military needs in the commodity areas of clothing and personal equipment;

---

*Renamed (October, 1983) U.S. Army Natick Research and Development Center.

airdrop; field shelters and equipage; field organizational equipment; food and food systems; containers and packaging. Conduct research and development in assigned areas of pollution abatement.

- Accomplish integrated Logistic Support functions for all assigned commodity areas and execute first production procurement and fielding of new end items designated for Army management.

- Provide technical and engineering support to all U.S. Army Materiel Development and Readiness Command (DARCOM) Research and Development Commands, Readiness Commands, Project Managers, Defense Logistics Agency (DLA), General Services Administration (GSA), and other DoD and Government agencies within designated commodity areas.

- Serve as the DARCOM coordinative manager for development and readiness matters related to the Individual Soldier.

- Provide installation support to satellite agencies and other activities as directed by Headquarters, DARCOM.

This study was awarded by the Individual Protection Laboratory (IPL). The four Natick laboratories conduct the majority of the research and development for the Department of Defense in these areas:

- Individual Protection
- Aero-Mechanical Engineering
- Science and Advanced Technology
- Food Engineering.

The structure of the entire NLABS command is shown at Figure 1.

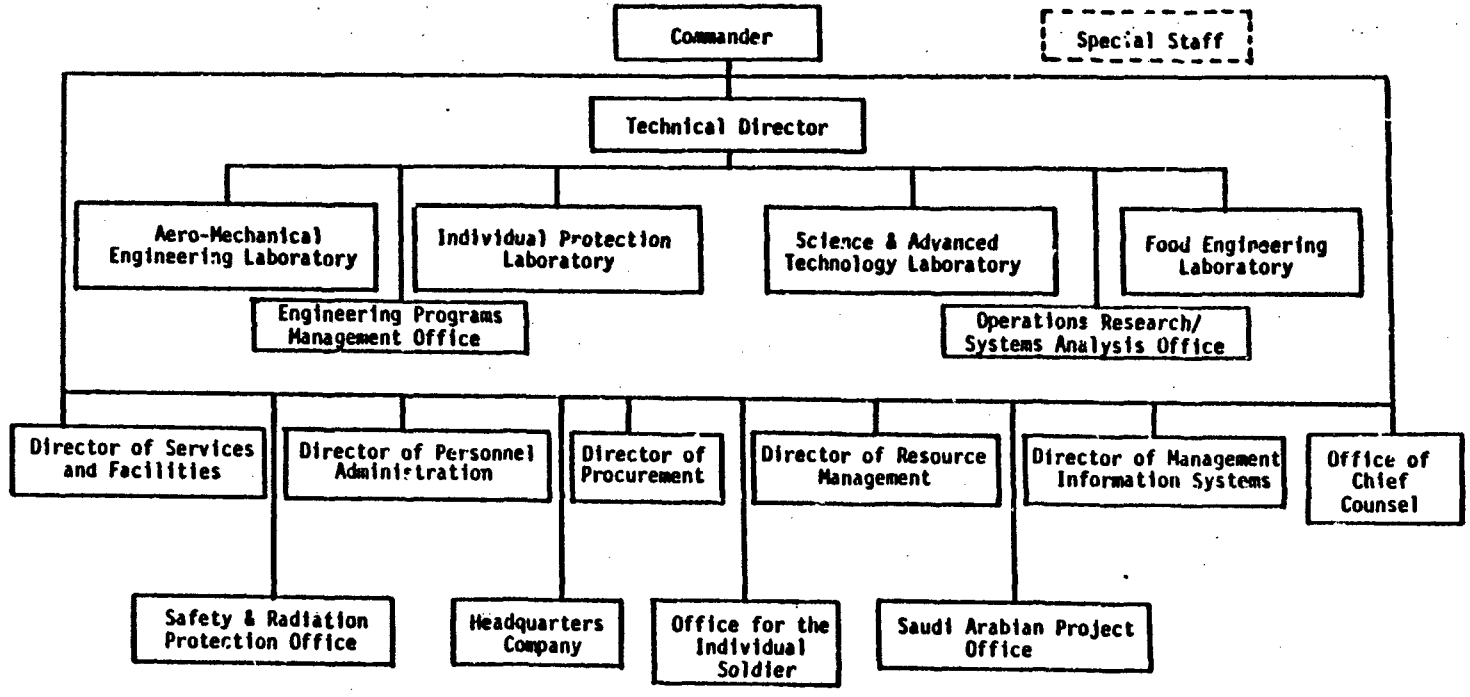


FIGURE 1. U.S. ARMY NATICK RESEARCH AND DEVELOPMENT LABORATORIES ORGANIZATION CHART (JUNE 1983)

The research, development and engineering activities of the Individual Protection Laboratory (herein referred to as IPL) contribute to solving the problems of sustaining and protecting the military person in combat or combat-related situations.

Responding to changing battlefield threats involves constant attention to industrial base capabilities and assessment of protection levels for military effectiveness. These threats include small arms fire, fragmentation weapons, chemical and biological agents, land mines, flame and flash fire, infrared detectors, and laser weapon and detection systems. The IPL develops body armor, clothing and equipment to deter these threats.

The NLABS scientists, technologists and engineers provide the technological base for performing the experiments and evaluating the systems required to stay abreast of advances in warfare. Additionally, a large part of the NLABS scope of responsibilities is to anticipate future developments in threat response and translate that need into a functional military item of clothing or equipment.

It is important to note that while the IPL of the NLABS is the primary organization for research and development of all Department of Defense items of clothing and equipment, but it is not the only such agency. Each separate military service—except the Coast Guard, which is an arm of the Department of Transportation - during peacetime maintains some form of clothing office for research, testing, development, or evaluation of clothing and equipment items. As will be discussed in later sections relative to research and development (herein referred to as R&D), these other facilities do not operate with missions which conflict with the IPL of NLABS.

B. Objectives

The objective of this project is to determine the national defense requirements for textiles and clothing and the impact these requirements will have on the United States industrial capabilities during peacetime or wartime. A further objective is to define the role NLABS should take to meet research and development requirements of the military services that are not expected to be met by the United States textile/apparel industry.

1. Military Requirements

The study shall determine the military demand for textiles and apparel in support of national defense under various states of preparedness. The study will be

concerned with the 1982-1992 time frame and the rates and extents of mobilization relative to historical periods as outlined here:

Scenario A - Peacetime (e.g., 1981)
Scenario B - Gradual mobilization (e.g., 1965-1970)
Scenario C - Limited but rapid mobilization (e.g., 1950-1955)
Scenario D - Total mobilization (e.g., 1941-1946)

Military requirements for textiles and apparel will vary according to the considered mobilization scenario. The determination of military textile demands involves the development of total requirements based on products used by the military services that utilize textile components. This development of total product demand involves an appreciation of the entire process of logistical support for clothing and textiles.

The study shall consider all textile and clothing items contained in a specific product list prepared by the IPL at the NLABS. Though not all-inclusive, the study list encompasses most textile and clothing articles required in support of national defense. The study does illustrate that certain items have distinct military technical requirements while others are not significantly different from those items used for similar purposes in the civilian market.

The items in the study can be considered to include the following categories of clothing and equipment:

a. Uniforms

(1) Winter Service Uniform
(2) Summer Service and Semi-Dress Uniform
(3) Utility Uniform

b. Protective Clothing/Equipment Systems

(1) Hot Weather Clothing
(2) Cold Weather Clothing
(3) Extreme Cold Weather Clothing
(4) Desert Clothing
(5) Aviator's Clothing
(6) Combat Vehicle Crew Clothing
(7) Chemical Warfare Protective Clothing
(8) Personal Equipment
(9) Personnel Armor

c. Tents, Paulins, and Covers

d. Parachutes and Related Airdrop Equipment

e. Miscellaneous Military Uses

(1) Sheets, Towels, Blankets, etc.

f. Other Textiles Used in the Production of Military Materials

2. Industry Capabilities

The study will extend the derivation of aggregate military textile and apparel demands to the consideration of industrial base capabilities to satisfy those requirements. The study will discuss specific areas where industry capability will meet or will not meet the military services requirements. In those areas where industry capability can meet requirements, recommendations shall be made to actively monitor and strengthen the capability in potentially weak areas. In the areas where industry capability cannot meet requirements, specific recommendations and action plans shall be made to correct the deficiencies. The study shall address current policies and procedures that the Department of Defense exercises in support of industrial capability for textiles and apparel, and provide recommendations for improved coordination between military demand and industry response.

The study will consider the current posture and environment of the textile and apparel industries and determine the effect these factors have on meeting military requirements. The following variables, which could influence industry capability, will be considered:

a. Effect of textile/apparel manufacturing technology on military requirements;

b. Inter-relationship of chemical, textile, and agricultural industries to clothing and textile needs;

c. New concepts in fabricating end items;

d. Limitations of manufacturing equipment, production rates, and spare parts;

e. Lack of a broad-based domestic textile machinery industry;

f. Manufacturing capacity limitation of certain textile items (e.g., duck fabric);

g. Effects of stockpiling military textile and clothing items;

h. Current military procurement policies;

i. Energy costs;

j. Effect of federal regulations on textile production plants, particularly in cotton processing and dyeing/finishing facilities;

k. Materiel shortages in the dyeing/finishing industry;

l. Increased use of noncelluose, manmade fibers either in blends with natural fabrics or as a replacement for them;

m. Long-term effect of nonwovens on military requirements;

n. Effect of export products on domestic industry product development;

o. Concentration (or narrowing) of the textile and apparel industries;

p. Ability to convert to different product base;

q. Long-term effect of petroleum prices on manmade fibers;

r. Increase in export products and markets;

s. Long-term effect on broadwoven fabrics;

t. Ability of industries to convert to military items on an emergency basis;

u. Increase in import products;

v. Effect of apparel manufacturers moving labor-intensive operations off-shore;

w. Lack of adequate labor force.

3. Research and Development

The research and development (R&D) objective of this study is designed to give the NLABS an analysis of R&D requirements for the military in the study time frame, with an additional objective to discuss the contribution to these R&D requirements which the apparel and textile industries will make. The result of this analysis will enable the development of recommendations regarding actions and organization structure required to meet these future R&D requirements.

a. Posture

The research and development issue is a critical one for overall Department of Defense readiness considerations. Because of the time frames involved in R&D programs, whether conducted by the military or any commercial organization, R&D requirements maintain a very different posture in mobilization than in peacetime.

Total military R&D involvement by the commercial sector represents a significant and often lucrative opportunity for businesses. Department of Defense R&D contracts cover the spectrum from billion dollar appropriations to low-cost agreements for low priority research programs.

b. Activities

These R&D programs which currently provide the input to decision-making on numerous defense products and expenditures follow specific contractural arrangements. There are numerous Defense agencies with appropriations authorized for R&D activities that impact on the readiness posture of all military services and numerous military products. The specific R&D activities related to textiles and apparel are primarily contracted and monitored by the NLABS. The other service agencies with somewhat equivalent R&D responsibilities for clothing and textiles do not represent as significant an expenditure and are more oriented to special purpose products for particular military missions.

The funding for the total R&D program does include a great deal of contract work performed for the military services by the commercial sector. This study will address that relationship and address procedures related to this facet of military spending.

c. Five- to Ten-Year Needs

A concern for any agency that conducts programs with multi-year life cycles is to focus on future product needs. The NLABS has as its primary mission the survivability and protection of the military soldier in the combat environments of the future. Just what those environments will be in the next 10 years is often a direct response to what we know to be battlefield "threats." These threats are capabilities represented by the state of technology for weaponry or detection equipment which either we possess or know to be developed and fielded by representative Warsaw Pact members. There are, however, survivability scenarios for which not all the answers are known, and NLABS must employ some procedure for selection of long range R&D programs which will influence clothing and equipment products utilized by the multiple Services.

These long range military product needs are as much a function of industrial base capability to resolve as they are of threat determination. The study will illustrate what the multiple parameters are for the combined NLABS and industry response to future R&D needs. It is not within the scope of the project to define exactly what the technical R&D needs will be in the next 10-year time frame for NLABS to respond correctly to battlefield threats.

As mentioned, in peacetime a significant portion of the R&D effort related to textiles and apparel is conducted by organizations external to NLABS or any of the other service agencies responsible for clothing and textile development. This R&D effort represents both the interest and capacities of numerous corporations, academic institutions, independent research and scientific laboratories, and government testing facilities or organizations. The fundamental consideration for NLABS is to project this similar availability of resources for future R&D support. These external resources either possess knowledge or technology which NLABS relies on now, but which may or may not be representative of the entire industrial base in five or 10 years. The entire issue of staying abreast of technology while predicting future military needs is constantly present in NLABS R&D planning.

C. Scope

To satisfy the objectives of the study, there were several major factors that required either definition or derivation for a thorough appreciation of both military demands and industry capabilities:

- Military demand for textiles and apparel must somehow be translated into quantitative form to enable comparison with industry base capabilities, which we traditionally reported as production, shipments, or some measure of volume.

- Military demand for textiles and apparel is not a combination of terms which can be addressed collectively. The demand for apparel end-products reflects an obvious demand on the textile industry for the raw materials used in their production.

- Several conditions required definition by NLABS to provide the dimensions of the study in terms of products considered.

- Military demand for clothing and textiles is not a fixed consideration for either the agency responsible for the determination of demand or the agency responsible for the determination of supply. The entire control of textiles as a commodity is not a static requirement and involves numerous government and nongovernment organizations.

- The definition of industrial base response is also not a fixed parameter for any comparison to military needs. Industry changes, independent of military product demand changes, cause disparities to exist betweeen demand and supply.

1. DoD Procurements

Purchasing of end-use items of clothing and textiles for use by the military services is accomplished through a logistics organization known as the Defense Logistics Agency (referred to as DLA). The majority of these procurements for clothing and equipment items used by the Services are managed by a single organization within the DLA, with a specific budget annually. The final determination of which demand for military products will be supplied rests with this procurement arm of DLA. The entire procurement process must be understood to appreciate the complexity of coordination between the demand and supply constituents.

2. Clothing and Textiles

This study does not include all items of clothing and textiles utilized by the military services and supplied by the domestic industrial base. NLABS provided a specific listing of products to be considered in the study and evaluated for industry capability. Additionally, the study does not include all nonclothing and textile items used by the military services that may contain textile components. This does require that reference be made to the relationship between those items selected for the study and total items involved in the defense logistics system that involve textile materials.

Clothing and textile procurement does not represent a significant portion of total DoD spending in any fiscal year, yet the peacetime procurement procedures have established some interesting relationships between defense agencies and civilian companies in the textile and apparel industries. These relationships require understanding to gain an appreciation of why industrial base capability may vary significantly between peacetime and mobilization conditions.

3. Multi-Service Requirements

The Defense procurement system for clothing and textile products basically responds to needs established by each individual service. These requests are based on a need to maintain established inventory levels of specific items, anticipated utilization of clothing and equipment items, or appropriations available for purchasing items of clothing and equipment in the system. This procedure ensures that the annual demand for clothing and equipment items received from the individual and independent services remains variable. The corresponding appropriations for procurement of the clothing and textile commodities is also a variable, and not necessarily linked to the aggregate service demand.

Multi-service requirements also dictate that many items of apparel and equipment in the system will have multiple service use. Though each service has distinctive items of clothing and equipment—represented most obviously by the different dress uniforms—and also distinctive products for special missions inherent to the service, a large percentage of clothing and equipment items in the procurement system has multiple service application. There are standardization guidelines for Defense apparel required by DOD-1 41.4032. The study does illustrate that mobilization

scenario conditions will be important for consideration of certain logistics system items.

4. Textile Commodity Control

The Defense Department procurement system involves thousands of end-use items, all of which are controlled in some fashion by a commodity manager. Not all commodities, however, are controlled in a similar fashion, and textiles represent a commodity for which there exists an entirely different control system than for tactical vehicles. The commodity control system for textiles has undergone some changes that the study will highlight and, until recently, was very fragmented. Since numerous agencies were involved and considerable duplication of effort existed, there were problems in textile commodity control, which impacted also on the supply side of the procurement process. Improved control of textiles will contribute to reducing misunderstanding between the NLABS, DLA, and the industrial base.

5. Study Variables

In the development of military textile demands, several variables required clarification as to their impact on study results. The remaining objectives of the study, primarily industrial base capabilities and military R&D needs in the future, also have numerous variables for consideration which will be addressed in the report, but the variables associated with total military textile demand required definition to support the derivation of the aggregate demand.

The primary study variables deal with end-items and mobilization scenarios. With respect to end-items, the following variables require consideration for development of a total textile demand:

- Item peacetime demand
- Item service utilization
- Item criticality
- Item replacement factor
- Item stockage level
- Item substitutability

With respect to mobilization scenarios, these considerations must be made both for demand and supply determinations:

- Duration of conflict
- Geographic location of conflict

- Logistical access limitations
- DoD strength growth rate
- Individual service strength growth rates

These variables will be discussed to show how difficult an exercise it is to pinpoint a specific textile demand for a given scenario, therefore making it a formidable task to plan strategically for military textile demands.

D. Procedures

The study objectives dictated a sequence of research requirements to be able to deal with the relationship between defense textile demands and industrial base response. The R&D objective was approached in a different manner, yet relying on data developed to respond to the initial project objective of supply and demand. Yet both major findings of the report are geared to the greater issue involved, that being the entire process of control for any commodity. The real value of the study will be to provide an appreciation of how the nuts and bolts fit together to illustrate a system that either has significant problems or functions well within the environment of industrial technological expansion and Defense appropriation and procurement procedures. Most of the facts are not in dispute, and many of the trends related to the U.S. industrial base will not have altered significantly in the short term. The real demand for change will not occur if there is neither understanding of the system shortcomings and constraints nor commitment by the principal agencies to give more consideration to preparedness planning than peacetime procurement.

In many ways the entire issue of obtaining finished apparel products from the domestic industrial base is fundamentally a sourcing consideration. The distribution consideration for the procured items is another critical element of the entire logistics function not in the scope of this study, but a constant concern for the military services, and most importantly an issue for mobilization planning. There is no question that several of the conclusions and recommendations of this study could impact materially on that distribution system.

1. Define Military Requirement Parameters

The study is an attempt to relate military textile demands to the existing domestic industrial base for textiles and apparel. Both elements represent large entities and could not be adequately addressed in this study. The demand for the full range of textile industry

products is not the quantitative objective of this report, rather those specific textile components associated with the finite list of military end-use products provided by NLABS. It is recognized both by KSA and NLABS that the total textile and apparel products utilized by the Department of Defense far exceed those on the study list. The important factor for any comparison of military demand to industrial capability is how representative that demand is of the actual mobilization demand for textiles and apparel. The study makes reference to this important factor by relating the study items both to existing logistical planning and total items in the system.

There are other parameters related to the study items that allow a legitimate comparison of demand to both availability and potential availability from the industrial sector. Total military demand is presented as representative of existing textile and apparel processes. Additionally, the cornerstone to the derivation of all military requirements for textiles becomes the source of initial product demand. The study details how these numbers were selected.

2. Mobilization Conditions

The study would not be providing a significant service if it were to only provide an indication of military textile demand under peacetime conditions, with corresponding analysis of domestic textile and apparel industrial capability to respond. It is clear that some textile demand from the services is manifest in the millions of apparel product items that enter the military procurement system annually. The supply therefore is capable of meeting the product demand in peacetime. However, the implications of how both the textile and apparel industries have structured themselves to meet this demand are important to discuss because of the impact that certain mobilization options would have on total military textile and apparel demands.

There is a historical perspective to this entire issue of industrial capability to meet military demands, and this study illustrates previous efforts to identify potential problem areas. The major concern with both previous and ongoing studies covering the relationship of the Defense procurement system and the response capability of industry is that all parties either have not been or will not be adequately or fairly represented. One overt objective for KSA was to ensure that all agencies and associations who are primarily influenced by defense product specifications or procurement actions relative to the items in the study were contacted and requested to offer their positions and recommendations. See Appendix FF for a listing of agencies and associations contacted.

It was not the intent of the study, however, for a single entity to benefit from any recommendation made, nor was any effort directed toward improving or damaging the competitive position of any single company. KSA, in the course of conducting an industry search for data relative to industrial base capabilities, has generated significant detail relative to individual companies and strategies. Information reported in the study, with exceptions only for situations already public knowledge, will reflect industrywide responses or trends without addressing individual company statistics.

Other mobilization considerations for total military textile demand include the numerous item factors previously mentioned, plus some relationship to existing mobilization planning and defense training base capabilities.

3. Military Textile Demands

The development of total military textile demands involved some attention to both the variable conditions relative to the four separate mobilization scenarios, plus a mathematical relationship of item demand to defense manpower growth. The growth of the Defense Department, reflected in the growth patterns of the individual services, is the primary driving force behind the increasing and changing item demand under the various mobilization situations. To quantify the impact that defense strength has on ultimate textile demand, KSA developed model functions to account for the many variables involved.

These formulas are applied against the four scenarios and produce demand figures for textiles over defined time periods. One objective of providing the derivation of the formulas is to enable the Defense establishment to verify them and modify as appropriate to account for other variables not included in the KSA analysis.

The military textile demand numbers derived from the formulas are presented in terms of the actual military fabric specifications for the appropriate textile component. This enables comparison to publicly available information on textile industry production. In addition, total military demand is also given as numbers of units by military specification designation in order to relate military products to apparel industry production by product category. In addition, military demand by volume of individual products allows a comparison to actual defense stockage levels of clothing and equipment items categories.

It is important to note that this type of analysis for actual military textile demand has no precedent. Exactly how beneficial the derivation of this database can be to both the Department of Defense and to the industrial base will be pointed out in this report. Regardless of whether every possible military variable has been considered in the derivation of KSA's aggregate demand figures, the importance of the exercise is in the magnitude of demand relative to both industrial production and mobilization capability.

4. Industrial Capability

Domestic and apparel industrial capability requires some clarification to avoid misinterpretation of either data or conclusions. For purposes of this study, the domestic textile industry involves a whole set of subindustries which are required to process raw materials into a finished fabric product, whether it will be a woven, knit, tufted, cord, or film product. Each phase of this textile process can be represented in terms of a finite number of operations or functions performed, as well as a designation of equipment utilized in the respective process. In this manner, the industry essentially has multiple dependent segments, each representing some quantifiable production capability. The methodology of the study was to attempt to segregate the textile industry into these production segments to define further what impact the various levels of military demand have on domestic industrial capability. The issue ultimately becomes one of specific demand instead of aggregate demand, with fiber and fabric distribution of total industrial productivity more important than the maxi. as reflected in collated industry or government reports.

This segregation of textile industry processes results in highlighting several areas where there are capability problems and where there is potential for problems under mobilization demands related to the study. There are many facets of this complete textile sequence where a minor piece of equipment or alteration to a process could have significant impact on overall industry capability for certain products.

With regard to the apparel industry, an entirely different set of mobilization issues deserve mention. The manufacturer certainly represents a critical step in the final production of a useful military end-item, and its basic raw materials are the fabrics which are the output of the textile process. Many of the same

variables are present in the apparel industry, but the entire focus of meeting the demand for military products requires observing the industry from a different perspective. These differences will be pointed out by the study, with comparisons to industrial capability similar to those made on the textile process area. In addition, separate recommendations are made relative to the existing coordination between NLABS, DLA, and the apparel industry, including reference to the existing procurement system. In this area KSA concentrated more heavily on the relationship of both government products and specifications to commercial production. Initial perceptions of apparel industrial response to mobilization demands may be misleading, and the study attempts to discuss existing defense facilities and planning relative to apparel and equipment procurement.

5. Problems with Meeting Demand

Any comparison of relative numbers will tend to illustrate differences that require explanation. The comparison of total military textile demand to industrial production did point out areas where there are no apparent problems against all scenario demands, and also some areas where there may be a problem for satisfying demand levels for certain mobilization conditions.

If once again the larger process is considered, it can be shown that there exist "bottlenecks" to ensuring an adequate supply of finished apparel or equipment products for military consumption. For planners, these bottlenecks range in degrees of significance, capability to correct, incentive to correct, and responsibility. There are additional considerations, which in themselves are not bottlenecks but are factors that bear more attention under mobilization. These are primarily sourcing considerations for raw materials and equipment. These bottlenecks are then presented relative to government specifications.

This identification of bottlenecks is a line of reasoning to orient both industry and defense toward thinking about the basic issue of supplying clothing and equipment items in mobilization. Peacetime procurement systems logically command the bulk of effort from the logistics agencies. The entire commodity control of textiles as a strategic item is another concept, far more critical to individual soldier survivability on the battlefield. To express it in the same way that one of

the top Department of Defense logistical commanders did recently, "Our most serious problem is just a shortage of things, not new things, just things. I'm not satisfied with our combat action sustainability."[2] As will be shown in the study, there is every reason to believe that textiles represent a strategic commodity to close the gap that exists between needs and stockage levels. The combat sustainability concern involves peacetime utilization of industrial capacity for military purposes, and an additional measure of available production called "surge capability." Is there an adequate proportion of resources allocated to logistics in peacetime for those mobilization considerations related to textiles? If the answer is important enough for the Defense Department Joint Logistics Commanders to consider, there is no question that any measure of system performance, to include procurement, must in some way be linked to contingency planning. KSA has taken the time to look into several aspects of the clothing and individual equipment planning procedures.

6. Changes to Industry Capability

The domestic textile and apparel industries are far from static entities, and the business environment of today involves both global markets and technological revolution. These two factors alone require adaptation and change, but these industries are subject to many additional forces, mostly not controlled by them. Therefore, a firm's capability today may have to be reassessed on a short-term basis. Additionally, the Defense establishment is not recognized as being subject to as many dynamic factors as the marketplace, and those agencies involved with and responsible for clothing and equipment program policies and specifications are traditionally not proactive.

These are certainly generalizations, but only to establish the point of dependency. The industrial base is the supplier to the Defense Department, yet the technical data for the required product emanate from defense agencies. If there is less than complete understanding of industry's position and capabilities, there are more likely to be long-term problems with procurement. The emphasis is not so much on technical demands or capabilities as it is with coordination from the initial research concept. This element of coordination cannot be overemphasized, as it tends to reduce misinformation between industry and NLABS, and enables NLABS to remain in a better position to make decisions that will impact on industry.

The additional factors that have an impact on overall industrial base capability are listed here and will be discussed individually. Each factor is considered relative to its impact on mobilization, both current and long-term.

- Textile machinery availability
- Industrial sewing equipment
- Industrial sewing needles
- Technology position
- Raw material sourcing
- Printing equipment
- Imports
- Dyeing technology
- Specification restrictions
- Industry consolidation

7. Research and Development Issues

Because the mission of NLABS is individual protection for soldiers against battlefield threats, and since threat changes are a function of improved technology, NLABS must give consideration to future capabilities. This involves considerable R&D planning and expenditures. The "right" R&D projects are critical to NLABS staying abreast of current threat technology. Yet NLABS is ultimately subject to the availability of products on the market, and therefore an inherent responsibility is to remain in close coordination with industrial base capability. Of even more importance is the consideration for average R&D project time from conceptualization to distribution of the end item into the supply system.

The industry, on the other hand, is also changing to respond to market demands and provide new products as technology improvements allow their development. Industry R&D primarily focuses on products for the commercial markets, and occasionally a development will result in some military application. There are reasons for industry R&D expenditures not having the improvement of military products as their primary objective, and these will be discussed with reference to the issue of mobilization and NLABS future R&D requirements.

Consequently, funding for military R&D activities related to clothing and individual equipment comes primarily from the Defense Department, with NLABS the largest single agency controlling the distribution of these funds. Again, the mission of NLABS is the major factor in the determination of R&D projects, which are

sponsored for the military. However, NLABS does have limitations on its own appropriations level, and whether that level is even sufficient to accomplish their stated mission is an area for discussion.

In terms of R&D performance in the industry, many factors contribute to a widely varying degree of participation in R&D activities within the textile industry alone, with separate consideration for the apparel industry. Generally, R&D expenditures for the textile and apparel industries run less than the average for all U.S. manufacturing, and trends are that this relationship of R&D to sales volume will not appreciably increase.

There is another element in the textile R&D field that does impact on military R&D projects. The independent laboratories not directly associated with a particular textile company, as well as facilities associated with major academic institutions, often have greater potential for conducting military R&D projects due to specialized equipment and the pure-research nature of much of their work. This area of R&D capacity is limited, however, and does not represent a major expansion of capabilities for NLABS in mobilization.

This project will address the major technology trends that have influenced changes in the textile and apparel industries, with attention to the process of how each industry responds to technology as well as highlighting technology, which has made a recent impact on these industries. In the next 5- to 10-year timeframe there may be some significant changes resulting from technology which is either in early developmental stages or receiving increased attention due to economic conditions and demographics. These interest areas are discussed in light of their impact on the Department of Defense capability to increase significantly end-product demand under mobilization conditions and have a more predictable response. In addition, many of these technology issues would directly impact on specification parameters that are prepared by NLABS and the other service clothing offices. The entire procurement sourcing function may be impacted as well, with the possibility of separate policies governing peacetime and mobilization sourcing of both textiles and finished products.

E. Conclusions and Recommendations

A study of this nature is tasked with developing conclusions relative to the major factors of military demand and industry response. However, there are numerous issues involved with making these major determinations that deserve mention as conclusions as well. Recommendations resulting from the study cover a wide variety of topics, with NLABS not necessarily the responsible agency for their solution. The recommendations are factors, however, which do impact on overall mobilization capability, and will need consideration by some Department of Defense agency.

The topic of mobilization is certainly one which draws immediate interest from planners and has also involved numerous projects over the years to assess particular elements of either military posture or the civilian impact of mobilization. Though some studies had no direct relationship to mobilization planning, when conducted, they involve "systems" that support defense planning and ultimately mobilization.

As with any other study with a scope of this magnitude, KSA does not expect to have uncovered every recommendation applicable to improving mobilization preparedness for clothing and individual equipment items. The recommendations presented are derived from an analysis of the variables that were included in the scope of this study. The major difficulty with an attempt to highlight all problems related to a given system is access to all information relevant to that system. In this study, certain information was classified and not available to us for this unclassified project. It is therefore understandable that certain recommendations relative to the commodity management of textiles and apparel may not be feasible due to internal Department of Defense organizational structure or procedures.

The real issue of this study is the process of controlling textiles as a strategic commodity. The entire planning sequence is involved when mobilization issues are considered, and this process must be strategic and be accomplished on a continuous basis during peacetime. Though textiles do not receive the attention they deserve either within the Department of Defense or Congress, the consequences of improper planning for combat-essential clothing and textile items could be as significant as improper planning for munitions.

As battlefield technological threats expand to infrared reflectance, laser detection, and other capabilities, vulnerability becomes the dominant issue for the individual soldier. Apparel products with appropriate finishing characteristics will be required to help deter those threats. The comfort properties of uniforms are not the key survivability issue, and commercially substituted apparel will simply not be adequate. This report should contribute to understanding the special needs of soldiers and other issues associated with the responsiveness or convertability of the textile and apparel industries to meet military mobilization demands.

This report was not written to support or condemn any industry, agency, institution, group or company objective regarding mobilization preparedness. The responsibility for mobilization planning and procurement rests with the Department of Defense, but the performance of the system is the multiple responsibility of industry, government and the military. Some of the system recommendations may appear to favor an individual industry or association position, yet all suggestions are designed to either improve the existing commodity control system, or offer alternatives to accomplishing both NLABS and DLA tasks to support the individual soldier with clothing and equipment that enable him or her to accomplish the battlefield mission. It is intended that the report will encourage additional thinking among the key agencies involved with mobilization planning. This increased interest level will likely generate numerous recommendations for mobilization planning, ideas from those closest to the sources of either military demand or industry capability.

One of the references for this report succinctly identified the issues of this study in this paragraph:

> This volume . . . should serve to impress students of military affairs, particularly those in staff and command positions, with the vastness and complexity of the activity involved in equipping and maintaining troops in the field. It tells a story of rapid expansion to meet the needs of a growing Army, of organizational readjustment in the midst of operations, of supply programs scrapped or modified in the face of unexpected demands, of improvisation and production under pressure when plans were inadequate or lacking. It clearly demonstrates the necessity in time of peace for a flexible organization, vision and care in planning, and a program of continuous military research and development to meet the sudden impact of war.[3]

II. MILITARY TEXTILE REQUIREMENTS

The initial step in providing an answer to the status of industrial base response capability for textiles and apparel was to establish what the military requirements would be. Because there exists a peacetime procurement system for textiles and finished apparel products, one could say that consideration of military demand is already established. There is certainly some relationship to the total military demand that normal peacetime procurement represents, but annual product procurements may vary significantly, making it less than accurate to establish any averages that would constitute a demand base.

Total dollar expenditures for military clothing and equipment have remained fairly constant in recent years, at the one billion dollar level, and that figure is a good one for comparative analysis to either total defense spending or appropriations for other mobilization critical programs.

A. Items List

Because the entire study conclusions depend on the quantification of a military demand, it was necessary for the contracting agency, NLABS, to provide a specific list of end-items to be considered for the project. After several revisions to account for the scope of this study, a final list was presented to KSA for consideration. Appendix A is an alpha-numeric listing by military specification number of these clothing and individual equipment end-items.

The main purpose for establishing a base for the study in this manner may be only partially obvious. The peacetime procurement system involves products spanning the entire spectrum of both textile components used by the Defense Department and utilization of end-items, which involve textiles. The point being that there may not necessarily be any correlation of military textile demand for mobilization and the end-items procured in peacetime. This holds true for both the types of textiles involved and the quantities procured.

NLABS agreed with the KSA analysis that a list of end-items should be prepared with the primary intent of identifying those products and textiles which would have the most significant impact on mobilization needs. As will be pointed out in a later section, there are several existing procedures within the Defense Department that consider products for mobilization. However, these various methods for identifying

key items have never been combined to demonstrate a complete demand for textiles.

The total number of finished products in the military supply system which contain at least one textile component probably exceeds one thousand items and this totality was not an objective of this project. The individual service need for those items varies from year to year under normal circumstances, and certainly mobilization needs for many of those items far exceed peacetime demand.

The final list of end-items contains 261 total products, and involves items of clothing, equipage, tentage, aerial delivery equipment, and vehicle parts. The breakdown is as follows.

Clothing	155
Equipage	57
Tentage	19
Automotive	21
Aerial Delivery	9
Total	261

In each of the five categories, the number of study items is fewer than the total number of items in the military logistical system for each category. This is stated to point out that a study to include every military end-item utilizing a textile component would be much broader in scope. Such a study might have some interesting results for both peacetime and mobilization planning considerations and would be a logical extension of the effect this study has on mobilization planning.

Perhaps one of the most beneficial aspects of such a study would be that the Defense Department would have a definitive body of knowledge relative to textiles demanded from industry under peacetime arrangements. The data could be used in many ways for logistical planning, to include expanding the demand for individual textile components for mobilization conditions using the functions and parameters developed by this study. Once an effort of this magnitude is made, however, it becomes a maintenance operation to keep the data up to date with regard to both changes in military demand brought on by new clothing or equipment items entering the system, or most importantly changes in industrial base capability brought on by new technology or loss of capacity in a certain area.

With reference to the items on the study list, it was NLABS intention to identify those products for which there is an acknowledged mobilization need, as many logistical system

items have no greater demand in mobilization than during peacetime. It must be noted, however, that this item identification itself was not an easy task, as item demand numbers for many items in the report have not yet been established for mobilization planning. This problem will be addressed in the section on Military Textile Demands (Section VIII).

Noticeably absent from the final end-item list is any reference to footwear outside of the covers for toxicological agent protection. This was deliberate on the part of NLABS due to the involvement of two additional major industries, rubber and footwear. Their absence from this study does not reflect desire on the part of either NLABS or KSA to negate the importance of either in peacetime or mobilization procurement.

B. Textile Components

Industrial base capabilities are measured in terms of number of finished products for the apparel industry and several numerical expressions for the textile industry. It was therefore necessary to define the military demand both as a fixed number of units of individual products as well as an equivalent measure of the textile components included in each product. For study purposes, it was again necessary for NLABS to identify the limits of consideration for textile components. The primary components are broadwovens, narrow fabrics, knits, nonwovens, tape, webbings, threads, braids, batting, and twine. Table 1 illustrates the breakdown of textile products included in these categories, and Appendix B lists each textile component by military specification number.

TABLE 1. TEXTILE COMPONENTS INVOLVED IN STUDY

Component	# Items	# Occurrences
Broadwovens	105	408
Knits	18	40
Nonwovens	3	7
Webbings	11	92
Threads	10	357
Braids	3	48
Batting	2	11
Tape	8	87
Twine	3	33

Basically, the study focused on base fabrics utilized in garment construction plus the thread requirements for manufacture. KSA was not tasked to evaluate either the demand nor industrial base capability relative to findings associated with end-item manufacture. Several of these trim items would be buttons, zipper sliders and tape, metal and velcro fasteners, snap closures and buckles. Some of these items are more critical than others in constructing a garment or equipment item in accordance with a written specification. For a good perspective on domestic industrial capability for these products, an effort similar to this project should be considered by NLABS to check on possible mobilization bottlenecks.

For example, slide fasteners and zipper tape are very essential trim items for numerous articles of combat clothing and equipment, where pockets and flaps are all constructed with zipper tape as the closure device. The slide fastener is a product in itself, composed of a certain width tape, a metal or plastic slider, and a set of metal or plastic teeth. The length and size of the slide fastener is garment design dependent, with most military items employing medium or heavy weight zipper tape, and the most common width of tape being 9/16" wide.

To have some appreciation for military demand relative to domestic production, we must first take a look at how the industry quantifies slide fastener production. The Slide Fastener Association maintains production data as a function of slider mechanisms produced, since the length of zipper chain (teeth) and the width of tape present variables too numerous to consider for aggregate production. It is a safe assumption that sliders are produced to end up as part of a slide fastener. If we therefore consider the domestic production of sliders and assume that each slider becomes part of a slide fastener which is of medium weight, averages 10 inches in length, and has 9/16" wide tape, then we can make some comments relative to military demand and domestic production. Table 2 illustrates unit sales of sliders in the United States over several time periods.

It must be pointed out that these figures do not reflect actual domestic production of zipper sliders, a number which would be important in order to discuss potential mobilization problem areas. The association figure reflects both domestic production and imports, and some significant changes have taken place in that ratio in the past ten years. A company called YKK, for instance, had approximately 2% of the domestic market share in the early 1970's, and it now controls greater than 45% of the domestic zipper slider market. If we use the 90-percent figure of YKK slides made domestically as

a norm for the total zipper sliders produced, then the 1982 expected domestic slider production would be 1.35 billion.

TABLE 2. UNITED STATES ZIPPER SLIDER SALES

Year/Period	Billion Units
1965 - 1972	2.1 - 2.3
1981	1.7 - 1.8
1982 (projected)	1.5

This compares to a military demand in peacetime of the total number of trousers demanded, increased by a 10 percent margin to account for the other end-items which contain slide fastener requirements but do not have the volume demand similar to trousers. The other consideration in the 10 percent margin is the fact that total annual trouser demands are variable, as are essentially the demands for all other clothing and equipment items involved in the study. The total trouser peacetime demand, taken from the computer printouts for the peacetime scenario, is 6.41 million units. Therefore, the relationship of this demand, increased by the 10 percent factor, to the 1.35 billion annual production of zipper sliders, is 0.522 percent.

The raw materials demanded for zipper sliders have altered drastically in the past fifteen years. In 1967, nonmetallic zippers represented only 5 to 10 percent of the market, but now account for almost 60 percent of unit sales. The raw materials sourcing patterns and requirements are different, as are properties of the finished product. An important consideration would be the relationship of military demand for the metallic and nonmetallic slide fasteners and the necessity to determine if the sources of any of the specialty size or length slide fasteners are sourced offshore. Government procurement regulations require all raw materials for military products to be produced in the U.S. for appropriated funds expenditures.

This is an example of the evaluation that would be required for each of the trim and textile component items not covered by the this study. Even with regard to zipper sliders, the basic number comparison described above may not guarantee the assumption that there would be no problem locating sources for slide fasteners for military products in a full mobilization situation. For example, additional consideration must be given to the actual supply base in the United States for the finished slide fastener product. If there are only three major suppliers whose products meet existing military specifications, then these manufacturers become strategic assets.

And what has happened to the many U.S. slider producers who have discontinued production as foreign manufacturers have established operations in the U.S. with modern, high speed equipment? The production gap represented by this new technology became a tenfold differential, and U.S. manufacturers could no longer compete on cost. The resulting excess capacity eventually becomes lost capacity, as plants are converted or equipment is scrapped, and skills are not carried on by newer generations. These considerations are real issues when dealing with mobilization planning and industrial base capabilities. An analysis of this type also permits justification for consideration of alternatives for sourcing or end-item construction. Peacetime procurement availability is no indicator of either increased or continued availability under emergency conditions.

C. Unit Allowances

The development of an aggregate military textile demand was only possible through the consideration of each textile component included in every end-item of the study. This involved the derivation of material utilization data on each product. KSA has used the term "unit allowance" to describe the amount of a textile component required in the manufacture of a single unit.

Each end-item involved in the study is described by a written specification, either military or federal. In addition, each textile component contained in every end-item is governed by a different military or federal specification. There are also end-item components which are not specified by a written document, and therefore are considered to be standard commercial products for use in the end-item manufacture. Therefore, the study involves 261 end-item specifications and 248 textile component specifications, or 509 total documents that contain specific information relative to the properties of the item.

KSA was not aware at the beginning of the project that there did not exist a data source for all the unit allowances associated with the study end-items. (This is not to be confused with "unit allowances" described by Common Table of Allowance (CTA) documents published by several of the Services, which describe units of item issue.) NLABS is the responsible agency for product development and technical data package submission to the procurement agency of the Defense Logistics Agency (DLA). For the most part, one of the final developmental stages is prototype manufacture and field testing. These steps require someone to have a basic idea of pattern parts and material requirements, yet no single agency maintains a storage facility for unit allowance information. The procurement agency, the Defense Personnel Support Center

(DPSC), located in Philadelphia, manages procurement of end-items on a competitive bidder basis, therefore not establishing material utilization as a contract element. As a matter of policy, no material utilization information is maintained with the Primary Contracting Officers (PCO) who coordinate directly with the end-item contractors. It is the responsibility of the individual contractor to maximize his raw material yield to improve his competitive bidding position.

There was therefore no single source for unit allowance information, and the only alternative to KSA development of each textile component unit allowance was the Directorate of Manufacturing at the DPSC facility. The factory mission and capability will be discussed later with reference to apparel industrial capability and military demands. The factory is the central repository for patterns on all military articles of clothing and equipment, including all branch uniforms. The capability existed, therefore, for a square-inch determination of every pattern piece. This would have yielded the material requirements for any end-item by textile component, not accounting for allowances required in either the cutting or construction of the product.

The factory is itself a production facility, however, and maintains on file the unit allowance data relative to items produced at the plant. In addition, whenever there have been contract problems with a product, the DPSC factory would prepare unit allowance files for resolution of contract problems. As it turned out, the combination of data derived from the DPSC factory files and the individual special item data received either from NLABS or one of the other service clothing offices resulted in approximately 70 percent of the unit allowances required for the study.

The remaining information was derived by KSA, but with assistance from many individuals in several agencies. Primary assistance in the clothing and individual equipment area was obtained from the DPSC factory. Helpful with the derivation of unit allowance data relative to aerial delivery equipment items included in the study were personnel of the United States Army Troop Support and Aviation Materiel Readiness Command (TSARCOM) in St. Louis. Unit allowance information for textile components included in vehicular items were partially supplied by the United States Army Tank and Automotive Command in Warren, Michigan. Additionally, numerous individual companies covering the full range of study items did assist in preparing the unit allowances.

The derivation of total military textile demand depends greatly on the correct analysis of product textile components. Each study item was taken individually and textile components displayed as indicated on Table 3. This is a

TABLE 3. INDIVIDUAL STUDY-ITEM TEXTILE COMPONENT LISTING

FILENAME: F43496C
DISK NO.: MATICS

SPECIFICATION NUMBER----MIL-P-43496C
SPECIFICATION DATE------04/28/78
SPEC. DESCRIPTION-------PARKA, EXTREME COLD WEATHER

MOB REPLACEMENT PCT OF STRENGTH	.063				
RECEIVING ITEM:	ARMY .1083	A.F. .108	NAVY .1079	MARINE .1075	C.G. .1109
ANNUAL DEMAND	231828				

MATERIAL REQUIREMENTS SPECIFICATIONS

FEDERAL:	SPEC. NO.	UNIT ALLOW.	LENGTH	WIDTH	DIAMETER	QUANTITY	SCENARIO A	SCENARIO C N+6	N+12	N+18	N+24	N+30	N+36
THREAD: GIMP, CTN, BUTTONHOLE	V-T-280	3.00					695484	558369	609499	644957	653903	663348	686491
WEBBING: TEX, (CTN, ELAS)	JJ-W-155		0.25	0.25			57957	46531	50792	53746	54492	55279	57208
CLOTH: RUCKRAN, CTN	CCC-C-438	0.05					11844	9511	10382	10986	11138	11299	11693
LABEL:	DDD-L-20					1.00	231828	186123	203166	214986	217968	221116	228830
MILITARY:	SPEC. NO.	UNIT ALLOW.	LENGTH	WIDTH	DIAMETER	QUANTITY							
BRAID: TEX, TUBULAR	MIL-B-371		5.85		0.13		1356194	1088820	1188523	1257666	1275110	1293529	1338657
CLOTH: FLNL, WOOL & CTN	MIL-C-3760	0.45					103163	82825	90409	95669	96996	98397	101829
CLOTH: OXFORD, CTN WARP & NYL FILLING, DURAPEL TREATED	MIL-C-3924	4.66					1080550	867519	946958	1002048	1015947	1030622	1066578
TAPE: TEX & WEBBING, TEX REINF. NYL	MIL-T-5038		1.25	0.25			289785	232654	253958	268732	272459	276395	286028
CORD: ELAS, CTN	MIL-C-43303		0.75		0.19		173871	139592	152375	161239	163476	165837	171623
THREAD: POLY, CTN-COV.	MIL-T-43548	340.00					78421520	62981821	69076552	73095118	74108984	75179437	77802256
TAPE: TEX, CTN, GEN FUR, NATURAL OR IN COLORS	MIL-T-43566		0.50	0.50			115914	93062	101583	107493	108984	110558	114415

single item example of the 236-page separate appendix, supplied to NLABS as the contracting agency, that contains a full unit allowance page for each end-item in the study.

The format of the product pages is self-explanatory, and shows the different levels of unit demand based on individual mobilization scenario period. The explanation of mobilization scenarios and the formulas used to expand the unit demand is covered in a later section of this report. The unit allowances are expressed in terms of square yard equivalents (SYE) for all broadwoven and knit items, which accounts for the width difference and enables comparison to available industry data. Narrow woven fabrics and all tapes, webbings, braids, and cords are expressed in terms of linear yards—with width and diameter expressed as appropriate. Threads are expressed in linear yards as well, but in the unit allowance column. The major items expressed as quantity are the premade labels and the knit cuffs associated with many of the end-items.

One of the purposes for not including the 236-page appendix with each copy of this report, beside the obvious factor of bulk and weight, was to preclude any problems with identification of what might be construed as proprietary information regarding the unit allowances. The reader should understand that Table 3, which is presented solely for the reader to follow the procedure which KSA adopted for the development of military textile demand, is not intended to represent any Department of the Army standards with respect to material utilization. The assignment of numbers to unit allowance requirements can be construed as an average from multiple sources, though KSA takes the responsibility for general accuracy considerations. Unless specifically source-referenced and documented, the same provisions apply to any other tables or figures appearing in this report. Numerous agencies, associations, and individuals contributed data to this effort, with KSA the only single source responsible for the derivation and analysis.

With respect to knits, as will be pointed out later in the discussion of total military textile demand, knit fabrics are not the primary source of fabrications for the end-items included in this study. They do, however, represent a measurable demand against the production of the domestic knitting industry. Determining the unit allowances associated with knitwear items was far more difficult than broadwoven allowances, primarily because the various knit processes traditionally measure production in different ways. Circular knit production is measured in either square yard equivalents, linear yards, or pounds, whereas full fashion knits are counted as dozens or some other multiple of a

finished unit. KSA chose to represent knit demands as square yard equivalents, and subsequent material presented on knits will compare this demand to industrial production.

D. Relationship to Planning

The basis of the study is the determination of a military textile demand. We have generated this demand based upon the listed items by NLABS. Though the end-item list is not all-inclusive of military items which contain textile components, both the list and the resulting textile products involved in the manufacture of those items are representative of military demands under the various mobilization scenarios.

There has been some planning accomplished along the lines of apparel and textile products for emergency conditions. In a later section of this report, mention will be made of the current Pentagon-level planning for "logistical determination," of which clothing and individual equipment represent one logistical factor. We will concentrate in this section on the activities which the Department of Defense maintains for mobilization planning in the textile and apparel areas.

NLABS represents the largest single DoD agency responsible for textile and apparel R&D, and their mobilization planning is essentially accomplished on an on-going basis through responding to changing battlefield conditions and threats, as well as satisfying product improvements relative to technology. So there is not a separate division or branch at Natick established for pure mobilization planning. NLABS does prepare five-year plans for budgeting and program considerations, and as a result some R&D projects are prioritized based on potential combat criticality, but no planning is done at NLABS relative to contingency specifications or procurement for textiles or apparel items. We will address later whether or not there should be more mobilization planning activity at NLABS.

At DPSC in Philadelphia, there is an office which does conduct mobilization planning for textiles and apparel, called the "Industrial Preparedness Section". This section is one of two which fall under the Production Branch of DPSC, and whose functions are as follows:

- Industrial Preparedness Planning
- Commercial Alternate Item Program
- Defense Materiel System.

The mobilization planning is performed based on individual service input of requests for end-items of clothing and equipment. In any given year, DPSC will receive more than

700 separate items for consideration from the five services. The service requests are submitted to the Management Support Office (MSO), which compiles the requests and determines peacetime stockage levels and other war reserve requirements. The MSO then prepares an item list and numerical requirements and submits to the Industrial Preparedness Planning Section.

The first question asked by the IPPS is whether or not each item on the list is combat essential. From this analysis, an Industrial Preparedness Planning List (IPPL) is prepared, containing items in the categories of textiles, clothing and equipage. Table 4 illustrates the items in the fiscal year (FY) 1983 listing. Guidance used by the IPPS is contained in Defense Logistics Agency Manual (DLAM) 4005.1, and DOD 4005.3-M, both titled Industrial Preparedness Planning Manual.

TABLE 4. DLA PLANNED ITEMS VS. STUDY ITEMS

	DPSC FY 1983 IPPL ITEMS
Textiles:	
Cloth	29
Tape	10
Webbing	12
Clothing	71
Equipage	135
TOTAL	257

In addition, the IPPS may include an item on the IPPL which is either new to the system or does have a combat need, but the services may not have generated any demand. An example is the fabric: Nylon, Tricot Knit, Polyurethane Laminated, Charcoal Impregnated, Cloth which is used in the Chemical Protective Suits. Since DLA recognized the need for additional or increased procurements in this fiscal year, they were able to include this item on the IPPL for planning considerations. An example of a single page from the clothing section of the IPPL is shown in Table 5.

The IPPS then determines whether the quantity in demand represents an economical production run before it is considered for planning. Once the list is finalized, accounting for quantities required and stockage levels existing, the IPPS undertakes the major functions of developing planned procedures. Planned producers are apparel manufacturers who represent sufficient production capacity to satisfy the quantities reflected on the list. Considerations involved in their search are geographic distribution, individual producer capability, and historical data relative to producer performance, if the producer is a former or active contractor for an

TABLE 5. INDUSTRIAL PREPAREDNESS PLANNING LIST - FY 1983
CLOTHING

Major Items and Components	Planning DSC and Priority	Weapon System	User
Hoods			
Hood, Cold Weather (Impermeable) Shore	DPSC-T (3)	Combat Personnel Use	N, CG
Hood, Winter/Synthetic Fur Ruff, Olive Green 107	DPSC-T (3)	Combat Personnel Use	A, AF, MC, N, CG
Jackets			
Jacket, Flyer's, Olive Green, Aviation Crewman	DPSC-T (2)	Combat Personnel Use	A
Jacket, Cold Weather (Permeable A-2)	DPSC-T (3)	Combat Personnel Use	N, CG
Jacket, Heat Resistant, Moderate to Cold Weather	DPSC-T (3)	Combat Personnel Use	AF, N, CG
Jacket, Extreme Cold Weather	DPSC-T (3)	Combat Personnel Use	N, CG
Jacket, Flyers, Cold Weather Nylon	DPSC-T (2)	Combat Personnel Use	A, MC
Jacket, Utility, Dark Blue	DPSC-T (3)	Combat Personnel Use	N, CG
Jacket, Flight, Very Cold Temperatures, Nylon	DPSC-T (2)	Combat Personnel Use	A, AF
Liners			
Liner, Cold Weather, Coat, Man's, Olive Green	DPSC-T (3)	Combat Personnel Use	A, AF, N, MC, CG
Liner, Cold Weather, Trousers Field, Olive Green	DPSC-T (3)	Combat Personnel Use	A, AF, MC, N
Liner, Extreme Cold Weather, Parka	DPSC-T (3)	Combat Personnel Use	A, AF, N, MC, CG
Liner, Snow Camouflage, Trousers White, Arctic M-65	DPSC-T (2)	Combat Personnel Use	A, MC, N
Liner, Wet Weather, Poncho, Olive Green	DPSC-T (3)	Combat Personnel Use	A, AF, N, MC, CG

item of military clothing and equipment. The result of the IPPS research results in documentation of several parameters:

- Information relative to consolidated planned procurement
- Item quantities required and planned for monthly production
- Letters of agreement between the government and the manufacturer.

There does exist an order of priority for consideration of planned producers to meet anticipated requirements. That priority listing is as follows:

- Small business, current government contractor
- Large business, current government contractor
- Small business, former government contractor
- Large business, former government contractor
- Qualified large business.

These planned producers basically agree to produce an established product or products at a specified rate for an agreed-upon duration. These agreements are not legally binding, and the Vietnam War, as a limited mobilization, identified the problem with demanding military production when the manufacturers still had more lucrative commercial options. The other major consideration regarding the planned producers is that 85 to 90 percent of the planned producers for the items on the IPPL are not current contractors for military items of clothing and equipment. This conceivably means that a large portion of the mobilization demand for end-items would be produced by companies not familiar with government specifications nor the manufacturing details of military products.

The important issues related to the IPPS and the IPPL are those that materially affect mobilization planning. Some of the major factors are:

- The final IPPL list is an internal selection by the IPPS. This judgement may not be consistent with NLABS determination of combat essential. In addition, individual service requirements submitted annually may not reflect the true normal need, and is therefore less than a legitimate number to forecast mobilization demands.

- The IPPL list does not necessarily reflect all end-use items for which there is a war reserve stockage requirement. This means that no industrial preparedness planning is being performed for some items which have been determined to be critical for mobilization. War reserve stockage levels are determined based upon continuous requirements which are furnished by the individual services.

- The quantity and type procurements made by DPSC for clothing and individual equipment in any given year are determined by the appropriations levels established for DoD by Congress. Individual services have similar buying decisions when submitting requests for end-items to DPSC.

- The major assumption which the IPPS makes in the derivation of the IPPL list is that textile products required for the manufacture of those items will be available from the textile industry. No investigation is therefore made concerning capabilities of the textile industry beyond the determination that the textiles included on the IPPL would be available in the quantities established by the IPPS. Since the textile and apparel industries represent very different production systems and have different capabilities, overall mobilization consideration for clothing and equipment end-items must include the complete manufacturing process, from the raw material sourcing constraints to the production and distribution of the finished products.

E. Relationship to Procurement

We have taken a look at how military textile requirements for mobilization are planned for in the existing peacetime structure, but do not imply that there are not other agencies with a mobilization planning responsibility for clothing and textiles. The key component of this study is in fact to illustrate the relationships between military textile demand, industrial base textile supply, and the planning and procurement functions which are currently operating. In that regard we shift our emphasis to the procurement related activities of the government involved with clothing and individual equipment items.

Overall military procurement for the millions of items purchased runs into billions of dollars spent annually. With regard to military clothing and individual equipment, there are three primary agencies that procure the majority of textile, clothing, and equipment items derived from textile industry products. These agencies are the Defense Logistics

Agency (DLA), the General Services Administration (GSA), and the individual military service exchange systems. The activities of each agency involved with CLI procurement will be described, with the objective of identifying similarities and differences. In addition, the magnitude of textile and apparel procurement in relation to industry sizes is an important perspective when considering mobilization demand and supply.

1. Defense Logistics Agency

The Defense Logistics Agency (DLA) is the agency of the Federal government responsible for supplying the military services with the products needed to support the country's defense effort. It was established as the Defense Supply Agency in 1962 and renamed in 1977.

The DLA maintains six supply centers throughout the country which procure over two million items used by the military services. These supply centers are listed at Appendix C. The primary center for procurement of textiles, clothing, and individual equipment is the Defense Personnel Support Center (DPSC) located in Philadelphia.

To give an idea of unit volumes handled by DPSC, in fiscal year 1981 there were more than 10.5 million individual requisitions from the armed forces, of which approximately 2.3 million were for clothing and textiles. The total DPSC purchases in that same time period exceeded two billion dollars.

For fiscal year 1982, the total DPSC dollar procurement for both textiles and finished items of clothing and equipment was one billion, or one-half of the total procurements managed by DPSC for food and medical material as well as clothing and textiles.

The DPSC Directorate of Clothing and Textiles is the agency which handles all the paperwork for the individual service requests submitted on an annual basis. This Directorate administers the purchasing of over 20,000 items of clothing and individual equipment, not all of which contain textile components. The one billion dollars in procurement for clothing and textiles is divided basically into three major purchasing categories as follows:

	$ Million
a. Government-Furnished Material (GFM)	250
b. Contractor-Furnished Material (CFM)	300
c. Cut, Make, Trim (CMT)	450

Each of the three categories is essential for the complete procurement process to be effective, either in peacetime or under emergency conditions. A general discussion of each will facilitate an understanding of the interdependence of the textile and apparel industries regarding manufacturing for government procurement.

Government-Furnished Material (GFM) is nothing more than specific textile products that are procured by the government either directly from a mill or through converters. These textile products are then stored in depots by the Government and issued to apparel manufacturers on the basis of individual clothing or equipment contracts. Determination of textiles to be considered GFM or CFM is a responsibility of the Supply Operations Division of the Directorate of Clothing and Textiles. This Division has prepared a memorandum (4140.28), titled Government-Furnished Material (GFM) Mechanized Requirements Computation Program, which delineates the factors requiring consideration by the selection team.[4] These factors are contained in Appendix D. The overriding factors indicated in the memorandum are storage constraints and the cost of maintaining system inventories.

Two current situations best illustrate these factors for GFM/CFM consideration. The first involves woolen-worsted textiles, some of which are procured by the government on multiyear contracts in order to establish economical volumes for the mills. The U.S. wool industry is not in a very strong position relative to overall fiber demands, as will be discussed later in terms of industry capabilities. The continued military demand for woolen and worsted products has caused the government to make many woolen-worsted textile fabrics GFM to ensure sufficient stocks for end-item demand. Multi-year contracts for any DPSC procurement item is the exception rather than the rule, but a definite consideration for certain mobilization issues pointed out later.

The second example involves the most popular government textile item of 1982, and it may continue to hold that position as the battle dress uniform remains as much in demand. The fabric is a 50/50 blend of a nylon and cotton twill, which is dyed, water-repellent, quarpel-treated (Class 2), and overprinted with a four-color camouflage print with infrared reflectance properties (MIL-C-44031A).[5] This textile cloth was initially

determined to be GFM because of the lack of a commercially available substitute, and because it was a new Government-required item which the industry had not yet geared up to respond to. This cloth was eventually removed from the GFM listing because more mills became interested in weaving this blended fabric for military consumption. As an example of GFM items, Table 6 lists the various textile products that are included in an annual publication distributed by DPSC for contractor information regarding quarterly procurements. This chart illustrates the rough yardages of the fabric groupings that are scheduled to be procured in fiscal year 1983. Both these yardage totals and the total peacetime demands for broadwovens will be compared to industrial production to demonstrate the magnitude of military textile demands and facilitate discussion of problem areas related to the textile industry.

TABLE 6. DPSC FORECASTED PROCUREMENTS - FISCAL YEAR 1983

Fabric Group	Number Textile Items	Total Yardage
Cotton Yard Goods	56	44,545,000 SYE
Woolen Yard Goods	17	3,310,020 SYE
Synthetic Yard Goods	18	2,875,000 SYE
Knitted Yard Goods		407,000 SYE
Narrow Fabrics	42	13,120,600 Lin. Yds
Total	133	

GFM products are described by documents called "specifications", which are either federal or military based upon the originating agency. These specifications are written on all textile products and apparel and equipment items as well. For instance, this study involved 261 end-items, each of which is governed by a separate specification. In addition, each textile component required for the manufacture of these end-items is governed by a specification. These specifications for textile components numbered 248, resulting in 509 specifications involved with this study. For instance, Table 3 is a sample printout page of one of the end-items, and it lists 11 different specifications for different textile components involved in the production of that product.

Appendix B contains a listing of all specifications, descriptions, and number of occurrences for each textile component in the study.

The occurrences range from a high of 86 in Military Specification MIL-T-43548 to a low of 1 in 62 of the specifications.[6]

Specifications are the basis of the contracting procedures which DLA maintains with private sector suppliers. There are two methods which DLA employs—formal advertising for bids and negotiation. Whenever feasible and practical, DLA is required to purchase all supplies through formal advertising procedures. In the case of clothing and textiles, invitations for bids are sent to prospective suppliers who are on the bidders list for specific products. Any manufacturer may apply to be included on a bidders' list for any number of items produced. There are more than 20,000 U.S. apparel, hosiery, and knitwear manufacturing facilities, according to Department of Labor statistics, and yet only 1,700 are registered with DPSC as bidders for clothing and textile products. This is less than 10 percent of the existing industrial base for the manufacture of military clothing and equipment items. The more startling fact in light of this study is the even smaller number of active manufacturers working on procurement contracts with DPSC. That number is right around 150. This means that less than 1 percent of the total domestic apparel industry is actively involved with the production of government items of clothing and equipment. It also implies that there are only 150 domestic apparel manufacturers who are intimately familiar with government product specifications and the administrative procedures relative to DPSC contracting. We will explore in a later section the implications of this condition on mobilization planning.

The second procurement method employed by DLA is negotiation. This procedure is primarily used for contracts of less than $10,000 on perishable food. Negotiation for clothing and textile contracts is seldom performed, but does occur when a bidding competition results in a single supplier and there is no procurement history for the item.

Prospective bidders obtain information relative to contracts through two primary sources, the annual DPSC forecast of procurements by quarter, and the Commerce Business Daily, published by the Department of Commerce. The latter provides information concerning:

- Current proposed procurements exceeding $10,000

- Recent contract awards valued in excess of $50,000, which provide opportunities for subcontracting.

Bidding procedures involve the submission by any prospective bidder of a sealed bid for a specific product by a certain hour and date. These sealed bids are publicly opened at DPSC at a specified date and time, and a contract award is made to the lowest single or multiple bidders, based on contract size and quantity bid for.

One of the most significant considerations relative to this 450 million dollar annual CMT business is that over 85 percent of the contracts awarded are to small business firms, which for the apparel industry means an organization of fewer than 500 employees. This high percentage of clothing and equipment contracts falling under Small Business Administration (SBA) is not by design. Certain elements of Congressional appropriations are earmarked for small business use. In the consideration of SBA disbursements, textiles and apparel are lumped together. Since few government contracts for textile procurement involve textile mills with fewer than the SBA employee limits, the majority of the procurement dollars which are "set aside" for SBA use rest with contracts involving apparel products.

Because of this distribution of SBA set-aside funds and the size constraints on manufacturers for SBA consideration, the majority of both the 150 active contractors and 1,700 listed as bidders are in fact legally small businesses. Therefore, currently producing almost every item of clothing and equipment for our total military apparel demand are roughly 150 small companies, whose growth potential may be very real but not possible. The implications are not so obvious when consideration is given to the fact that there are some 20,000 or so other apparel manufacturers in the U.S. who obviously represent a tremendous productive capacity for military apparel items. Just how quickly that potential capacity can be converted is the subject of specific conclusions presented later.

Suffice it to say that industrial response times are real and do represent significant mobilization considerations for textiles and apparel.

2. General Services Administration (GSA)

The General Services Administration (GSA) is the second government agency that has some involvement with procurement of military items. The GSA is a multi-billion dollar procurement operation which services numerous federal agencies, the military being one of its customers. The division involved with procurement of military clothing and clothing-related items within GSA is the General Products Division, and the Paper and Textile Branch monitors this procurement.

Though recent changes to the GSA structure and funding have caused considerable alteration of this Textile Branch, its procurement involvement is in the $60- to $70-million range for textiles and clothing items. The military accounts for approximately 80 percent of this volume. The main difference between DPSC and GSA procurements for the military is that GSA items, with few exceptions, are in the category of "general use" items which are utilized by many governmental agencies. Table 7 is a partial list of items that appear in the federal supply classes for which the Textile Branch arranges procurements.

TABLE 7. GSA PROCURED ITEMS - PAPER AND TEXTILE BRANCH

Athletic Outfits
Raincoats
Chemical Protective Rainwear Outerwear
Traffic Safety Clothing
Household Textiles
(Sheets, Mattress Covers, Towels)
Safety Footwear
Rope, String, Cordage
Nonwoven Cleaning Cloths
Flags

There are no military clothing items other than the athletic uniforms procured by GSA. These clothing items are also governed by specifications, and generally these specs are prepared by NLABS. GSA, however, retains the final approval for all federal specifications on textile and apparel items. Recently, with the changes in GSA organization, concentration on specifications has yielded to emphasis for Commercial Item Descriptions

(CID), which are descriptions of items to meet specifications on materials that can be commercially procured. The CID program is one of the most beneficial from the industry perspective, because it encourages more manufacturers to become government suppliers Another benefit is derived from the reduced labor and contract administration of a CID versus a specification item.

The CID program originally did not receive full support from NLABS, as it was a drastic departure from the very specific technical specifications required on all military items. Now, CID's exist on some items of clothing procured by the military, primarily in the areas of undergarments and food service clothing. This program is heavily endorsed by industry and DoD, though efforts to assign CID's to specific items of military clothing and equipment will never materialize due to their nonapplicability to civilian items.

GSA contracting for these textile and clothing items is handled by competitive bidding and lowest price arrangements. GSA also has a facet of procurement called "multiple award schedules", which essentially enables a customer to select apparel items directly from retail catalogs submitted by approved manufacturers or suppliers. This system offers a wide variety of products to customers and does not involve lengthy or cumbersome bidding or contract control procedures. These provisions apply mostly to athletic uniforms and firefighting equipment, and the military is a major customer utilizing this system. (Not all firefighting equipment is purchased under GSA specifications.)

Manufacturing sources for these apparel and textile products range from small to big companies. The CID items are sought by the larger apparel firms and the competitive bidding items are generally awarded to small companies because there are certain commodities for which there are SBA "set-aside" restrictions. In addition, similar to DPSC procurement policies, there are provisions on certain contracts for favorable consideration of minority businesses and contractors from labor surplus areas. These factors tend to keep the competitive bidding contracts in the small business segment of apparel manufacturers due to size and administration. Two of the primary suppliers to GSA for linen and household textile items are the National Industry for the Blind (NIB) and the Federal Prison Industries (FPI). The FPI has been affected by recent economic conditions—their textile mill operations closing down, and the shifting of weaving capacity between two of their largest operations.

The reduction in GSA size and appropriations has affected another area of their apparel and textile procurement activity, that of Quality Assurance (QA) testing. GSA had seven laboratories around the country which were responsible for testing textiles and finished products in accordance with the specifications and the designated federal test methods. This procedure for the DPSC procurement is managed by the textile testing laboratories at the DPSC headquarters in Philadelphia. These GSA QA labs have been closed now, and some of the testing of products and monitoring of manufacturing quality is performed by QA inspectors who are in the several regions around the country. However, the loss of these labs should have a significant effect on the overall administration of the GSA QA program. NLABS does have testing capabilities that could be used to support the GSA QA program, yet these facilities have not received numerous requests for assistance from GSA. These NLABS facilities are primarily for support of R&D, but could provide some form of verification testing.

One measure which GSA has taken to reduce the impact on their QA system due to the loss of the textile labs is to expand their Quality Approved Manufacturer Program. This program is an effort to have the manufacturer monitor and guarantee the product quality before it is delivered to the GSA warehouse. Individual manufacturer quality programs are certified by GSA standards, after which the GSA QA representative monitors the administration of the in-plant program. The GSA has 11 regional offices for contract administration, and though all apparel and textile products are procured out of the Boston office, actual administration of the contracts is performed by the geographic regional office closest to the manufacturer.

Despite procurement authorizations and commodity management arrangement strictly spelled out, there are duplications in procurement between DPSC and GSA, primarily in the household furnishings federal supply class (7210). These duplications may be the result of individual service requirements involved with dress uniforms. An effort to review procurements for duplications and CID substitution should be made the responsibility of the agency that has the larger procurement dollar amount.

The Paper and Textile Branch of the General Products Division of GSA does not maintain current membership with the American Society for Test Methods (ASTM). The ASTM D-13 subcommittee has been involved with many aspects of textile and apparel testing and production

definition, and GSA membership would enhance the agency's ability to expand the CID program and stay current with government activities related to test methods and product specifications.

3. Army and Air Force Exchange System (AAFES)

The third major procurement system responsible for providing clothing items to the military services is the exchange system organization associated with each service. The only combined activity, and the largest in terms of dollar sales and procurement, is the Army and Air Force Exchange System (AAFES). The other three services have similar operations on a much smaller scale. For the most part, procurement procedures are similar among the Exchange Systems, as the same federal regulations and standards apply to sourcing, contractor responsibilities and retailing operation.

AAFES operates worldwide to furnish merchandise and services of necessity and convenience for active duty and retired military personnel. They procure these services through a network of 254 retail stores operated along commercial lines, with the objective of providing products at approximately 20% lower than retail prices. There are 35 separate departments in the retail stores, plus a catalog system that has distribution throughout all five military services.

AAFES purchases retail merchandise, supplies, services and equipment in numerous markets involving competitive arrangements and bargaining positions. Some purchases are made from government sources, but the general procedure is from private industry through negotiation. This is different from the formal advertising and bidding procedures utilized by DPSC. Full and free competition from all interested and qualified sources is maintained by negotiation.

Total AAFES sales for their five major categories in Fiscal Year 1981 are listed in Table 8. Retail sales of $2,975,848,000 represent 70 percent of total AAFES sales. Military Wear is one of the thirty-five retail departments, and sales related to Military Wear for Fiscal Year 1981 were $47,528,000 or 1.6 percent of total retail sales. However, sales of military clothing are related to two procurement sources, one totally the responsibility of AAFES and the other a direct result of DPSC procurement operations for clothing and equipment.

TABLE 8. AAFES SALES SUMMARY (FY 1981)
($ in Thousands)

Category	Domestic	Overseas	Mail Order	Worldwide Total
Retail	$1,766,501	$1,161,851	$47,496	$2,975,848
Food	144,040	164,675	—	308,715
Services	316,171	153,154	—	469,325
Vending	84,801	60,438	—	145,239
Subtotals	2,311,513	1,540,118	47,496	3,899,127
Concessions	183,630	130,805	—	314,435
Total	$2,495,143	$1,670,923	$47,496	$4,213,562

The military clothing sections of the AAFES retail stores contain two distinct product lines. Approximately two-thirds of AAFES military clothing sales are related to DPSC originally procured items that are made available to the service personnel for losses and normal replacement of issued clothing items. These items are purchased by AAFES from DPSC, and it really amounts to a secondary distribution channel for DPSC clothing products. Any DPSC item of clothing is available for stockage by the AAFES retail facilities, but the actual items presented in the stores vary among military installations based on the mission of the major unit or activity on the installation. The most frequently stocked clothing items relate to the dress uniforms and accessories. As an example of the DPSC and commercial sales relationship, year-to-date (as of November 1982) sales for military clothing were $170 million with DPSC sales $128 million, or 75 percent. The remaining $42 million of commercial sales represent an average mark-up of 15 percent, resulting in approximately $36.5 million in commercial procurement for military clothing items.

The commercial procurement volume and procedures are of interest for this study, since they represent another portion of textile and apparel industry capacity currently involved with military procurement. The procurement procedures for this commercial element differ from those of DPSC primarily with respect to fewer limitations regarding supplier qualifications and contractual arrangements involving duration and quality. Any contractor may prepare and submit products for consideration, but the approving authorities for Army and Air Force items are NLABS and the USAF Clothing Office at Wright Patterson AFB in Dayton, Ohio, respectively. These agencies are involved because they were

responsible for the specification document covering that product. These specifications are similar to those governing the DPSC-procured items except that they are less restrictive. This is to be expected since all military clothing items involved with AAFES commercial procurement are dress-related, and therefore have no criticality associated with a combat-essential function as do many of the DPSC products. Generally, these certifying agencies are single individuals whose function and experience make them very knowledgeable of the formal specifications for issue of items of dress clothing.

The main consideration for AAFES military clothing products is that they are offered as optional clothing items for service members. The entire philosophy for providing these optional clothing items is simply to enable the military officer or enlisted person to include higher quality items in their wardrobe. The fabrics and the construction of these optional items are generally of more expensive material and higher quality. There are no requirements whatsoever for any military person to purchase any optional clothing items, though many do when the originally issued item wears out. In fact, in terms of retail sales, military clothing operations historically have represented a loss to AAFES, which is a totally nonappropriated activity.

The process for quality assurance differs from DPSC procedures in that AAFES has primarily a system for quality audits at the central distribution facility rather than in-plant inspections. The manufacturer must ensure compliance with the quality standards as written in the specification. There are no regional AAFES agencies for monitoring manufacturing procedures as those that exist with the DPSC system to be discussed later. These qualifying provisions for contractors to manufacturer for AAFES have no restrictions relative to company size as do most DPSC apparel contracts. However, greater than 85 percent of the contractors currently producing military clothing items for AAFES do fall into the Small Business category of fewer than 500 employees. Again, for mobilization considerations, these manufacturers do represent apparel productive capacity which is already involved with government procurement. Though these products would not be needed in a full mobilization posture, these manufacturers are already familiar with government procurement procedures and could more easily convert capacity to similar items needed in combat than another commercial apparel manufacturer with no military procurement experience.

The military clothing products offered by AAFES are in four major apparel categories and are listed in Appendix E. These merchandise listings are produced approximately every other year, and suppliers' lists are determined from responses to this document. Current apparel manufacturer sources for AAFES military clothing items number 50. There are differences as well between these sources for AAFES military products and DPSC apparel contractors. Though there are several duplications, for the most part these AAFES apparel contractors represent an entirely different sub-set of the domestic apparel industry, and though the majority of them are in the small business category, many of them have other customers for similar or different products, unlike the DPSC apparel contractors.

The majority of AAFES contracts are one year in duration, but do not involve a fixed volume. As described earlier, AAFES military clothing products are not duplications of DPSC items, and when DPSC begins to carry an AAFES item on their inventory, AAFES sells its stock of the item to DPSC. This does occur often, as new military clothing products are often retailed by AAFES long before they are "fielded" by DPSC. The reason is that AAFES, due to its different procurement procedures, can bring a new clothing item on line much faster than DPSC--an average of 8 months versus 24 months for DPSC.

A recent example is the new wool sweater that was required to be procured by the Army Uniform Board (AUB). Though AAFES sources, as with DPSC, must be U.S. suppliers, there was not a single U.S. manufacturer who could meet the original sweater specification. Therefore, to meet the initial fielding requirement, the original contract was awarded to a U.S. distributor whose source was a British manufacturer, who had experience with making the identical product for the British forces. The original specification, in fact, was almost a replica of the British spec, which called for a wool count that could not be met by domestic sources.

Since that initial contract, NLABS has changed the wool yarn requirements, and there are now at least two domestic sources for the wool sweater. The original sweater was black and continues to be offered by AAFES as an optional clothing item. The new green wool Army sweater is a DPSC-procured item which is not yet issued to every service member, but is carried in AAFES retail stores on

those installations where the sweater is authorized. If the black sweater were to be added to DPSC's inventory, AAFES would no longer procure it and would sell remaining stock to DPSC. If the sweater had replaced another clothing item authorized for wear, a five-year period would exist where both items would be acceptable for wear.

One area that AAFES is involved with relative to military clothing is taking a position on piece goods. This inventory position is required because the specifications written for AAFES clothing items require fabrics that are not standard commercial items, and the arrangements with the mills that supply the textiles involve minimum yardage commitments. The usual arrangement with a mill involves 50,000 yards per month with a minimum order of 150,000 yards. Due to the specification requirements, AAFES is sometimes limited to a single supplier, which adversely affects its ability to receive low prices. It is felt that the assurance of uniformity and availability by being in the piece goods business is part of supplying service to the military customer. The mills have traditionally made only minimum lots of greige goods for Army items, and some DPSC textiles have become Government-Furnished Material (GFM) because of nonavailability as a standard product in the private sector.

One of the major concerns that AAFES officials have is the differential between fabric required by the Government specification and the range of fabrics commonly produced in industry. If fabrics demanded in a spec are not commercially available, then AAFES must enter into these minimum contract agreements with a supplier, even if the piece goods delivered will amount to more than required for the current and projected procurements. An example is the raincoat that is utilized by both the Army and Air Force. The required fabric is a 50/50 blend of polyester and cotton, and the standard similar blend is 65/35 polyester and cotton. The fabric can be woven with no technical difficulty, yet the mills have no other market for a 50/50 blended fabric to induce them to manufacture any quantity above that demanded by AAFES. Because AAFES items often end up in the regular DPSC inventory, sourcing considerations of textile components should be as consistent as possible with commercially available production. This strategy accomplishes two objectives for the government: ensures availability of certain fabrics for emergency procurement conditions, and produces savings resulting from competitive pricing by multiple industry suppliers.

Standardization of multiple service clothing items is another source of concern for the AAFES military clothing division, as it multiplies both the number of specifications in the system and the piece goods required to support numerous products. This service standardization between the Army and Air Force would be the logical starting point, judging from these data on shirts currently in stock by AAFES:

Category	Style	Poly	Ctn	Wool
USAF	1550	65	35	
AAFES	1580	75	25	
Army	415	65	35	
AAFES	428	80		20

Unless there are specific reasons why the Air Force optional shirt and the Army optional shirt need to be different, since they are both dress items, then the two proponent agencies, NLABS and the USAF Clothing Office, could standardize the specification down to the dyeing requirements to account for the different services' use. Inter-Service uniform differentiation will lose its significance in full mobilization.

The standardization issue involves both fabrication and design. The dress clothing area offers the greatest opportunity for standardization. The Army and Air Force each have a dress uniform which could be a standard blouse and trouser with modifications of color only. As a minimum, the same fabric could be utilized, but there are certainly no "life and limb" properties involved with a dress coat which would require separate designs and specifications. The uniform does have Service-distinctive qualities which are necessary for recognition purposes, but traditional aspects of dress uniforms are due consideration for standardization. The costs associated with maintaining five separate and distinct dress uniforms for each of the services would be interesting to consider against a standard uniform with minor construction and color differences. The basic uniform variations often create differences in all related dress products and accessories, resulting in an operational burden to contract and monitor quality in accordance with multiple government specifications. The U.S. Air Force, in line with this standardization issue, may be taking some action to form a clothing steering committee similar to the Army Clothing and Equipment Board (ACEB).

These consolidation activities regarding dress clothing items for the military may become a matter of necessity as opposed to choice, as Congressional appropriations

for dress uniform activities (DoD-wide) have remained constant for a number of years, and the usual frequency of uniform changes may be reduced in the near future. This fact alone will have a positive effect on industry, as it will enable those active suppliers to reduce production changes and improve pricing to the government. It should also increase the vendor sources available to government contracting, as multiple changes on military clothing contracts drive away many suppliers.

AAFES procurement regulations, though less restrictive in certain ways than DPSC procedures, could be changed to simplify contract administration and expand the negotiation systems. For mobilization consideration, the AAFES procurement system offers an expanded means of tapping into the resources of the industrial base. The fabric suppliers for AAFES textiles are for the most part the same large and small textile mills which provide either GFM or CFM items for DPSC procurement. The combined effect of AAFES and other service Exchange Services on overall military textile and apparel procurement is approximately 15 percent of the DPSC total. Though the products themselves would not be utilized in a full mobilization, the apparel manufacturers would be capble of converting their military production to end-use items required in combat.

F. Relationship to Textile Apparel Processes

The study items are for the most part not commercially available, yet they do represent many standard construction procedures in both the textile and apparel industries. The determination of industrial base capability to meet these military demands for textile and apparel items is a function of how representative the demands are of typical products and procedures. The major issue relative to meeting the mobilization demands is a matter of both quantity and special item requirements. The demand functions generated for this study expand the textile and item demands to reflect quantities, and analysis of specific textile and apparel properties determine specialty aspects of the fabrics in demand and apparel construction procedures.

1. Broadwoven Fabrics

The 261 study items involve 248 different textile components, most of those components being broadwoven fabrications. The remaining textiles are narrow fabrics and knit items, numbering 22 and 18, respectively. Of the 105 broadwovens involved in the study items, the majority are fabrications which involve industry standard fibers and blends, as well as spinning and weaving

techniques which are common to industry production norms. The one major textile area where military demands are not as representative as standard industry production involves the finishing requirements for textiles and apparel equipment end-items. Some of the finishing properties required for military products are not common to any commercial production, requiring specialty equipment and occasionally special chemicals. These items and processes are available in the industry, and therefore all military peacetime requirements are satisfied with domestic manufacturers. Some properties, however, could represent a problem in full mobilization and may require action in peacetime to ensure availability.

2. Narrow Fabrics

The military is a large consumer of narrow fabrics, both woven and braided. The narrow fabrics industry is a separate segment of the textile industry, employing different equipment and satisfying different markets. Again, for study relationship purposes, the majority of the narrow fabric military requirements are items which are exactly like or very similar to commonly produced narrow fabric products, and therefore represent no real problem in terms of development of entirely new processes or equipment.

The major concern for narrow fabric producers is the controversy with the Government regarding equipment and fabric acceptability. There is, however, a larger issue which this study will address, involving some of the end items requiring the greatest usage of narrow fabrics, the aerial delivery equipment. As will be pointed out, total peacetime military demand for narrow fabrics is a small percentage of domestic production, yet mobilization demands cannot be computed due to limitations of military planning.

The products of the narrow fabrics industry are critical to the design and performance of military products. Generally, narrow fabric items are associated with combat-essential products which have "life and limb" considerations. The specifications for these products are therefore very specific and require the utmost attention to detail on the part of the manufacturer.

3. Knit Fabrics

The study items that have knitted fabric associated with their manufacture represent the smallest product

category. Though there are numerous knit items in the entire military inventory of apparel and equipment, the majority are not considered to be combat-essential and therefore do not represent the greatest demand on the domestic textile and apparel industries in a mobilization. Many end-use items have pieces or components which are knit products, but not many fully knit items are designed for mobilization. The single apparel item requiring most knit fabric construction is underwear, with gloves the next in demand.

As far as construction requirements for military knit study items are concerned, all the basic knit fabrication processes are utilized to some extent. Circular knit construction is the most frequently demanded for cuffs and coats, with warp knit products for linings, shirtings, and some uniform applications second in demand. For study purposes and total mobilization considerations, the knit fabric variables do not represent a significant problem, both from the standpoint of domestic productive capacity and ability to substitute options with other products.

4. Special Items

As mentioned, most end-items in the study reflect standard or common textile and apparel processes. Of the items requiring special attention, the textile end of the product cycle is most influenced. Though many military equipage items are one of a kind and involve unique patterns and operational methods, the sewing construction techniques and basic raw materials are similar to those of other apparel products. In some cases there is specialty equipment involved with the manufacture of a particular item, but the same finished look could be achieved with other types of readily available equipment. In fact, with regard to apparel procedures, as called for in many military product specifications, alternative techniques exist that would produce an equivalent garment and equal or exceed the specified properties.

Special items, for purposes of definition, refer to any raw materials or processes that are out of the ordinary or not common to normal industry practice. For this study, this includes situations related to fiber content of blended fabrics; fiber properties of natural fibers; weave patterns in broadcloth construction; woven fabric properties of weight, edges, and shrinkage; and finished fabric applications for specific military purposes. These irregularities are important for peacetime in that the industrial base must develop the capability to respond to the military demand.

The more significant issue related to specialty items is certainly the impact which mobilization will have on responsiveness. If it is clear that military peacetime demands for any specialty property or item are maximizing the capacity of either the textile or apparel industry to respond, then some action should be taken to either improve the industrial base capability, alter the specifications to encourage a greater response from industry, or pursue and select alternative materials or methods to satisfy the military requirement in an emergency. It is one thing for a particular fiber to provide unequaled properties for a given end use, but quite another for that fiber to not be available from any domestic source in any quantity beyond that already required for peacetime needs. The same holds true for any raw material in any stage of the textile or apparel process, and this sourcing issue could be the most critical logistic consideration in a mobilization. It is even more significant for those apparel and equipment items having a specialty need that are considered critical to the performance of a military mission. These particular cases will be pointed out in the section related to problems that the industrial base may experience in meeting military requirements.

For a complete analysis of fiber, yarn, weaving, and finishing properties associated with every textile component involved in the study, Appendix F displays all the properties listed and required by the individual Federal or Military Specification. Where not specified, the intention of the specification preparing agency is to give the maximum flexibility to industry to use whatever raw materials are appropriate and provide the finished product. The appendix is divided into sections related to fiber content of the textile products, with sections for natural fibers, man-made fibers, blends, knits, and nonwovens. These tables were prepared directly from the specification and are not KSA-generated. It is not the intent of this study to illustrate any better combination of raw materials or finished fabric properties which would retain or improve on the product. It is the purpose of the study to identify those specifications for either individual textile components or end-items which are either restrictive from the standpoint of not giving maximum consideration to industry capabilities, or involve inherent limitations for industry to respond to an increased demand caused by mobilization.

NLABS is in the best position to initiate any action regarding specification discrepancies and product requirements. NLABS can also influence the procurement

activities of DPSC, though DLA is the responsible agency for military textile and clothing procurement. Having met with and interviewed numerous companies and individuals in the textile and apparel industries, it is clear that industry for the most part is willing to work with the government agencies to improve the current product life cycle system, from development through procurement and fielding.

G. Item Peacetime Demand

Military textile requirements for any set of conditions, whether peacetime, limited mobilization, or full mobilization, are directly related to the quantity of end-items required to support logistically that level of operation. The determination of that quantity is the subject of considerable planning activity for all military logistic commands.

For purposes of this study, the determination of item peacetime demand was based on the data used by the supply branch of DPSC. The annual individual service requests for end-items of clothing or equipment, combined with the status of depot stockage levels and available appropriations, yield both average monthly demand and annual demand figures that determine forecasted procurements for both GFM textiles and items of clothing and equipment. The supply branch utilizes a computer printout called a "flash report" to reflect these demand figures for end-items, categorized by either Federal or National Stock Number (FSN or NSN). Most study end items were contained in this flash report, and the remaining were requested from DPSC. The separate appendix submitted to NLABS, which contains printouts by item, indicates the annual demand figure for each end-item which is used in the formulas to generate item and textile component demand for the four mobilization scenarios.

It is important to clarify the accuracy of these item-annual-demand figures from the DPSC documents. The number on the flash report is related to annual information relative to individual service utilization and demand for the product, plus funding availability for procurement. The demand for every item does not remain constant from year to year, nor do appropriation levels. In addition, new items in the system tend to reflect abnormally high service requests because there are no field stocks to draw from. These are the most current numbers relative to military peacetime demands for clothing and equipment items. There were no other unclassified data sources available to KSA that would have provided more accurate item demand information.

The "flash report" is a logical foundation to use for this study, since the development of textile demands is derived from peacetime unit demand, and these data are relative to the individual service strengths. Manpower levels, then, are the basic determinants in considering military textile demands under variable mobilization conditions.

Appendix G, which lists the study textile components by specification number, also contains a column that identifies the peacetime demand in equivalent square yards for that textile item. These numbers indicate the total demand for each single textile component based on the number of end-item occurrences for each scenario. These peacetime numbers give some indication of quantity demanded relative to peacetime domestic production.

III: MOBILIZATION CONDITIONS

Peacetime demand for military textiles and items tells us only that a given level end-item demand translates into a finite quantity of textiles required. Because the industrial base can and does meet this peacetime demand, there is no real indication of industrial base capacity to meet an increased demand for military textiles and clothing.

To measure this relationship of demand and supply, some method of expressing either an increased military need or the full capacity of the industrial base is required. Both of the requirements would be difficult to pinpoint because there are multiple variables to consider and make assumptions for. For this study, NLABS determined that starting from the military demand perspective would be the better avenue, due to some measure of control available through them and the DLA procurement system. In addition, a DoD study should be able to discuss manpower requirements for mobilization perhaps better than predicting domestic textile industry capabilities and trends over the next 10 years.

A. Historical Perspective

Mobilization conditions are not foreign to either military history or military planning. The basic parameters for manpower considerations are number and duration. These variables are critical from the logistical standpoint of providing and sustaining any force in combat, and the commodities of clothing and equipment are as equally affected as tanks and planes.

As for mobilization planning, there are both DoD and civilian think tanks involved with intricate details of alternative emergency plans. Contingency planning is done in the military at all command levels, and there are probabilities based on existing global economic, political, and military conditions. However, there is no simple mobilization posture which is guaranteed to match the needs of the next conflict in location, duration, or size of forces required. NLABS therefore determined that a more reasonable approach to establishing military textile demands under different mobilization conditions would be to consider historical experience.

Certainly there is no dearth of literature, both fiction and nonfiction, on the last three major armed conflicts involving the United States. Logistical lessons learned, for the most part, have either been overtaken by the events of the technological explosion of the past 30 years, or absorbed

into military doctrine and planning. What can be used as valuable data in determining contemporary end-item demands for military clothing and equipment is the manpower information related to defense strength levels.

An excellent method of considering historical manpower data is contained in a DoD report completed in 1973 for NLABS by Dr. S. J. Kennedy[7] (updated in 1975). Before 1973, Dr. Kennedy was the Director of the Natick's Clothing, Equipment, and Materials Engineering Research Laboratory, the former name for the Individual Protection Laboratory (IPL) at NLABS. Dr. Kennedy's report was significant in that it presented an overview of potential DoD problems in the textile and clothing area in the event of mobilization. He developed his position regarding logistical shortcomings by using historical data from World War II, Korea, and Vietnam. Included in his analysis were manpower data for the three conflicts obtained from Department of Defense manpower statistics, which are used for this study in a broader sense than to illustrate total defense growth.

Total manpower increases in the last three conflicts represent the best database to illustrate both quantity and duration of end-item demand and textiles required by the military under emergency situations. These last three conflicts also represent different enough strategic and tactical situations to consider them as viable alternatives for possible future mobilizations, with some exceptions to the full mobilization variables of World War II. NLABS requested that KSA focus on these three conflicts for development of manpower data.

B. DoD Concurrence

Dr. Kennedy's report discussed the impact on increased military textile demands that manpower growth would have under mobilization conditions. His report made a prediction relative to manpower growth for a full mobilization, indicating that the total defense strength level could conceivably double in the first year of a mobilization. DoD did not object to this prediction, and it forms the basis of our assumptions regarding full mobilization.

Dr. Kennedy's major point throughout his report involved the concept of industrial capacity. He contends that the U.S. industrial base was not really "tested" to the limit in any of these conflicts, due primarily to stockage levels maintained between emergency and manpower build-up rates. The true test of the industrial base would of course be difficult to quantify, but it must in some way relate to existing industry capabilities translated into the capacity to meet rapidly increasing demands for military textiles.

DoD concurrence was requested through NLABS on the rate of manpower increase for the full mobilization scenario used in the study. To appreciate what impact on the industrial base a rapid increase in total DoD strength would have, KSA has projected a doubling of total peacetime strength in the first six months of a full mobilization, and increasing the strength each six months by a factor of 1. This equates to a six-fold increase in the peacetime strength 2-1/2 years after initial mobilization. These projections were verified with DoD by the Natick Labs.

C. Peacetime - Scenario A

Peacetime strength levels have differed in all three of the major conflicts considered, and current total DoD strength is over three-quarters of a million personnel fewer than the most recent of those conflicts. Total DoD strength as of June 30, 1982 was 2,133,677 personnel in all the five services, a larger peacetime force than at the start of either World War II, (1,801,101), or the Korean conflict (1,483,155). Peacetime strength on June 30, 1965, an acceptable starting date for the Vietnam war, was 2,882,679.

This current peacetime strength level of 2,133,677 will be the baseline figure for expanding the DoD manpower strength in the various mobilization scenarios. For the peacetime scenario, not involving any expansion of manpower beyond normal attrition and accession, military textile demands are derived from a direct analysis of annual demand for each study end-item. The peacetime scenario is labeled "Scenario A" for purposes of referring to appendices with scenario data. Because of the peacetime nature, Scenario A does not give an indication of how burdened the textile and apparel industries are, but it does give some indication of the types of textile processes and apparel techniques that are predominant in military fabrications and products. It has been established that the study items, though not all-inclusive of military supply system products containing textile components, are representative of textile items required in emergency conditions. Therefore, from an analysis of the peacetime military demand for these textile items against industry production, certain projections can be made relative to potential problem areas under conditions requiring increased demand. The additional scenarios therefore represent a method of quantifying what are reasonable "increased demands" for different manpower levels. All textile quantities generated by the scenario formulas are derivations of historical manpower data and current item demand figures managed by DLA.

D. Limited Mobilization - Scenarios B & C

Peacetime conditions certainly represent the most desirable option on the mobilization continuum (with full mobilization the least desirable from any standpoint). Those two conditions, however, are connected by a whole range of possible military contingencies. These other options involve both differing manpower levels and logistical problems, all requiring rapid response by the U.S. industrial base for critical materiel. The main consideration regarding these "less than full" mobilization scenarios is that they are the most probable for U.S. involvement and cover many more sets of conditions than do peacetime and full mobilization.

These limited scenarios have considerable historical background for the U.S. military, and the two selected for use in this study are the Korean conflict and the Vietnam war. They are similar in that they were both mobilization conditions short of all-out war, but differ in many respects.

Study Scenario B utilizes manpower data from the Korean conflict, and is labeled a "limited mobilization necessitated by an enemy attack in a single theater." Whether or not this definition exactly fits current Pentagon strategy is not as important as the discussion of the impact on the industrial base which the manpower growth rate would have. The date selected for manpower growth rates is June 30, 1950, and manpower figures are tracked until June 30, 1953. During the 36 months both the total DOD manpower level and the individual service strengths reached their peak volume.

Dr. Kennedy's report is an analysis of just how an industrial base for textiles and apparel was impacted by the conditions surrounding World War II, Korea and Vietnam. The major lesson learned even from World War I was that manpower and industrial mobilization had to be closely linked to ensure adequate logistical support in any military mobilization. With regard to Korea, Dr. Kennedy asserts that the strategic allied retreat in mid-1950 was a significant factor in buying time for our logistical system to support the subsequent tactical operations. The concept of readiness for total mobilization, though the experience was a limited engagement, received strong recognition from the Korean conflicts.

The second limited mobilization scenario used for the study is the Vietnam war, whose start date for manpower considerations is June 30, 1965. This is labeled "Scenario C," and is an example of a gradual mobilization to support a limited military objective. The rate of mobilization in this military effort was very different from the experiences in World War II and Korea.

The designation of full or partial mobilization also involves significant differences in industrial base response to military textile demands. Procurement actions in Vietnam, for instance, did not involve rapid and extensive conversion of either the textile or apparel industries. This resulted in longer procurements of military items of clothing and equipment since commercial markets remained viable and most productive capacity was geared to satisfying those demands. Rated orders for end-items were exercised in the Vietnam situation because there was not sufficient apparel industry capacity committed or converted to military production.

So limited mobilization, though potentially diverse, may represent the largest set of problems to industrial mobilization response. It should, therefore, mean that the most consideration for planning should be geared to solving the special problems associated with limited mobilizations. It is understood by both KSA and NLABS that military history may not repeat itself with the same set of conditions. A given set of circumstances 20 or even 10 years ago may have dictated a conflict which was geophysically and internationally limited, and yet today might yield greater risk for global confrontation and full mobilization.

E. Full Mobilization - Scenario D

World War II is the last major conflict which satisfies anyone's definition of a full mobilization, referred to in this report as "Scenario D." The manpower rate of mobilization exceeded those of either Korea or Vietnam, with total DoD strength increasing to a peak four years from a recognized start date of June 30, 1941, and total strength increased more than six times the base strength of 1,801,101 personnel. Total mobilization of the country's resources for an all-out war would imply conversion of existing textile and apparel industrial capacity. Just what that capacity represents in terms of broadwoven production is one measure of whether military textile demands can be met.

As previously mentioned, the study does not use exact historical manpower data from World War II for the full mobilization scenario. Instead, current peacetime strength of 2,133,677 million personnel is used as the base number, and strength is expanded as a total DoD number by a factor of this peacetime level every six months out to M+30, where M is the start date for the mobilization. These multipliers are used to constitute a reasonable "what if" manpower scenario in terms of both rate of increase and total strength involved with a full mobilization.

These assumptions may not resemble manpower projections of DoD planners, but they were verified by NLABS as appropriate for use in this study. As subsequent discussion and appendices point out, KSA has designed the formulas used in projecting military item demands to allow substitution of different manpower multipliers. If the manpower multipliers are realistic and one or more of the other variables can be made more accurate by substitution of classified data, this is also possible with the demand functions developed for the study.

A second major assumption for the study involves the designation of end-items as combat essential for full mobilization. Specifically, clothing items that were designated as dress uniform components were not included as part of the demand function for full mobilization. This designation of dress items was made by several sources, with NLABS the final authority for inclusion. This provision for not including dress items has the greatest impact on the military demand for woolen and worsted fabrics, which dominate the dress uniform fabrics. Additionally, all mobilization scenarios are addressed from the standpoint of temperate climate requirements. There are certainly other major factors to consider for mobilization response to an arctic or desert region. Cold weather battle requirements would have a significant impact on domestic supplies of wool, down, or equivalent thermal products.

With reference to Dr. Kennedy's report again concerning industrial base response to this full mobilization posture, his position is that for both World War I and World War II, the U.S. had warning time prior to full engagement. For World War II, two years prior to Pearl Harbor the country was actually undergoing a partial mobilization in preparation for increased commitment. This period brought most military supplies to high inventory levels prior to December 1941—again, illustrating the fact that the industrial base as far as the textile and apparel industries are concerned was not tested for response. If contemporary thinking is that the ultimate capacity of industry to produce will determine the outcome of the next major war, then industrial mobilization planning should be closely connected to current military planning as far as manpower and other critical variables are concerned.

F. Service Strength Growth

When an effort is made to quantify military demand for textiles, and it is based on manpower levels, both the rate of growth and total growth values are needed. Dr. Kennedy's report demonstrated the rate of increase of total military strength for the last three wars (see Figure 2 and Table 9).

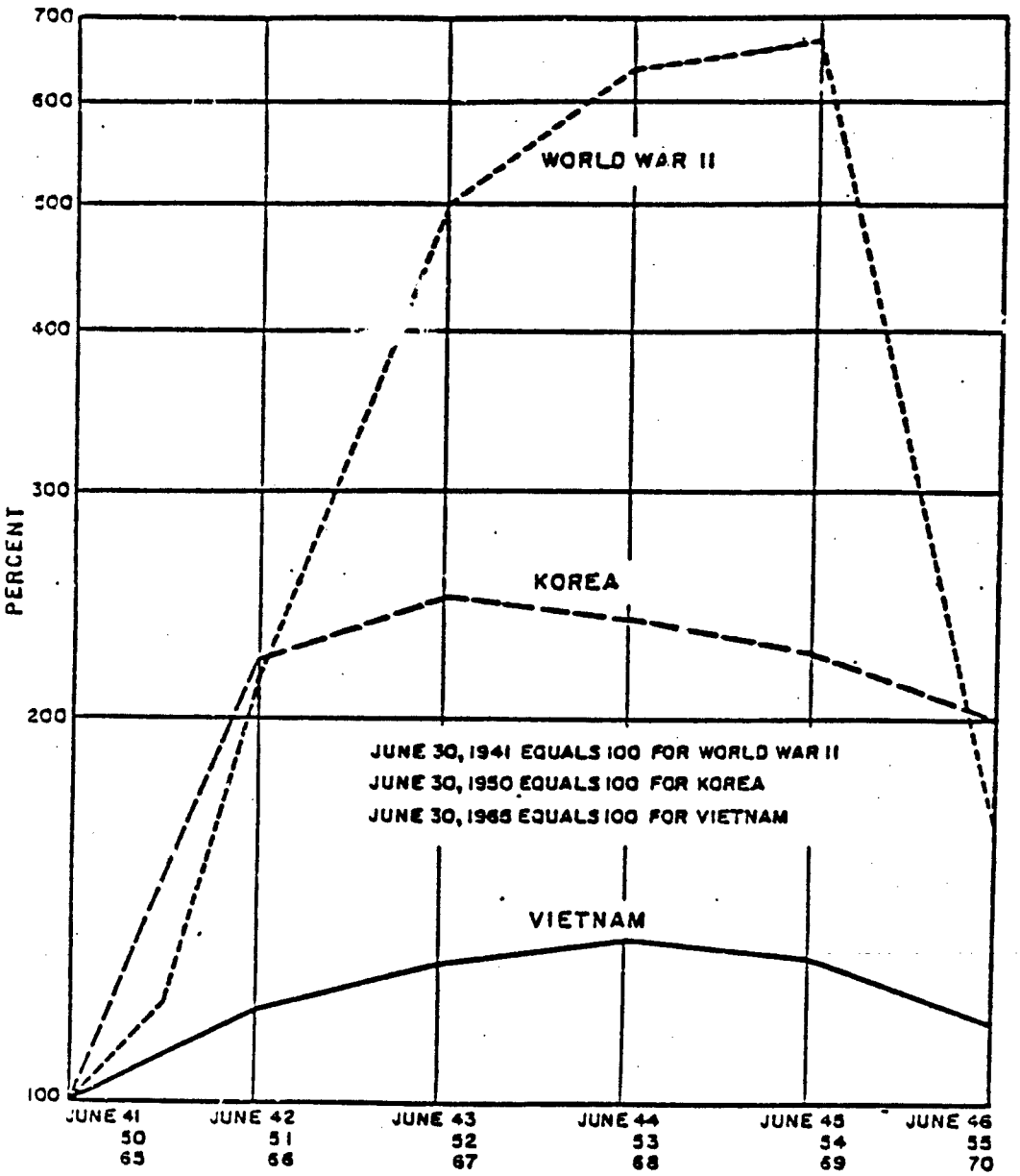


FIGURE 2. RATE OF INCREASE OF TOTAL MILITARY STRENGTH WORLD WAR II, KOREA, VIETNAM (KENNEDY, 1975, p. 5)[7]

TABLE 9. HISTORICAL MOBILIZATION RATES[8]

Scenario	Beginning Strength	Total Manpower Increase (%) 6 mos.	1 yr.	2 yr.	3 yr.	4 yr.
Total Resource Mobilization (WWII)	1,808,101 (6/30/41)	119	214	502	636	673
Limited But Rapid Mobilization in Single Theater (Korea)	1,460,261 (6/30/50)	161	223	249	240	226
Gradual Mobilization For Limited Military Objective (Vietnam)	2,655,389 (6/30/65)	107	117	127	134	130
Peacetime	2,133,677 (6/30/82)					

From the standpoint of rate of mobilization, the three wars differed greatly. In World War II, military strength almost doubled in the first seven months of the war and doubled again during the next year. In Korea, the total strength doubled in the first year but did not experience much of an increase after that. In Vietnam, total military strength increased gradually and did not peak until three years after initial involvement.

The other dimension that is needed for a derivation of true military textile demands is the growth of the individual services which are the users of the end-items. The overall DoD strength levels and rate of increase are important for consideration of manpower planning, reserve force size, and training base capability. Each individual service, however, grows at varying rates and to very different totals depending on many factors related to the type conflict. As mentioned earlier, one of the study assumptions is that the mobilization scenarios' item-demand levels illustrate needs associated with temperate geographical areas. Obviously, in cold weather or tropical climates, demands for certain items would be drastically affected. This factor and others are included in the following list (Table 10).

TABLE 10. INDIVIDUAL SERVICE GROWTH - MULTIFACTOR DEPENDENT

Location
Season
Duration
Type Conflict
Reserve Strength Level
Reserve Conversion Rate
Accession Rate
Training Base Capacity
Training Base Capability

These factors must be considered by both military and industrial mobilization planners for textile and apparel industry response.

Individual service strength levels and growth rates for the last three conflicts are contained in Figure 3 and Table 11. In addition, Table 12 shows these strength numbers as manpower factors related to the beginning strength levels of each conflict. These figures demonstrate how the individual services grew in these conflicts, and factors are used to expand the end-item demands in the study scenarios. The next conflict may involve to a greater degree a single service,

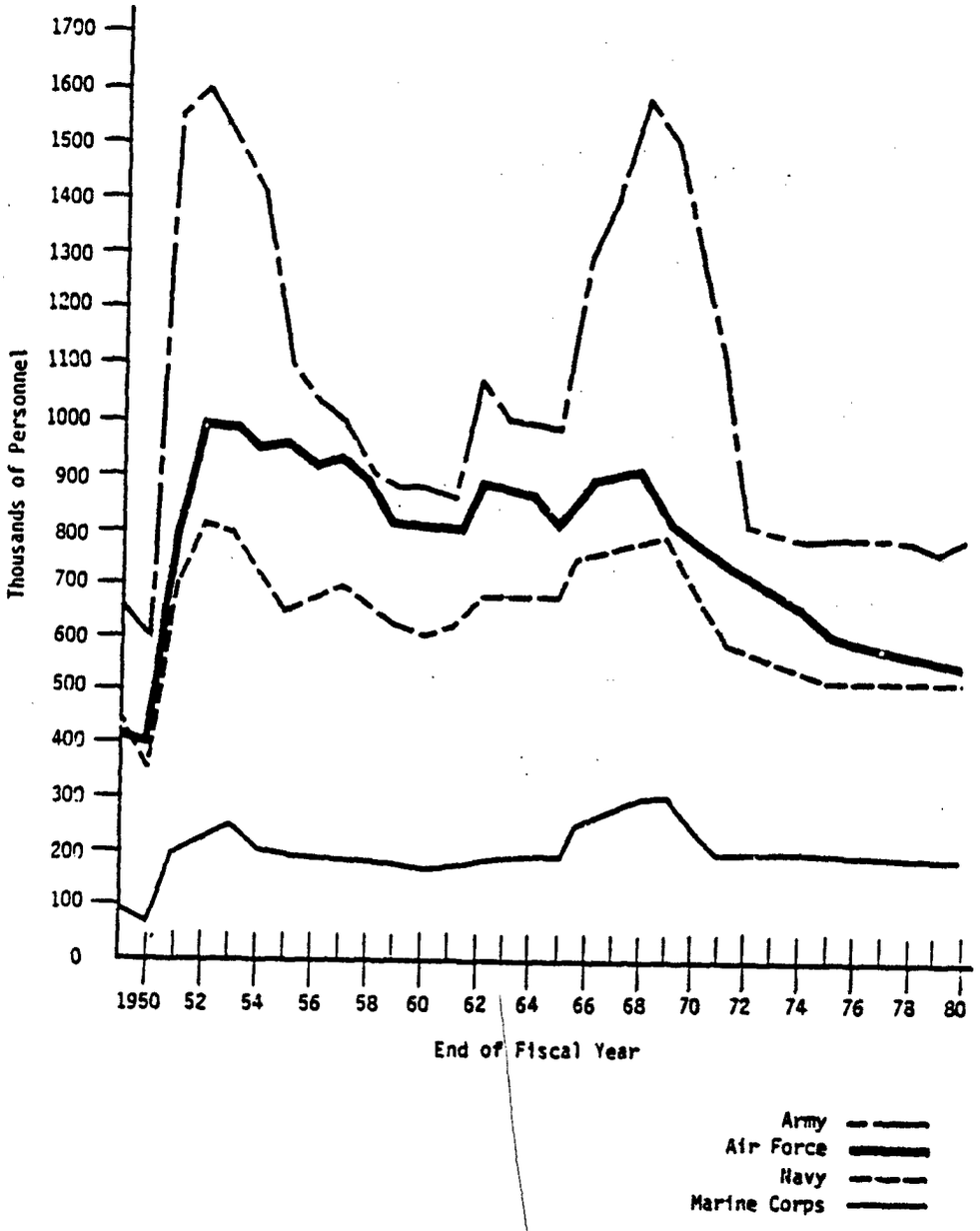


FIGURE 3. DEFENSE MANPOWER.

TABLE 11. MANPOWER LEVELS

Scenario	Service	M	M+6	M+12	M+18	M+24	M+30	M+36	M+48
A	Army	782,973							
	Navy	544,048							
	USAF	576,930							
	USMC	190,362							
	USCG	39,364							
	Total	2,133,677							
B	Army	593,167	1,076,514	1,531,774	1,563,343	1,596,419	1,510,535	1,533,815	
	Navy	381,538	560,754	736,680	787,449	824,265	807,220	794,440	
	USAF	411,277	559,329	788,381	897,366	983,261	957,603	977,593	
	USMC	74,279	160,008	192,620	217,083	231,967	231,867	249,219	
	USCG	22,894	25,906	28,921	31,828	34,734	34,441	34,148	
C	Army	969,066	1,075,196	1,199,784	1,405,804	1,442,498	1,442,999	1,570,343	
	Navy	671,448	725,394	745,205	746,076	751,619	745,598	765,457	
	USAF	824,662	842,148	887,353	902,777	897,494	890,606	904,850	
	USMC	190,213	214,341	261,716	279,621	285,289	298,498	307,252	
	USCG	31,566	32,563	33,560	34,078	34,597	35,194	35,791	
D	Army	1,310,190	1,334,110	2,311,193		4,797,358		5,622,458	5,985,699
	Navy	284,427	383,150	640,570		1,741,750		2,981,365	3,380,817
	USAF	152,125	354,161	764,415		2,197,114		2,372,292	2,282,259
	USMC	54,359	77,736	142,613		308,523		475,604	474,680
	USCG								

TABLE 12. MANPOWER LEVELS

Scenario	Service	M	M+6	M+12	M+18	M+24	M+30	M+36	M+48
A Peacetime (6/30/82)	Army	782,973							
	Navy	544,048							
	Air Force	576,930							
	Marine Corps	190,362							
	Coast Guard	39,364							
	Total	2,133,677							
B Limited but rapid mobilization in a single theater (6/30/50)	Army	593,167	1.814	2.582	2.636	2.691*	2.546	2.586	
	Navy	381,538	1.469	1.931	2.064	2.160*	2.116	2.082	
	Air Force	411,277	1.359	1.917	2.182	2.391*	2.328	2.377	
	Marine Corps	72,279	2.134	2.593	2.922	3.123	3.121	3.355*	
	Coast Guard	22,894	1.131	1.263	1.390	1.517	1.504	1.491	
	Total	1,483,155							
C Gradual mobilization for a limited military objective (6/30/65)	Army	967,049	1.109	1.238	1.451	1.489	1.509	1.620*	
	Navy	738,440	1.080	1.110	1.111	1.119	1.110	1.140*	
	Air Force	884,201	1.021	1.076	1.095	1.088	1.080	1.097*	
	Marine Corps	261,423	1.128	1.377	1.470	1.500	1.569	1.615*	
	Coast Guard	31,566	1.032	1.063	1.079	1.096	1.115	1.134	
	Total	2,882,679							
D Full mobilization (6/30/61)	Army	1,310,190	1.018	1.764		3.662		4.291	4.568*
	Navy	284,427	1.347	2.252		6.124		10.482	11.886*
	Air Force	152,125	2.328	5.025		14.443		15.594*	15.003
	Marine Corps	54,359	1.430	2.624		5.676		8.749*	8.732
	Coast Guard								
	Total	1,801,101							

*Largest service factor

though in every conflict the Army has always been the largest service at all stages. It is probably safe to assume that the ground forces will continue to be the most heavily engaged service element in any future conflict. Table 13 shows the current DoD peacetime strength breakdown and illustrates the dominance of the Army as the largest single manpower user.

TABLE 13. DEFENSE MANPOWER LEVELS (As of 6/30/82)

Service	Strength	% Total
Army	782,973	36.7%
Navy	544,048	25.5%
Air Force	576,930	27.0%
Marine Corps	190,632	8.9%
Coast Guard	39,364	1.8%
Total	2,133,677	

TABLE 14. DEFENSE MANPOWER RATIOS (Personnel—000's)

LIMITED BUT RAPID MOBILIZATION IN SINGLE THEATER (Korea)

Service	Start	Finish	Duration (Years)	Factor
Army	593	1,533	2	2.59
Air Force	411	977	2	2.38
Navy	381	794	2	2.08
Marines	74	249	3	3.36
Coast Guard	23	34	2	1.48

GRADUAL MOBILIZATION FOR LIMITED MILITARY OBJECTIVE (Vietnam)

Service	Start	Finish	Duration (Years)	Factor
Army	969	1,570	3	1.62
Air Force	825	905	3	1.10
Navy	671	765	3	1.14
Marines	190	307	3	1.62
Coast Guard	32	36	3	1.13

One key element from the figures is the reflection of largest service growth as a function of time. For Scenario B, all but one service realized their largest strength two years into the war, whereas in Scenario C, all five services had

their largest strengths at M+36, three years after the mobilization date. For full mobilization, this maximum strength level occurred at M+36 for two services and M+48 for the two largest services. Table 14 depicts these ratios for the two limited scenarios.

G. Service Item Utilization

The fact that individual services have different strength levels and have historically grown at different rates during the last three conflicts is important to the study because the end-items of clothing and equipment are not used equally by all the services. The Army has traditionally been the largest of the five services, and many clothing and equipment items are designed and developed primarily for Army use. Some of the other services do use many of these items for the same purpose, but there are numerous items that are service unique for special tasks.

KSA requested NLABS' assistance in developing the correct utilization matrix for all study end-items. Each service was also asked to indicate item utilization, and inaccuracies were settled by NLABS. There are numerous sources for this type data, as shown in Table 15 below.

TABLE 15. ITEM SERVICE UTILIZATION

Source	Service
CTA 50-900	Army
CTA 50-970	Army
TAM, USMC	USMC
NLABS	Army, Navy
DPSC	All

Item utilization by services is a constantly changing picture. The Army and the Marine Corps have the highest frequency of multiple-service use of items, mostly based on the similarities of major missions.

These service utilization factors are contained on each item sheet in the separate appendix presented to NLABS. As previously mentioned, NLABS is the major agency for DoD textile and apparel research and development, and is involved with individual product R&D programs from the other services. Additionally, as the major source for specifications, both military and federal, NLABS has a unique opportunity to increase the interservice utilization of end items. There will always remain some service differences for dress uniform items, but continued review of combat-essential items for multiple service use is important to reduce product demands on industry in emergency situations.

H. Item Replacement Factors

The study items are a composite of products used by all five services for both peacetime and mobilization conditions. Those products which have a definite mobilization use are technically assigned a replacement factor for use by logistical planners. For items of clothing and textiles, there is a single source document for wartime replacement factors and consumption rates for all DLA- and GSA-assigned items. Department of the Army Supply Bulletin 10-496[9] lists eight categories of supplies, four of which contain apparel items and equipment. The most recent issue of this document is dated January 1982, and its coverage is for items required for mobilization planning.

Of the 261 study items of clothing and equipment, only 35 percent were contained in this document. NLABS was asked to assist in establishing replacement factors for those items in the study considered combat-essential and lacking factors in SB 10-496. These factors are indicated on each item sheet applicable to the user service or services.

This document, unless augmented by classified bulletins unknown to NLABS or KSA, represents the military's best estimate for replacement and consumption of mobilization items. This document is used by logistical planners and is a critical element in determining an emergency demand level for textiles and apparel. Factors are identified for training and active areas as well as for three separate climatic zones. The factors are based primarily on issue experience from World War II and Korea with some adjustments for Southeast Asia operations. Provisions are included in the document for assignment of temporary factors comparable to items listed, and each service maintains a Service Item Control Center (SICC) with responsibility to maintain supporting data for each factor.

The item replacement factors are essential for the determination of the increased military demand for textiles and apparel under mobilization conditions. As the manpower levels increase, there are simultaneous increases in both initial issue and replacement items of clothing and equipment by all the services. The demand on industry is therefore greater than an increase in manpower during peacetime or a gradual mobilization. These factors are included in the format of the KSA demand functions in Appendix H.

I. Item Criticality

Item criticality refers to the combat-essential need of individual apparel and equipment study items. Discussion has already centered on the definition of dress and combat uniform items, with dress items not considered under the full mobilization scenario. Though there is some concern from the industry side that dress uniform items should be retained for consideration in all scenarios, even the replacement tables mentioned in the previous section do not contain any provision for dress items. For the remaining items in the study, both clothing and equipment, NLABS was asked to assist with that designation, as there is no single source document available.

The best resource for determination of study item criticality is a list prepared by the Industrial Preparedness Planning Section at Defense Personnel Support Center (DPSC). This list combines the individual service requests for supply items with consideration for depot inventory levels. Essentially, the list is the Defense Department's way of identifying to industry which textile and apparel products will have an increased mobilization demand. The most current IPPL contained 112 study items of clothing and equipment, as well as 47 fabric items which are textile components of one or more study items. Items not considered combat essential for this study have a mobilization (MOB) factor of zero (0) for Scenario D on the individual item pages of Volume II. Both NLABS and KSA feel that the legitimacy of the study as an indicator of specific products demanded by the military is verified by the fact that the study items list does contain the items of largest volume that are combat essential requested by the services.

J. Relationship to Mobilization Planning

Just how accurate the study projections are against current DoD planning is beyond the classification of this report. As previously mentioned, there are numerous agencies, both internal and external to the military, that plan for the next armed conflict using computer war games with strategic and tactical inputs. Sometimes, however, the games are played without regard to all constraints that may be present with the industrial base. In a later section of this report an example of an excellent logistical planning system is explained.

Contingency planning is multifaceted; the probability is that each different scenario involves either a different manpower commitment or some other variable such as climatic zone which has the effect of changing military requirements for textiles

and apparel. The point is that logistical planning for textiles and apparel for every optional scenario would be valuable if the critical textile items could be identified and emphasis on industrial planning were made accordingly. The other important consideration for contingency planners would be an appreciation for the capabilities of a particular segment of the industrial base. In the case of this study, certain measurements are made of the U.S. textile and apparel industries that can be used as guidelines to gauge the impact of either broad textile categories or special items. Two examples would be narrow fabrics and heavy army duck cloth.

Military contingency planning occurs at the global, theater, group, division, and unit levels, with obvious variations in degree of sophistication and logistical support required. Major options are theater-dependent, because they are based on large static forces and augmented with rapid deployment units. At every planning level, however, there is a basic formula that governs contingency planning, presented below in Figure 4.

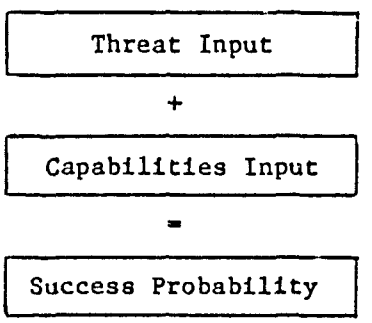


FIGURE 4. CONTINGENCY PLANNING SEQUENCE

The threat input is a function of military intelligence and strategic war gaming. This posture changes over time and certainly impacts on the combination and volume of capabilities needed to give some success to the Operations Plan (OPLAN).

Our focus for this study and recommendations is on the Capabilities Input for logistical requirements. Essentially, this study asks the same question that military planners should have as a constant priority, and that is "What drives the capabilities input?"

We view the answer to that fundamental planning question to be a function of four major variables:

- Manpower
- Equipment
- Training base
- Appropriations

No argument will necessarily be made in favor of any individual factor, as they are to a degree interdependent. If we look at manpower from the standpoint of combat strength, Table 16 gives the current posture of DoD forces.

TABLE 16. DEFENSE COMBAT STRENGTH

Number of Divisions	Service	Air Wings	Warships	Aircraft Carriers
16	Army			
3	Marine Corps	3		
	Air Force	26 (Tactical)		
	Navy	13 (Carrier)	325 GP	13

Source: Department of Defense Abstract, U. S. Government Budget FY83

The study identifies textiles and clothing as items of equipment which do influence the ability of the defense structure to piece together a CAPABILITIES INPUT for a particular OPLAN.

The basis of any capability factor is funding, and we have discussed that appropriations for DPSC procurements related to textiles and apparel are in the $1 billion range. Additionally, total research and development by DoD for clothing and textiles is in the range of 0.1 percent of the total military R&D, T&E budget annually. For example, of the 1982 budget estimate of $20.06 billion for R&D, T&E, approximately $20.06 million will be allocated for clothing and textile R&D. Appropriations for manpower, training base capabilities and other equipment issues certainly exceed what is spent on R&D, T&E for clothing and textiles.

It is KSA's position that attention must be given to those logistical constraints that occur when a selected OPLAN is tested. This concern essentially matches that of the Army's senior logistical officer, General Donald R. Keith, DARCOM commander, which is combat sustainability.[10] In that regard, any logistical category which appears as a shortcoming significant enough to reduce the effect of a response to a

threat is a "war-stopper" and requires attention by planning agencies in peacetime to correct. A system of identifying these war-stoppers and communicating them to commands responsible for making appropriate adjustments is required for clothing and textiles just as it is for tanks and ammunition.

K. Relationship to Reserve Base

If it is agreed that the purpose of the DoD Reserve forces is to augment the existing active duty manpower posture, then mobilization planning in all logistical areas must account for both their size and equipment capabilities. The better these Reserve units are manned and equipped, the less of an initial drain they will be on the existing war reserve stockage levels for all supply classes.

With respect to size of these Reserve forces, Figure 5 and Table 17 illustrate the DoD Reserve personnel status as of September 30, 1981. The various categories of Reserve organizations and status while not on active duty make the total administration of the Reserve system a monumental task. Appropriations for these Reserve forces never seem adequate to maintain the readiness posture either desired or required.

If the Reserve manpower level is considered adequate for the contingency plans of the future, the next big concern involves the combat potential of these forces, either as complete organizations or individual replacements. Training and equipment are the major factors contributing to reserve combat readiness, and apparel clothing and equipment items are critical to performing any combat mission. With the disparity that exists throughout the country regarding Reserve unit levels of training and equipment availability, it is very difficult to place an accurate figure on the percent of these Reserve forces which could be considered properly "uniformed" for mobilization. Responses from several military sources ranged from 30 to 60 percent, the high figure probably applicable to those ready Reserve units with creative logistical support systems. If the real percentage is half, it means a significant number of Reserve personnel, depending on activation timing, will require immediate issue of the full complement of combat clothing and equipment. It will have an immediate effect on the supply system because these Reserve forces do not represent normal accessions which will be in the training pipeline for three to four months. Again, numerous variables will determine just what specific type equipment is required, such as climate, Military Occupational Specialty (MOS) and type unit.

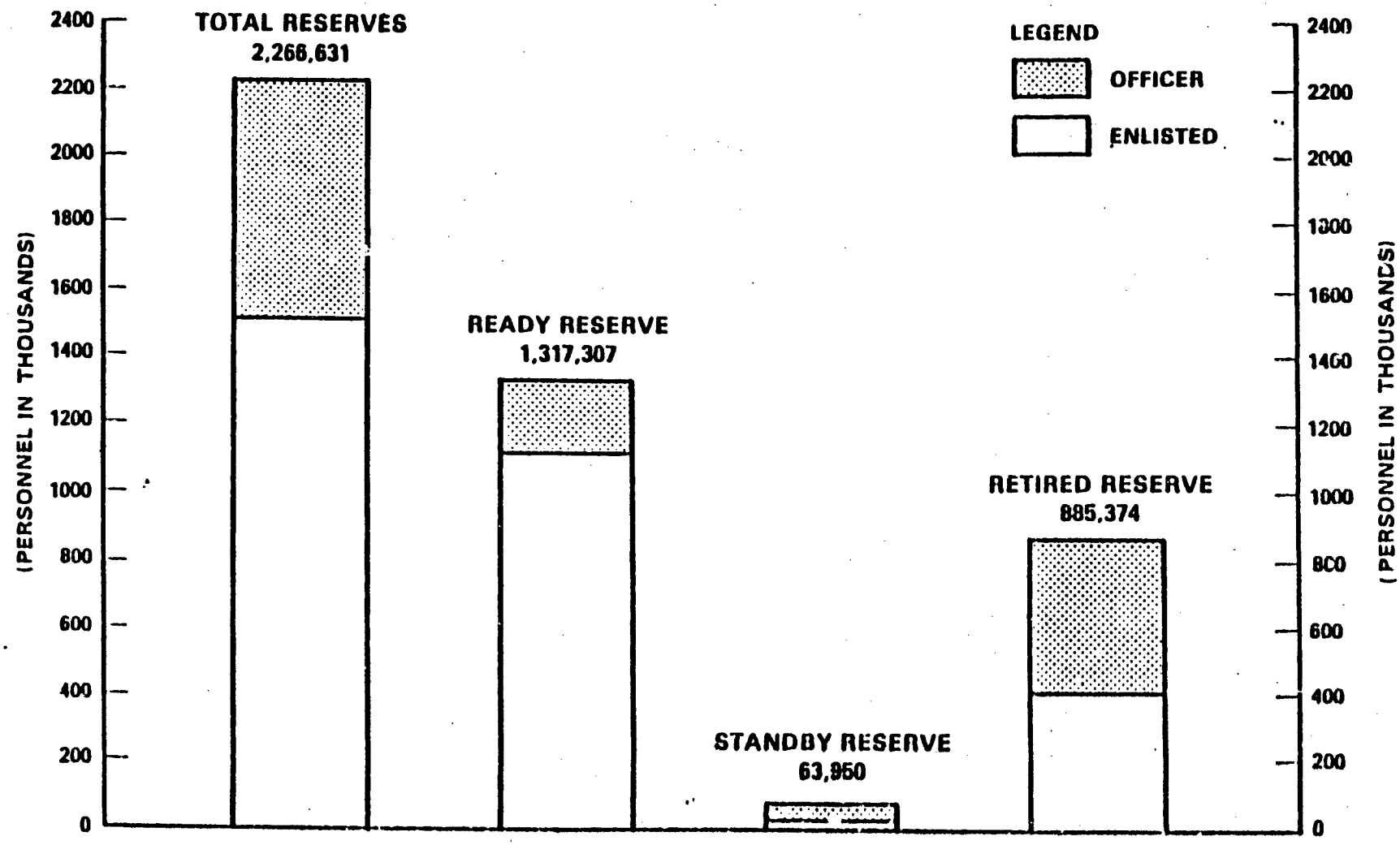


FIGURE 5

DEPARTMENT OF DEFENSE

RESERVE PERSONNEL OVERVIEW

SEPTEMBER 30, 1981

TABLE 17. DEPARTMENT OF DEFENSE RESERVE STRENGTH AS OF 30 SEPTEMBER 1981

	Total DOD	Army National Guard	Army Reserve	Naval Reserve	Marine Corps Reserve	Air National Guard	Air Force Reserve	Coast Guard Reserve
Total	2,436,302	400,126	990,600	435,134	104,114	98,673	437,655	20,855
On Active Duty	169,671	596	53,252	68,285	5,302	255	41,981	1,045
Not on Active Duty	2,266,631	399,530	937,348	366,849	98,812	98,418	395,674	19,810

NOT ON ACTIVE DUTY

Total		Officers	Enlisted
1,317,307	Ready	204,535	1,112,772
63,950	Stand By	56,810	7,140
885,374	Retired	466,987	418,387
2,266,631	Total	728,332	1,538,299

In a mobilization situation some portion of this total DoD Reserve strength would be physically available for deployment. Exactly what percentage would be in that category is arguable, but for study purposes consider that all personnel listed in Table 17, except the retired Reservists, would fall in that category. That assumption would yield the following total:

Category	Manpower
On Active Duty	169,671
Ready Reserve	1,317,307
Standby Reserve	63,950
Total	1,550,928

Assuming hat these were personnel fully uniformed and equipped for mobilization, this would mean that in a relatively short period of time, certainly before any regular training personnel would be ready for deployment, a force equal to 72.7% of the current DoD peacetime strength level (Table 9) would be available. This is a significant fact not only from the standpoint of reducing the impact on the logistical system, but more importantly because the pressure on the peacetime training base is reduced from an initial shock requirement.

For the full mobilization scenario presented by this study, where total military peacetime strength can be expected to double within the first six months, the Reserve forces could conceivably satisfy 72 percent of this increase, leaving roughly 585,000 personnel to be drawn from the civilian labor force.

As of December 31, 1981, this labor force was 91,591,000 people between the ages of 16 and 55, both sexes, full-time and part-time, employed and unemployed. Males represent 56 percent of this total civilian labor force, yet represent 92 percent of the total defense strength. In a mobilization situation, the ratio of male/female personnel may in fact be more heavily weighted toward males due to combat requirements.

In addition, depending on average recruiting levels experienced by each of the four services, the total manpower requirements to be drawn from the civilian labor force beyond the normal defense manpower replacement policies may be in the neighborhood of only 200,000. Table 18 indicates fiscal year 1982 total DoD recruiting objectives at 379,160 personnel. This would result in a loss to the civilian labor force in the first six months of only 0.22 percent.

TABLE 18. DEFENSE RECRUITING PROGRAM OBJECTIVES

Service	FY 1982 Enlisted Men	FY 1982 Officers	FY 1982 % Female	FY 1983 Enlisted Men	FY 1983 Officers	FY 1983 % Female
Active:						
Army	130,600	10,400	15.6	150,300	10,200	17.2
Navy	93,300	7,600	8.4	106,000	8,500	10.4
Marine Corps	44,200	2,100	3.0	44,200	2,400	3.0
Air Force	75,000	8,900	9.3	81,300	10,800	9.2
Coast Guard	6,670	390	5.8	6,600	396	6.0
Subtotal	349,770	29,390		388,400	32,296	
TOTAL	379,160			420,696		

Reserve:	1982	1983
USAR	94,300	91,100
ARNG	63,900	60,100
NR	28,400	25,200
USMCR	14,500	13,800
AFR	13,400	14,700
ANG	12,600	11,400
CG	1,454	1,455
TOTAL	228,554	217,855

Though this is a rough analysis of manpower alternatives for full mobilization, it does not appear that even a worst case analysis regarding the Reserve forces would cripple the U.S. structure. The full mobilization scenario calls for a six-fold increase in total DoD strength level, or a total strength of 12,800,862 within 30 months after mobilization. This increase generates a somewhat different set of circumstances for the industrial base, but not necessarily as far as the civilian labor force is concerned. For example, assume that normal DoD losses from attrition back to the labor force are reduced to zero, and that the total increase would then come out of the labor force. This total addition would be in the neighborhood of 8,900,000 spread over a 2.5-year period, or 3,560,000 per year. Again assuming that no changes are made to the 91,591,000 labor force size, this reflects only a 3.9 percent impact in the first year. If we further assume that no women will be used for mobilization in DoD, then the work force is reduced to 51,292,640, and the 3,560,000 per year mobilization requirements results in a 6.9 percent effect in the first year. The subsequent yearly effects would be higher due to a correspondingly reduced labor force, but not by the same amount as mobilized due to entries to and exits from the labor age limits.

It appears, therefore, that the labor force could absorb this increased manpower demand for full mobilization. The next major variables for contingency planning involve training and logistical constraints. There are numerous large-scale exercises and schools within the Defense Department which concentrate solely on teaching and testing logistical planning. The larger process of matching the logistical and training system capabilities to mobilization requirements is the study focus.

L. Relationship to Training Base

If a conflict requires a doubling of peacetime manpower levels within the first six months, irrespective of what portion of the Reserve forces would be capable of responding, what is the capability of the current training base to respond? This question led KSA to the U.S. Army Training and Doctrine Command (TRADOC) and to another system requiring some attention by mobilization planners.

We will discuss DoD training base capability from the Army perspective, because the Army represents greater than one-third of the total DoD strength level, and the Army is the one service which will experience the greatest increase in number of personnel in the majority of the contingency scenarios. KSA did not research the training base capacities for the other services, but from responses in discussions

with other service personnel, there are fewer separate major training facilities for the other services. There is no question that the other services should have an equal capability to project actual mobilization training capabilities.

The DoD capacity to train accessions is the very subject of a study in process as this report is written. This study was directed by and is managed by TRADOC, which has responsibility for operating all training aspects of the U.S. Army, to include all Military Occupational Specialty (MOS) school facilities. The study requested feedback from all TRADOC installations concerning facilities and support capabilities for both individual and unit training. The report is titled the Emergency Wartime Capacity of the Training Base, and it is the first study of this nature done since extensive changes have occurred to both TRADOC and FORSCOM after the Vietnam war.[11]

Currently, there are three sets of figures that TRADOC uses to determine mobilization training capabilities:

1. What TRADOC thinks the capacity is.

2. What Department of the Army (DA) says TRADOC will have to do.

3. What the Pentagon (JCS) says will occur under mobilization scenarios.

The TRADOC study will help to establish position #1 and that could cause #2 to change accordingly. The figures related to #3 are variable based on the conditions, but the training base capabilities should probably be geared to meeting at least the needs of the top three or four priority mobilization scenarios.

Mobilization accessions for the Army are those personnel required for both Basic Training and One-Station Unit Training (OSUT). Basic Training currently lasts seven weeks, and OSUT is approximately 13 weeks in addition. This occupies the first five months of an individual's service commitment; it also means that the committed forces cannot expect other than normal training base replacements during that period, with the exception of the Reserve strength previously discussed. This training cycle time of roughly 20 weeks is not scheduled to be shortened under mobilization conditions.

The TRADOC study has requested feedback on training capability for the first 13 weeks after mobilization, as the DA requirements are expressed in those time increments. The

current DA mobilization requirement for this initial 13-week period is in the range of 400,000 personnel to be trained. The preliminary returns from TRADOC installations indicate an actual capability of 150,000 to 175,000 that includes both Basic Training and OSUT. Though this appears to represent a shortfall of some 225,000, the returns are preliminary and may not look disproportionate when completed.

There is another complementary addition to DA training capabilities under mobilization that would contribute to reducing the existing shortfall between DA requirements and TRADOC capabilities. There are six Forces Command (FORSCOM) installations which convert to TRADOC control under mobilization. These are current bases for active Army divisions and organizations that would be deployed in a mobilization, thus making both facilities and space available for additional training of accessions. The big question is of course; "Who would provide the training?"; and the answer is, "designated Reserve and some active duty units that will become Training Divisions." The equipment required for this expanded training base must come from these existing Reserve units, as the parent unit would carry the installation equipment with it when deployed.

How effective and what quantity of "trainees" this alternative to the training base will be able to provide is an issue this study does not address. The requirements for these Reserve units to be operational at the FORSCOM sites and ready to receive initial accessions is seven days. However, some measure of time will be required physically to prepare and extract the FORSCOM unit before any Reserve unit could even begin to establish a training base. This period would conservatively take 15 to 30 days. Mobilization planners at those designated installations work for FORSCOM in peacetime and may only give minor consideration to the mobilization requirements of an occupying unit. In addition, the FORSCOM Fighting Plan is different from the Installation Fighting Plan. These issues require continued attention in peacetime to establish a guaranteed minimum training base capacity for mobilization, whether full or limited.

It is estimated that at full potential, these FORSCOM installations converted to training facilities could add 30 percent to the 175,000 TRADOC estimate, or another 50,000 personnel. It must be considered, however, that some percentage of this reported TRADOC training capacity of 175,000 includes training for MOS's that are not required for mobilization. In other words, some of the schools that in peacetime are managed by TRADOC would not necessarily contribute to a mobilization training capability because

their MOS's would not be required. Just how much of the capability they represent could be converted to a mobilization-required MOS is not known by KSA, but presumably it is an element of the existing TRADOC study.

The limitations to the total DoD training base after this initial 13-week requirement are similar in all the services. It is not known if this initial training base capability of 175,000 could be doubled. The three major factors for that determination are physical space, size and expertise of the training staff, and logistics. Military clothing and equipment for every accession is a requirement, and any demands in the initial 13 weeks would come from depot stockage levels or the inventories maintained at each TRADOC or FORSCOM installation.

Where these 400,000 accessions would come from is not an element of consideration for this study, but should be looked at by military planners. The recruiting goal for fiscal year 1983 is near the 420,000 figure for all services, which for a three-month (13-week) period would be roughly 100,000, if averaged. Where the remaining 300,000 personnel would come from is a function of executive authority for conscription, which is based upon a declaration of war and/or congressional approval. Whatever the restrictions on authority for expanding the defense manpower capability in a limited mobilization, actual training capacities may prove to be the limiting factor.

IV. MILITARY TEXTILE DEMANDS

The foregoing information has been presented essentially to provide an improved appreciation for the multiple variables that impart on actual requirements for the clothing and textiles required by the military. This section details the method of the procedures employed by KSA in developing military textile demands. Because many study assumptions were either provided by NLABS or established by KSA with NLABS approval, it is understood by both parties that not all assumptions may agree with positions held by military planning agencies. Because of the unclassified nature of the report, it was not possible for KSA to obtain data relative to actual contingency planning for manpower, war reserve stockage levels on items of textiles, clothing, or equipment, actual listings of planned producers for manufacture of clothing and equipment items, or projected wartime requirements for certain critical study items such as aerial delivery equipment. In addition, because of nonavailability for one reason or another, other data that could have been valuable for the study are not used. These include a listing of total GFM items procured by DPSC, the annual quantities of GFM procured by DPSC, the annual quantities of GFM issued to manufacturers against contracts for clothing and equipment items, and performance data relative to Small Business Administration (SBA) issued Certificates of Compliance (COC) on contracts for government items of clothing and equipment.

Despite these qualifications, NLABS is satisfied that this approach to the development of actual military textile demands is legitimate and has significant merit both for logistical planning and continued improvement of coordination with the domestic textile and apparel industrial base. Having coordinated this study with many military agencies and industrial firms regarding military requirements for textiles in mobilization, KSA is convinced that this is the first time that an attempt has been made to quantify textile requirements. The scope of this study was limited to 261 items, but the procedures and demand functions could be used to extend the coverage to all military products used in both peacetime and mobilization.

A. Items and Components

Aggregate textile product demand for all items in the study was derived from the demand functions that increased the items required for the multiple scenario increments. For each six-month period in each scenario but peacetime, unit demands were calculated. These required unit quantities were multiplied by each textile component used in the manufacture of that unit to yield the total materials required to produce

the required units. Once this is done for all units, the computer program conducts a sort to collate all values for a specific textile component. These summaries are contained in Appendix G.

These summaries do indicate the frequency of use of each textile component, the most frequently used components being the thread items. The scenario summary formats are identical, and each six-month period is displayed to reflect total quantities demanded by textile component.

End-item quantities by scenario period are contained in Appendix H. The end-items are listed by military specification number arranged alpha-numerically. The volumes are expressed in units and are not consecutive. For example, in scenario B the quantity expressed in column M+6 is the quantity required during that six-month time period, obviously not a requirement for delivery on that date. The quantity reflected at M+12 is independent from the M+6 number, and again is a quantity required during that period.

B. Demand Functions

The number of variables involved with an increasing military strength during a limited or full mobilization required the development of several equations. These equations are used in the demand functions to generate aggregate units required for each mobilization period. The demand functions complete the derivation by computing the individual textile component demands for each end-item.

The factors used in the development of these demand functions are based on the two main factors of manpower and item demand. In any mobilization, these additional considerations were included in the functions:

- Item criticality
- Item replacement factor
- Service utilization
- Service growth
- Peacetime strength
- Peacetime item-demand

The manpower base is peacetime strength. The demand base is peacetime average monthly demand. Each service strength is expressed as a relationship to total DoD strength and total item demand based on peacetime utilization. Item-demand increase in six-month increments reflects both individual service growth and item replacement requirements. The percentage of individual service receiving any end-item in peacetime remains constant as both manpower and item demands grow.

Appendix I illustrates the equations used and provides some explanation relative to their derivation. As previously mentioned, these equations are an attempt to quantify a military demand for textiles under certain mobilization scenarios. They were designed to enable substitution of one or more factors and retain the relationships between variables.

C. Four Scenarios

NLABS decided on the use of the four scenarios primarily based on Dr. Kennedy's report which originally addressed four. NLABS and KSA feel that these four scenarios will give an acceptable representation of military textile demands under different mobilization conditions. By using a combination of historical manpower growth figures for the limited scenarios, actual manpower levels for peacetime, and acceptable assumptions of maximum DoD strengths for the full mobilization posture, we feel that ample consideration has been given to variables that would produce different military textile demands in a future conflict.

As can be seen in Appendix G, where the demand totals by textile component are listed, each scenario produces a different total volume, and the maximum demand for each textile component does not necessarily occur at the last six-month increment of each scenario. The main reasons for these differences are the rate of service growth factors and the item criticality factors, where dress items are not included, in the full mobilization scenario.

Scenario D, the full mobilization scenario, produces the greatest demand for most textile components, and the largest demand is represented at the M+30 increment due to the steady doubling rate of manpower for that scenario. These amounts are purposely large relative to peacetime demands for the same components, with the intent of giving some indication of how significant aggregate military textile demands could be in a future mobilization. The next report section discusses the impact of these demands on current industrial production, and it is the intent of the study to point out potential problem areas with respect to meeting very high military textile demands relative to peacetime demands to which the industrial base responds.

D. Textile Item Categories

Military demands for textiles can be grouped into broad categories for comparison to industrial base production. The study items involve over 248 different textile components for their manufacture. The various categories are listed in Table 19, with broadwovens and narrow fabrics being the two most important for an industry comparison.

TABLE 19. TEXTILE ITEM CATEGORIES

Category	Quantity of Study Items
Broadwovens	105
Narrow Fabrics	22
Knits	18
Nonwovens	3
Threads	10

Broadwovens will always receive the most attention from industry since they are the base fabrics for the majority of military items. Narrow fabrics represent some critical components of military equipment items, primarily in the aerial delivery equipment area. Knits are found as complete items in the case of undergarments and footwear, and are found in specialty clothing and accessory items such as tunics and neckwear. Nonwovens primarily appear as interlining material in dress clothing items, though the potential for nonwovens for military use is just being recognized and utilized in current R&D programs. Threads are critical from the standpoint of garment and item construction, but represent a more fundamental textile industry production capability.

Appendix J lists the totals for each of these textile categories for each of the four scenarios by six-month increments. These totals will be compared to industry production numbers for a comparison of demand to supply. The numbers reflected in each six-month increment reflect the total demand for that component over that time period, which assumes a gradual production response increase by industry.

V. INDUSTRIAL CAPABILITY

The focus of this report section will be on the existing industrial base response to military textile and apparel demands, with indications of capabilities to meet the increased military textile demands represented by the four study scenarios. Much use is made of information supplied by industry to government agencies or industrial associations. Indications of potential or capacity in certain industry areas are presented with assumptions or qualifiers to explain the relationships.

The overall comparison of military demands to industrial base production, both textiles and apparel, will demonstrate that for most conditions reflected in the four selected scenarios, there is ample production with existing circumstances. The issue of industrial base capabilities to meet increased military demands will most likely not be a matter of total production numbers as much as the ability to provide specialty military requirements. Specialty military requirements refer to any item in the complete fiber-to-end-use manufacture chain and include raw materials, processes, capacities, and construction techniques. It is therefore a more important analysis of industrial base response from a micro rather than a macro perspective.

This study primarily deals with the aggregate picture in that it is the first attempt of this type to quantify military textile and apparel requirements for periods of increased manpower utilization. Comparison of these military demands is primarily made to aggregate industry performance.

Those specialty requirements associated with the study items are highlighted and discussed from the standpoint of their becoming potential "bottlenecks" in periods of increased demand.

A. Relationship to Peacetime Stockage Levels

The exhaustive efforts to identify what domestic industrial base response would be to increase military demand for end-items might best be illustrated by a representation of military levels of stockage items. The connection is related to the ability of the military to maintain adequate stockage levels in peacetime for contingency purposes, which has no bearing on what the domestic industrial base could supply. In other words, if the military services were to be able to satisfy completely all stockage levels for items deemed critical to a mobilization, the effect on the textile and apparel industries would be minimal.

The important consideration here is that war reserve stockage levels of textile and apparel items for the Army, the major service in terms of strength, are very low. The implication is that an emergency situation would even increase the demands for textiles and apparel items beyond what is represented by this study because the very items needed for issue to units and personnel for deployment would not be in the logistical system. If the stockage levels were increased in peacetime to an acceptable level, the impact on the industrial base would be more predictable by a set of equations and factors similar to what this study has developed. There are undoubtedly excellent reasons for the stockage levels to be lost, but military planners must consider that industrial base response will be neither as rapid nor as accurate quantitatively if stockage level maintenance becomes first priority in an emergency.

War reserve stockage levels for all Army commodities are controlled by DARCOM through the issue of supply bulletin (SB) 700-40, the War Reserve Stockage List, Army (WARSL).[12] This document reflects all end-items which are required to be maintained in war reserve for worldwide use. The clothing and equipment items are selected by major theater commanders, and thus represent that portion of the capability input applicable to textiles and apparel which are required for successful implementation of operational plans. Item quantities are not specified in this document, but are determined by DA level staff and procured by the logistical element, DLA.

Table 20 illustrates the relationship of study items to the listed commodities in SB 700-40. In certain categories there is a high correlation of items required for stockage to study items and very low correlation to textiles and clothing.

TABLE 20. WAR RESERVE STOCKAGE ITEMS - STUDY ITEMS VERSUS SB 700-40

	SB 700-40 Items	Study Items In SB 700-40	Total Study Items	Study Items In SB 700-40 (Percent)
Textiles	0	—	132	—
Clothing	50	36	125	29
Equipage	74	51	118	43
Trucks	107	19	21	90
Aerial Delivery Equipment	18	8	9	89

It is interesting to note that textiles are not considered a commodity item requiring stockage for war reserve purposes. This does tie in with the information from DPSC concerning GFM items with depot inventories. The assumption is clearly that all broadwovens will be made available to the military by the industry in the event of mobilization.

To establish some perspective to the issue of industrial base capability to supply war material requirements for textiles and apparel, it is interesting to look at existing Army stockage levels for certain clothing and equipment items. Figures 6 through 9 are graphic displays of assets and shortages for clothing and tentage items. These charts are produced in a quarterly review by the U.S. Army support activity co-located at DPSC in Philadelphia. The summary chart, Figure 7, shows an 81-percent shortfall over all clothing items requiring war reserve stockage levels. Figure 8 shows a 68-percent shortage of tentage required for war reserve stockage. These charts are examples of extensive evaluation of U.S. Army Support Activity Philadelphia (USASPTAP) operations and command programs. One of the command programs is maintenance of war reserve stockage levels of clothing and equipment items. These charts accurately reflect the shortages of critical war reserve commodities, and essentially illustrate the difficulty of measuring what a total demand for textiles would represent to the industrial base. Though appropriations for textile and apparel items would obviously not be an issue under mobilization conditions, they are obviously a factor in peacetime preparation of war reserve stockage levels. If these stockage requirements are maintained at such a reduced level, how important must they be to either operations or planning personnel in DoD?

B. Peacetime Production

The initial phase involved establishing military textile requirements for various readiness states. The second study objective was to relate this aggregate military demand to industrial base production and capability.

Industrial base production for textiles and apparel must be considered initially as separate industries, with additional subdivisions made in each to appreciate the relationship of military textile demands to specific industry units of production.

Domestic textile production can be measured in many ways, reflecting the industry capability from fiber formation to finishing. With respect to finished industry products, production listing is in terms relative to the military demands reflected by the study. We have used the categories

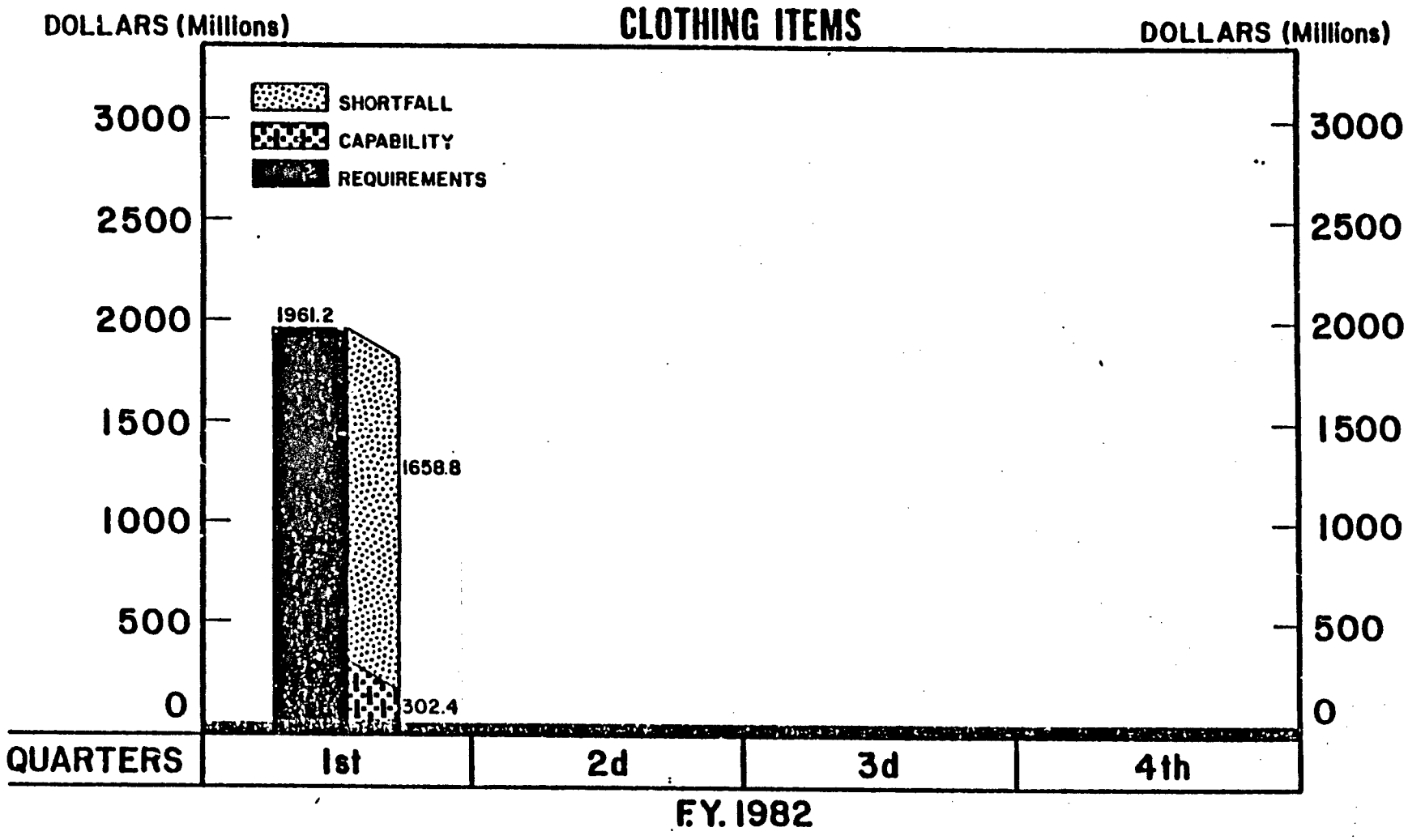
ACTIVITY	RQMTS (DOLLARS) BILLIONS	1.0 2.0 3.0 4.0
DEFENSE PERSONNEL SUPPORT CENTER	2.126	.409 1.717
U.S. ARMY SUPPORT ACTIVITY PHILA.	1.961	.302 1.659
MAJOR ARMY OVERSEAS COMMANDS	.215	.103 .112
TOTAL REQUIREMENTS	4.302	.814 3.488

F.Y. 1982

ASSETS SHORTAGES

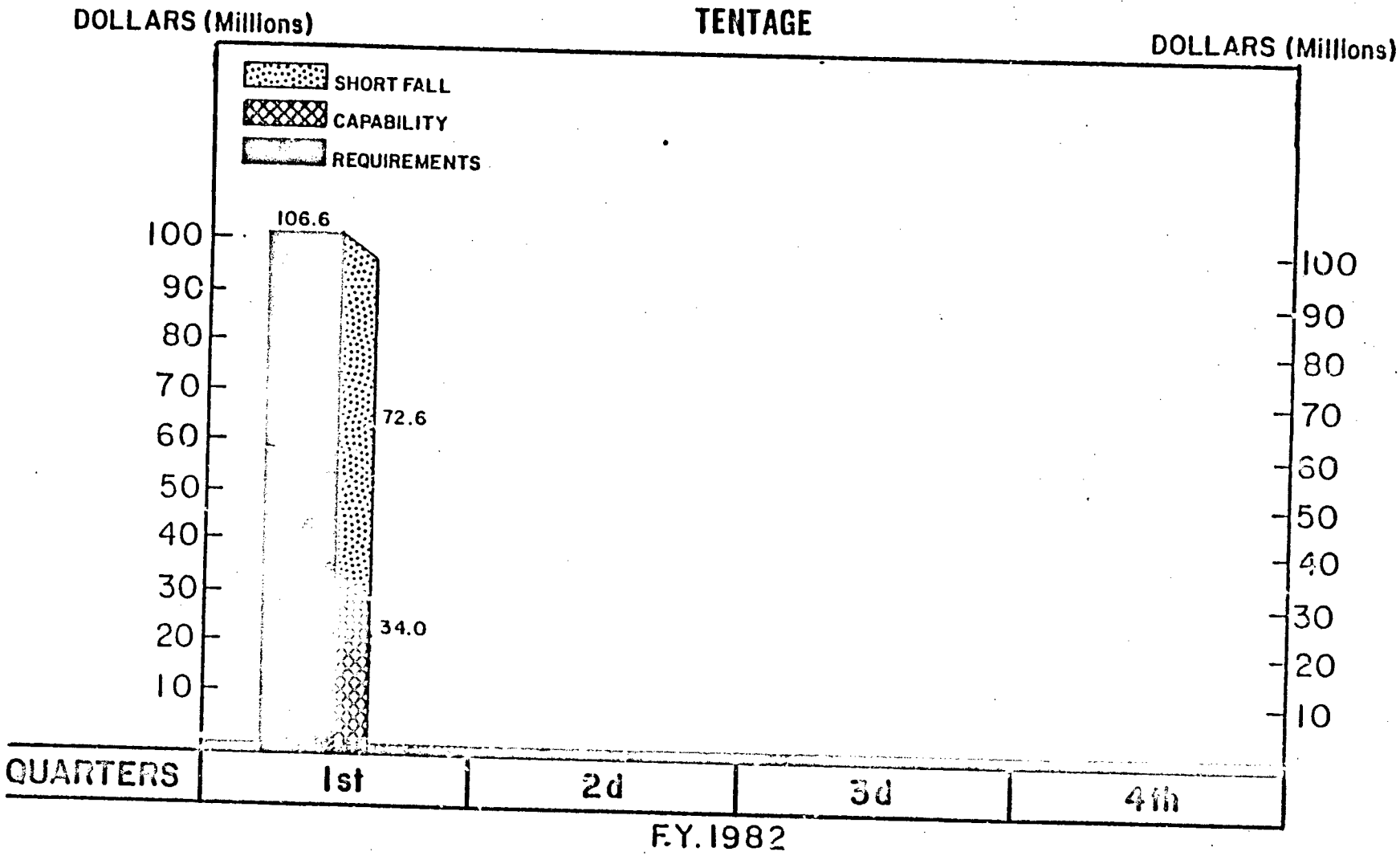
Source: U.S. ASA, Philadelphia, 3rd Quarter, FY 1982.

FIGURE 6. WAR MATERIEL REQUIREMENTS - CLOTHING



Source: U.S. ASA, Philadelphia
3rd Quarter, FY 1982

FIGURE 7. STATUS OF PREPOSITIONED WAR RESERVE MATERIEL REQUIREMENTS AND ASSETS



Source: U.S. ASA, Philadelphia
3rd Quarter, FY 1982

FIGURE 8. PREPOSITIONED WAR RESERVE BY CATEGORY OF ITEM

1-ST. QTR F.Y. 1982

CONTINGENCY PLANS	NO. OF LINES / REQNS	TOTAL DOLLAR VALUE (000's)	TONS	PERCENT OF FILL INDEX 0 20 40 60 80 100
CONSSTOCS	1,061	239,331	22,598	
TR-3	789	830,350	68,205	
PRIMOB	560	168,371	9,683	
FAM	664	313,093	14,053	
4102	97,276	803,770	63,639	
5027	45,781	87,858	8,728	
1/75 RANGER BN	8	1	1	

CLOTHING - USASPTAP

CLOTHING - DPSC

Source: U.S. ASA, Philadelphia
3rd Quarter, FY 1982

FIGURE 9. WAR RESERVES AND CONTINGENCY PLANS SUPPLY CAPABILITY INDEX

in Table 21 to illustrate domestic production that could be designated peacetime industry production.

TABLE 21. DOMESTIC PRODUCTION - TEXTILE CATEGORIES

Category	Volume (Year)
Broadwovens	16.134 BB ESY (81)
Narrow Fabrics	6.251 BB LY (81)
Knits	1,735 MM LB (80)
Nonwovens	3,877 BB ESY (81)
Thread (Cotton System)	76.2 MM LB (81)

C. Peacetime Military Requirement

In the aggregate comparison, the military requirement totals for the major textile categories of broadwovens, narrow fabrics, knits, nonwovens, and threads for all scenarios are represented in Appendix K. These totals for the peacetime scenario are summarized in Table 22, and represent an analysis of each textile component involved in the study.

The number of items represents the total number of components in each category involved in the manufacture of the 261 study end-items. Broadwoven components represent greater than 60 percent of the total textile study components, and clearly the largest contributor to total military textile demand.

TABLE 22. PEACETIME TOTALS

Category	# Items	Total Volume
Broadwovens	92	145,394,291 (ESY)
Narrow Fabrics	15	112,079,084 (LY)
Knits	14	21,074,698 (ESY)
Nonwovens	2	141,180 (ESY)
Thread	10	12,050,635,861 (LY)

These peacetime totals reflect certain percentages of demand by the military for industry production. The distribution of fiber and fabric requirements involved with these peacetime demands are listed in Table 24. This table clearly indicates that blended fabrications are the dominant source in broadwovens for military items of clothing and equipment, and man-made fibers are present in almost three-quarters of the fabrics required by the military. Natural fibers are dominant in narrow fabric products required by the military, primarily tapes and webbings used in equipment and aerial delivery end-items. In the thread area, blended products dominate the demands by the military, primarily for strength and durability properties.

To establish a full perspective of aggregate military demands in these same broad textile categories for each of the mobilization scenarios, Appendix K also summarizes the volumes by six-month increments. Table 23 below illustrates a percentage relationship for each of these mobilization scenarios between the volume required and the peacetime production represented above. Again, the six-month incremental scenario requirements indicate total volume required during that period to account for increased service strengths, losses, and item replacement factors.

TABLE 23. MILITARY MOBILIZATION TEXTILE REQUIREMENTS BY GENERAL CATEGORY, AS A PERCENT OF PEACETIME PRODUCTION (1981)

General Category	Peacetime	Scenario B	Scenario C	Scenario D
Broadwovens	0.9%	2.8%	1.5%	4.7%
Narrow Fabrics	1.8%	6.0%	3.3%	11.7%
Knits	0.46%	1.8%	0.96%	3.7%
Nonwovens	0.0036%	0.012%	0.0062%	0.02%
Thread	1.7%	5.6%	2.9%	8.3%

TABLE 24. FABRIC/FIBER DISTRIBUTION - PEACETIME STUDY DEMAND

	# Items	% Total Volume
BROADWOVENS		
Natural	35	26.2
Man-made	41	19.1
Blends	29	54.7
NARROW FABRICS		
Natural	7	69.4
Man-made	12	30.6
THREADS		
Natural	4	1.2
Man-made	5	16.1
Blend	1	82.7

D. Aggregate Demand Versus Specific Requirements

The previous figures clearly show that military textile demands for the broad textile categories for most scenarios do not represent a significant amount to cause concern. In the full mobilization scenario, where military strength was expanded beyond both Dr. Kennedy's estimates and most contingency manpower planning, the numbers required do represent a much larger percentage of current peacetime

production. Just what percentage constitutes a significant burden on the industrial base is difficult to establish because the variables of increased capacity utilization are not accounted for in these figures. If it is agreed that textile mill production is currently operating at near 70-percent capacity, then almost a one-third increase in productivity would be assumed to correlate more closely with increased military demands.

The real issue may not be related only to a comparison of aggregate military textile demands against textile industry production. From that standpoint above, there would appear to be no cause for significant concern that the capacity is available to meet the increased military demands. Capacity availability is only a paper issue, however, whereas actually converting what is essentially commercial capacity to government production is where the real issue of industry capability exists. Though not an immediate objective of this study, this area of tapping into that vast available capacity for military use is of great concern to textile industry executives. In all cases short of an extreme national emergency, the realities of business will find the parameters of price and availability instrumental in establishing the level of response from industry. Rated order examples from the Vietnam years illustrate this capacity availability issue.

The textile industry response in a full mobilization brings an entirely different set of conditions. Industry executives will not hesitate to convert capacity to military production, and the critical element then becomes what products are needed in the greatest quantity in the shortest time. This, of course, is a service logistical responsibility, which should be part of industrial planning activities. However, with each service maintaining separate clothing management operations, it is doubtful that a single agency has developed an aggregate textile demand by fabric category and military specification.

Aggregate demand on the textile industrial base can be adequately met for the conditions established in this study. The impact on the commercial markets cannot be measured by this study but would require consideration by industry and government alike. Most large textile organizations probably have some contingency planning in place already to react to mobilization demands for products.

What may be of more concern to both military planning and industry capability to meet increased defense needs for textiles are the specific requirements associated with individual military fabrications. The majority of textile fabrics associated with this study have involved what would

be considered standard industry processes and raw material requirements. Perhaps 10 percent of the products, however, involve one or more specialty properties which require the producer to allocate equipment and costs to meet the special need. These specialty requirements range from certain fibers to specific weaving requirements and finishing properties. To meet peacetime military requirements for these special fabrics, the textile industry has responded with capacity and processes just equal to those peacetime demands.

The problem arises when consideration is given for the increased requirements of mobilization. Whereas the increased standard broadwoven fabric demands can easily be met by utilization of other capacity normally committed to commercial use, for the specialty requirements there may not be any excess capacity either with the textile company currently producing that property or with the remainder of the industry. Conversion then is not an option to increase production, and adding new capacity is the only solution short of altering the original specification requirements to permit alternate processes, fibers or finishes as applicable. The focus of NLABS and military planning for industrial mobilization needs to be evenly divided between consideration of aggregate textile demands and special fabric properties required by specification.

E. Fiber Production

The textile story begins with fiber production, and the study end-items involve both manmade and natural fibers. Table 24 illustrates the percentage of fabrics for broadwovens and narrow wovens which were constructed with natural, manmade, or blended yarns. Another breakdown of fiber usage is presented in Table 25. Here the usage of generic fibers for all the study items required in peacetime is presented. These totals are derived from calculating fiber content and weights involved with each textile component specification. Many of these fibers are further defined by the individual fabric specifications, involving some properties or combination of properties that result in specialty items (see Appendix F). Total fiber demand for the peacetime study item requirements is 117 million pounds, with manmade fibers representing 26.4 percent and natural fibers 73.6 percent.

These military fiber demands can be compared to industry production of equivalent fibers to illustrate what relationship exists between demand and supply. Table 26 shows domestic manmade fiber production for the period 1971 through three quarters of 1982 for the most significant fibers. Figure 10 is an illustration of domestic cotton production, consumption and exports for the period 1972 through 1981.

Table 27 shows U.S. mill consumption of raw wool from 1970 through 1981.

TABLE 25. FIBER UTILIZATION - PEACETIME DEMAND

Fiber	Total Pounds (Est)
Cotton	60,400,000
Wool	26,450,000
Nylon	17,365,000
Polyester	8,972,000
Aramid	2,848,000
Rayon	778,000
Acrylic/Modacrylic	453,000
Acrylonitrile Copolymer	385,000
Olefin	180,000
Novoloid	30,000
	117,861,000

Cotton = 51.2%
Wool = 22.4%
Manmade = 26.4%

A very cursory comparison of the natural fiber demands versus production or consumption clearly shows that military demand for natural fibers to satisfy peacetime CIE requirements is less than one percent. Especially in the case of wool, because many military apparel items in the dress uniform category are made of a wool or blended wool fabric, there would be a decreased demand in some mobilization conditions. This is due to the fact that dress uniform items are not combat essential and would not be required for mobilization. The single military item having the greatest impact on wool fiber and fabrications is the blanket, which does have a mobilization requirement, and would be significant in any study of cold weather requirements, as well as consideration of wool usage in underwear.

As pointed out at the beginning of this section, aggregate military demands will not demonstrate a significant burden on the textile industry, and this is certainly true for the fiber industry. However, the area of most concern for NLABS and any industrial base planning involves specialty organic fibers. These fibers are usually sought for specific military products, and have certain properties that do not necessarily lend themselves to mass consumption for commercial use. Appendix L is a chart on high performance fibers that have industrial application and are considered for military use through NLABS programs. These high performance fibers are generally of high modulus, made from organic polymers, and are characterized by high-temperature

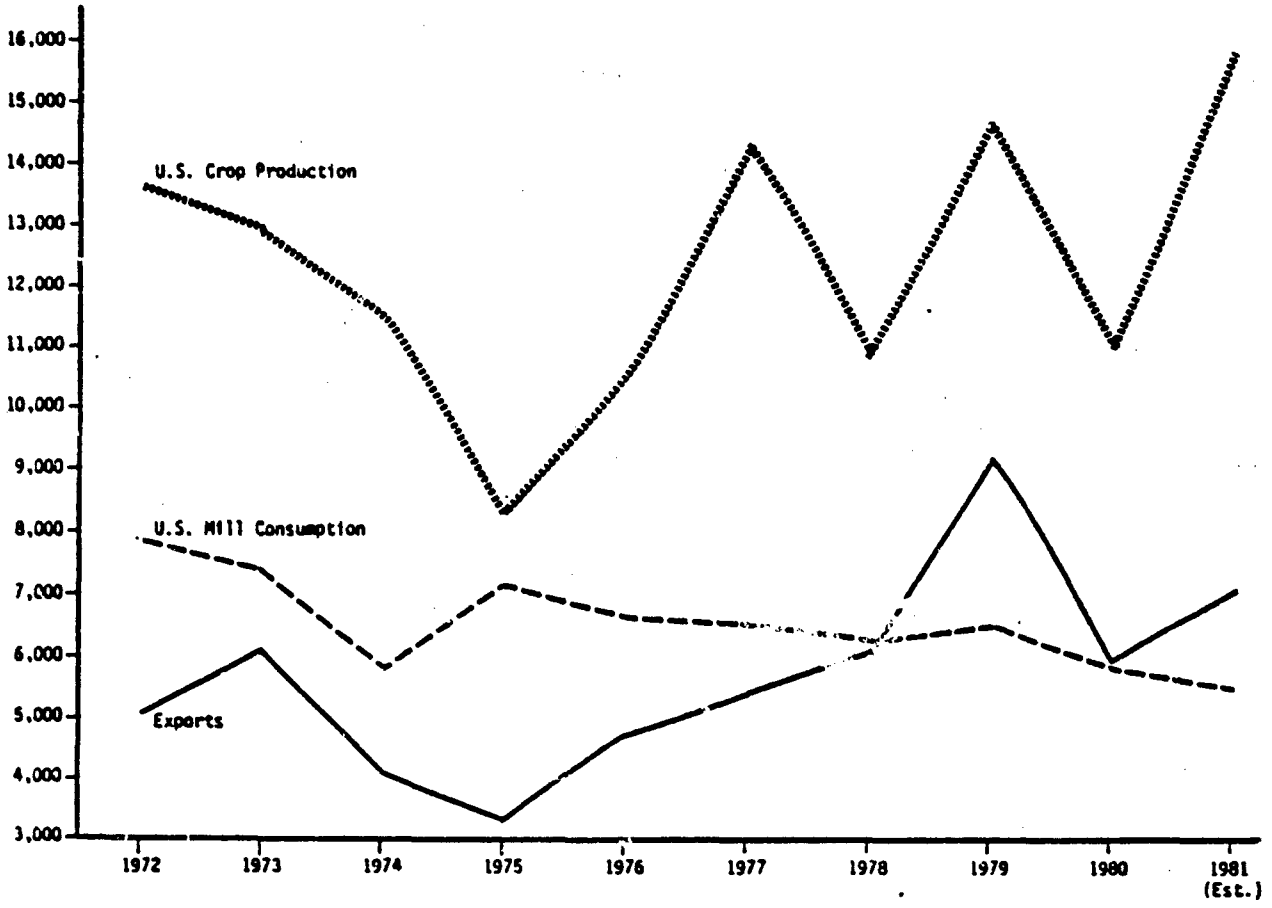
TABLE 26. DOMESTIC MANMADE FIBER PRODUCTION

(MM LB)

	Rayon		Acetate(4)		Nylon(1)		Polyester		Olefin(2)	Acrylic(3)	Textile	Other(5)	
	Yarn	Staple and Tow	Yarn	Staple and Tow	Yarn & Monofilament	Staple and Tow	Yarn & Monofilament	Staple and Tow	Yarn & Monofilament	Staple and Tow	Glass Fiber	Yarn & Monofilament	Staple and Tow
1971	303.4	611.7	449.3	26.5	1,237.9	357.4	688.2	1,142.5	261.8	545.2	468.2	--	59.8
1972	251.7	713.2	401.4	28.0	1,463.9	510.6	951.7	1,376.2	346.5	625.9	571.6	11.2	69.7
1973	198.1	696.7	437.2	25.0	1,582.8	591.9	1,319.8	1,568.0	423.8	742.1	688.0	13.2	67.8
1974	171.8	645.4	361.6	20.0	1,560.0	563.7	1,408.0	1,517.5	463.1	631.2	682.9	11.9	68.2
1975	64.8	370.9	301.3	12.0	1,295.4	561.9	1,458.9	1,536.2	442.9	524.6	546.5	11.7	54.1
1976	67.6	475.4	286.9	11.0	1,372.5	702.7	1,404.7	1,935.6	515.7	621.0	676.0	13.5	60.9
1977	70.7	527.0	282.0	8.0	1,512.4	813.7	1,592.1	2,050.1	554.1	708.8	786.7	15.5	81.2
1978	62.0	534.6	300.9	7.0	1,654.0	895.9	1,563.7	2,235.8	596.6	725.7	923.3	16.0	95.3
1979	56.8	549.4	316.6	7.0	1,781.6	938.8	1,715.6	2,462.2	639.1	761.1	1,014.4	18.0	120.2
1980	47.2	443.3	308.5	7.0	1,631.1	726.6	1,462.0	2,526.7	632.2	779.2	867.3	19.0	115.7
1981	48.5	460.6	257.0	4.0	1,580.7	751.8	1,569.2	2,606.5	642.9	690.8	1,041.1	22.0	142.0
1982**	--	361.0	203.0	--	1,228.0	668.0	1,240.0	1,928.0	592.0	639.0	87.8	--	--

(1) Includes Aramid.
(2) All polypropylene.
(3) Includes Modacrylic
(4) Saran, Spandex, staple and tow olefin and vinyon.

**Based on 3 quarters '82.



COTTON

(000) STATISTICAL BALES

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981(Est.)
U.S. Crop Production	13,704	12,974	11,540	8,302	10,581	14,389	10,856	14,629	11,122	15,733
U.S. Mill Consumption	7,871	7,448	5,834	7,228	6,674	6,509	6,352	6,506	5,891	5,556
Exports	5,012	6,081	4,011	3,397	4,784	5,484	6,180	9,229	5,926	7,015

FIGURE 10. DOMESTIC COTTON STATISTICS
(000 STATISTICAL BALES)

resistance, chemical resistance, and high strength. For the most part, most of these fibers were developed to combat the high temperatures found in aerospace applications. An additional attribute for military consideration is that these fibers are reasonably fire resistant.

TABLE 27. U.S. MILL CONSUMPTION OF RAW WOOL, SECURED BASIS
(1,000 Pounds)

Year	Apparel Wool	Carpet Wool	Total
1970	163,652	76,609	240,261
1971	116,310	75,151	191,461
1972	142,233	76,368	218,601
1973	109,872	41,394	151,266
1974	74,856	18,595	93,451
1975	94,117	15,908	110,025
1976	106,629	15,117	121,746
1977	95,485	12,526	108,011
1978	102,246	13,009	115,255
1979	106,533	10,513	117,046
1980	113,423	10,020	123,443
1981	127,701	10,538	138,239

Compiled from reports of the Bureau of the Census.

From the chart of these high performance fibers, the two most widely used currently by the military are Nomex® and Kevlar®*. du Pont is the major producer for both of these fibers, and has a reported capacity of 70 million pounds for their production. Kevlar capacity is in the 45 million pound range, and current yearly consumption of Kevlar amounts to roughly a $65 million market and growing at 20 percent annually. du Pont has just added an expanded plant for the production of these aramid fibers.

In NLABS' favor, of course, is that these high-strength and high-performance fibers are showing excellent growth signs, which make an appealing market for additional fiber companies to get involved in production. Currently, patent rights on DuPont's aramid fibers are contested by Enka, who submits that the aromatic-polyamide technology relative to their development has been around and is not unique to du Pont. As more fiber companies become involved in specialty fiber development, NLABS benefits from R&D performed by the industry. Military application of these fibers is generally

* The use of trade names does not constitute an endorsement of a particular product.

not the initial driving force for their development, and NLABS must avoid dependency on single-source fiber suppliers to preclude capacity shortfall in the event of mobilization.

Appendix M lists the major domestic manufacturers of manmade fibers. These companies are all members of the Manmade Fiber Producers Association (MMFPA), and represent greater than 90 percent of all domestic production of manmade fibers. It is clear from the chart that there are several major fiber producers which have production capability for many of the popular manmade fibers and represent strategic assets to the textile industry. Though there are movements in the fiber industry by individual companies into or out of production of specific fibers, conversion of capacity on an emergency basis is not possible in most cases. In addition, increasing capacity for production of any fiber is an entirely different situation for a fiber producer than for any other manufacturer in the textile chain. Additional fiber capacity requires long-term planning and commitments, involving significant investments in capital equipment. The minimum time required for new capacity addition by most sources is two years.

In recent years, there has been as much activity with fiber producers reducing capacity by closing facilities rather than adding capacity. (Appendix N shows manmade fiber capacities through 1982). Monsanto has shut down all its polyester filament and staple operations in its industrial division, representing 125 million pounds of staple and over 300 million pounds of filament annually. The reduced capacity is not recoverable either, as one-half was sold to Celanese and the remaining will not be used for other fiber production.

In terms of fiber convertability to shift capacities if ever required for mobilization purposes, there are few opportunities available to manmade producers. Due to equipment and processes required to yield specific properties, most fiber production is not convertible. The basic conversion consideration is dependent upon staple or filament capacity. A polyester staple capability is convertible to a nylon staple capability, but the reverse process is not possible. No conversion will yield necessarily equivalent capacities, and conversion times will vary based on fiber types. Neither nylon nor polyester fiber capacities are convertible to rayon, as different equipment is required for each production process. Certainly the specialty, high-performance fibers, most resulting from a generic fiber type, such as Nomex and Kevlar from an aramid structure, are not at all convertible outside of the generic classification. The consideration of domestic fiber capacity conversion should not be figured into industrial base mobilization planning. What should be of more direct concern to R&D agencies are projections of the domestic fiber industry.

Several large fiber companies have marketing departments which have developed some projections for the manmade fiber industry. Most agree that market conditions will have only one constant variable in the 1980's, and that is change. The variables that will keep the domestic fiber industry viable involve less government interference, reduced taxes, increased productivity and improved quality. Personal consumption expenditures for clothing remain at roughly five percent, compared to food, housing and transportation expenses of 66 percent. Population and family size projections show increases of 4.9 and 6.9 percent, respectively, with population age differentials increasing somewhat. However, the U.S. still leads the world in per capita consumption of almost everything, which includes fibers.

Manmade fiber demand and supply has achieved a better balance since 1979, before which capacity was growing and production decreasing or lagging in the years 1973-78. Table 28 is a projected relationship of capacity to shipments for the industry. Though capacity is expected to increase in the next several years at only one percent, demand is expected to increase by two or three percent.

TABLE 28. MANMADE FIBER SUPPLY VERSUS DEMAND

Time Frame	Capacity	Shipments
1967-1973	+10%	+13%
1973-1979	+ 4%	+ 3%
1979-1985(est.)	+ 1%	+ 3%

This capacity slowdown is due to some understandable hesitancy on the part of fiber companies to commit assets without a guaranteed market demand. There exists a more conservative approach than the polyester capacity building days of 8 to 10 years ago. The projected fiber capacities through 1984 for the major fibers are illustrated in Appendix O.

The relationship of manmade to natural fiber usage is expected to involve decreased total demand for natural fibers. The versatility of manmade fibers and the extensive R&D opportunities make the manmade fibers more attractive for consumer and industrial uses. The technological improvements in shuttleless weaving favor usage of manmade fibers. OSHA and EPA regulatory problems impact more heavily on natural fiber production. Table 29 briefly illustrates anticipated growth of fibers through 1985. The shift is significant and must be a continuing factor for government planning related to fiber/fabric R&D.

TABLE 29. PROJECTED SHIPMENTS - DOMESTIC FIBERS (BB POUNDS)

	1980	1985	Percent Change
Manmades	7.7	9.8	+26%
Cotton & Wool	3.2	2.5	-21%
Total Fibers	10.9	12.3	+13%

Usage of manmade fibers, now at 72 percent, will grow to nearly 80 percent by 1985. Utilization of total capacity for manmade fibers should increase from an 82 percent level in 1980 to around 90 percent in 1985, with domestic shipments increasing by 25 percent and exports decreasing in the range of 40 percent.

Another factor related to future capacities and flexibility of the manmade fiber market is the decreased number of major fiber suppliers in the past six years. Table 30 lists the major fiber types and the number of suppliers in 1974 and 1981. This reflects a consideration of the fiber industry as well as a capacity commitment on the part of producers to the strongest markets.

TABLE 30. FIBER SUPPLIERS - MANMADE FIBERS

Fiber	# Major Suppliers	
	1974	1981
Textile Polyester	13	6
Polyester Staple	9	7
BCF Nylon	9	5
Nylon Staple	9	7
Textile Nylon	7	5
Rayon Staple	3	3
Acrylics	6	5

The future of the manmade fiber industry, therefore, appears secure and able to be flexible with economic shifts. Capacity and production is more than adequate to meet the military demands represented by this study, even at the six-fold increased demand numbers represented by Scenario D. Manmade fibers are subject, however, to a possible sourcing problem in the event of a mobilization due to their dependency on petrochemical feedstocks. This particular aspect is discussed in a later section in relation to the chemical industry, but can be summarized by making reference to the relative consumption of crude oil. The total manmade fiber use of a barrel of crude oil is in the range of one percent, which includes all the raw materials and the energy for manufacturing. There should be no question that a commitment of

one percent could be made to the manmade fiber industry given any mobilization conditions.

F. Yarn Production

Domestic yarn production is also sufficient to handle the requirements of military textiles in all scenarios, with the only exceptions possibly relating to special requirements for the high performance fibers. Basically, the yarn spinnning segment of the textile industry is involved in a very active period of improving technology.

Table 31 illustrates domestic yarn production from 1975 through 1981 and indicates the production related to filament and spun processes. Though total domestic yarn production from 1975 through 1981 increased 14 percent, the relationship of total spun to total textured yarns remained at roughly a split of 75/25 percent.

Total noncellulosic yarn production did increase 23 percent over this same period, with spun yarn increasing to 60 percent of total noncellulosic production.

The spun yarn segment of this textile industry area is experiencing change due to technology. Traditional ring-spinning production is losing ground to open-end spinning and the air-jet spinning techniques now marketed by MURATA. In 1980, 80 percent of all rotors shipped to North America were sent to the U.S., resulting in 30,000 rotors. In the same year, only 37 percent of short staple spindle shipments to North America came to the U.S.

Cumulative worldwide shipments from 1974 to 1980 of spinning machinery illustrate that 19.5 million short staple spinning spindles were shipped, with less than 6 percent going to North America and more than 50 percent to Asia and Oceania. For open-end rotors in the same period, 2.9 million were shipped with over three quarters going to Europe, and only 7.3 percent to North America. An interesting statistic developed by this International Textile Machinery survey concerns the Soviet Union. In this same seven-year period, 57 percent of total rotor shipments worldwide went to the USSR; the next largest market (the USA) was only one tenth of the size of the USSR market.

Machinery manufacturers are using size, speed, and automation to demonstrate to textile mills that machines are available which will give more and better production of yarn at a lower cost. Even though at the recent American Textile Machinery Exhibition International (ATME-I), manufacturers of ring spinning frames outnumbered those of open-end spinning

TABLE 31. DOMESTIC YARN PRODUCTION
(MM LB)

	Cotton Spun	Wool Spun	Other Natural Spun*	Cellulosic Spun	Non-Cellulosic Textured	Non-Cellulosic Spun	Total Tex.	Total Spun
1975	2,428	117	74	237	1,758	2,278	1,758	5,134
1976	2,693	134	54	239	1,745	2,912	1,745	6,033
1977	2,516	141	39	230	2,157	3,084	2,157	6,010
1978	2,417	140	38	234	2,119	3,270	2,119	6,099
1979	2,452	140	33	219	2,301	3,218	2,301	6,062
1980	2,455	126	24	176	2,173	3,197	2,173	5,978
1981	2,182	143	19	186	2,152	3,150	2,152	5,680

* Other is jute, sisal, burlap

machines 15 to 11. There were 10 manufacturers displaying other types of spinning machinery.

The MURATA air-jet machinery is reported to be 10 times faster than conventional ring-spinning and is fully automatic with the recent addition of an automatic doffing device. MURATA has over 100 orders for the U.S. market, 30 of which are currently operating MURATA equipment. Other manufacturers with open-end machinery in the market are:

Company	Model
Toyoda Automatic Loom Works	AS
Rieter	M1/1
Savio Cognetex	Rotating Ring
Zinser	319 SL
Investa	200 BD-S1
Schubert & Salzer	R820
Dawson, Inc.	FPK/8C
Suesson	Parafil spinning

The big question in the textile industry is whether these new developments in yarn preparation technology have reached a level of sophistication and economic effectiveness to encourage textile mill capital outlays in the near future. Many textile observers are sure that level has been achieved, and the industry will reflect the developments' response in 1983 business.

G. Fabric Production

Perhaps the best comparison of the military textile demands generated by this study can be shown in the relationship to domestic industrial production of specific textile categories. These actual production figures, of course, represent peacetime production volumes, and textile mills, as an industry average, are currently operating in the neighborhood of 68 to 71 percent capacity. This is mentioned to further illustrate the magnitude of domestic fabric production when compared to the demands for military textiles.

In making such a comparison, KSA selected to work with the broadwoven volume of military textile demands, as they represent the major fabric category for the production of the study end-items. An equivalent extensive analysis is not made for the narrow-woven fabrics, nonwovens, or knits required by the items in this study, as they represent a low aggregate demand relative to peacetime production. What has been done for those categories is a graphical representation of demands in each scenario, and a comparison to current production reported by each industry.

In the case of nonwovens, military usage by the items in this study is almost negligible when compared to industry production. Appendix J has already illustrated the peacetime demand for nonwovens as 141,180 equivalent square yards, and showed a domestic annual production of 3,877 million square yards, or a military demand of 0.0036%. This quantity only includes durable nonwovens, which would be applicable for military use. This amount equates to 769 million pounds of fiber representing a raw material value of almost $400 million. The same Frost and Sullivan report reflecting these data projected durable nonwoven usage to approach 1,150 million pounds by 1986.[13] The nonwoven industry represents tremendous potential for the development of military products that can satisfy technical specifications as technology improves fabric properties.

Appendices P through S represent the demands for broadwovens, nonwovens, knits, and narrow fabrics by the study items against the four scenarios. The relationship to peacetime production is included on each chart. These graphs were compiled by assigning every textile component to a fabric category, then totaling all the components in each fabric category over each six-month increment of each scenario. Though thread usage is certainly significant to the manufacture of military clothing and equipment items, the aggregate comparison graphically would not be significant due to the fact that thread production and consumption in the total domestic textile industry is huge relative to the demands of the study items in any scenario. In other words, thread availability is not considered a major logistical concern for mobilization.

For example, thread production is reported in terms of pounds, with domestic production in 1981 of 76.2 MM pounds. The totals from the scenario printouts reflect thread demands in linear yards, with the largest demand at M+30 of scenario D, full mobilization. If the demand at M+30 of 27,842,237,949 linear yards is doubled to reflect an annual demand to compare to peacetime production, the demand is in the range of 56 billion yards. To convert this quantity to pounds, we selected the thread with the greatest demand based on the study items, and used the relationship of length to weight most applicable. That thread was MIL-T-43548B[14], a polyester core thread with cotton and rayon covering, and a relationship of 9,000 yards per pound in size 40, or 55 tex. This results in a conversion factor of 0.00011 pounds per yard, yielding 2.1 million pounds represented by the total thread demand. This equates to roughly 2.8% of peacetime production.

The most significant relationships are found in the broadwoven category. For study consideration, KSA used the same classes of broadwoven textiles employed by Dr. Kennedy in his report, listed in Appendix T. Additionally, Appendix U contains a listing and definition of standard industry fabrications by which the majority of the textiles involved in the study can be categorized. Numerous other fabric classifications exist for broadwovens which have much greater application to comercial use. These classes of broadwoven textiles approximate the product codes employed by the DOC in their Current Industrial Report (CIR) series.[15] Table 32 lists U.S. broadwoven goods production for the three major fiber categories. The totals in linear yards have not appreciably increased, whereas manmade broadwoven production has increased 35 percent to absorb the 42 percent reduction in cotton broadwoven production and the 34 percent decrease in woolen/worsted production.

An expanded picture of U.S. broadwoven activity is presented in Table 33, which considers import and shipment values of these same three major categories. Import values are up in all three areas greater than the total shipment values, resulting in increased import percentages. This factor is of major concern to the domestic textile and apparel industries, as imports of finished products adversely affect both. The entire issue of imports has resulted in major government activity in the past several years, with significant decisions regarding limitations, quotas, and local content factors made frequently. Many of the industry associations have made their positions well known to Congress, as loose policies could severely impact the U.S. broadwoven industry. The most relevant discussions on trade agreements are those with China, which will have a direct impact on the U.S. textile industry in calendar year 1983 regardless of the outcome. China represents a unique market in that it presents almost unlimited opportunities for U.S. textiles and apparel products, and at the same time poses a significant threat to the stability of the domestic textile industry through imports.

TABLE 32. U.S. BROADWOVEN GOODS PRODUCTION
(Millions of Linear Yards)

Year[1]	Cotton[2]	Manmade	Woolen/ Worsted	Total
1970	6,246	5,028	179	11,463
1971	6,149	4,885	113	11,147
1972	5,666	5,567	102	11,335
1973	5,086	6,109	106	11,301
1974	4,714	5,923	81	10,718
1975	4,095	5,278	79	9,452
1976	4,718	6,087	97	10,902
1977	4,356	6,273	102	10,731
1978	4,007	6,657	117	10,781
1979	3,857	6,584	117	10,558
1980	3,619	6,798	119	10,536
1981	3,133	7,107	112	10,352

[1] Annual production totals are from quarterly data based on 13-week periods approximating the calendar quarter.

[2] Over 12 inches in width.

Source: U.S. Department of Commerce, Bureau of the Census.

TABLE 33. U.S. BROADWOVEN FABRIC TRENDS

(In Millions of Dollars)

FIBER	1972	1977	1978	1979	1980	1981[1]	Compound Annual Growth 1972 to 1981
COTTON							
- Value of Shipments	2,660.6	4,431.2	4,153.0	4,864.8	5,138.9	5,020.3	+ 7.3 (-2.3[2])
- Value of Imports	254.3	329.8	421.3	367.3	424.5	560.3	+ 9.2
- Import Percentage	9.56	7.44	10.14	7.55	8.26	11.16	+ 3.1
MAN-MADE							
- Value of Shipments	3,856.6	6,325.9	6,523.3	7,291.5	8,098.0	9,180.0	+10.2 (+2.9[2])
- Value of Imports	219.9	324.4	467.5	437.7	500.3	715.4	+14.0
- Import Percentage	5.70	5.13	7.17	6.00	6.18	7.79	+ 6.4
WOOL							
- Value of Shipments	450.1	583.3	626.1	662.6	708.3	820.2	+ 6.9 (+0.1[2])
- Value of Imports	32.0	67.1	83.1	80.0	83.1	106.4	+14.3
- Import Percentage	7.11	11.50	13.27	12.07	11.73	12.97	+12.8

[1] Projections
[2] Constant 1972 Dollars

NOTES: 1981 broadwoven fabric mill imports account for 9.2% of industry shipments.
Imports as a % of new supply.....8.1%
Imports as a % of apparel consumption...8.7% (exports are excluded here)

Source: Bureau of the Census, U.S. Industrial Outlook (1982)

Wool imports have increased the most of the three categories since 1972, reaching $106.4 million in 1981, or 13 percent of total shipment value. Table 34 lists imports of raw wool to show that actual consumption decreased drastically from 1969 to 1974, then recovered for several years until the poor years of 1978 and 1979. The last two years show strong growth in wool imports, and should be of concern to both the woolen/worsted industry and industrial mobilization planning. Table 35 takes another look at wool imports from the standpoint of content of total imports. Woven fabrics account for 25 percent of total wool imports, and wearing apparel is 36 percent of the total. Both these statistics bear attention by the domestic woolen/worsted industry, and are related to the ongoing trade negotiations and multi-fiber arrangements.

TABLE 34. U.S. IMPORTS OF DUTIABLE AND DUTY-FREE RAW WOOL FOR CONSUMPTION, CLEAN CONTENT
(1,000 Pounds)

Year	Dutiable	Duty-Free	Total
1969	93,230	95,664	189,187
1970	79,810	73,325	153,134
1971	42,682	83,893	126,575
1972	24,790	71,849	96,639
1973	19,587	40,694	69,281
1974	11,800	15,147	26,947
1975	16,605	17,021	33,626
1976	38,387	19,076	57,463
1977*	36,303	22,655	58,958
1978	27,000	23,404	50,404
1979	20,283	22,047	42,330
1980	30,491	25,992	56,483
1981	48,106	26,146	74,252

* Beginning November 1977 duty-free wools include all 46's and coarser grades of wool by Public Law 95-162.

Source: Compiled from reports of the Bureau of the Census.

The emphasis on fabric production for this study was to evaluate military demand as represented by the scenario functions against domestic production. The foregoing data is presented to illustrate some of the factors impacting the domestic textile industry that may have greater implications in the future. For the present, the comparison of military demand to domestic production must be prefaced with the

TABLE 36. BROADWOVEN DEMAND VS. PRODUCTION

(MM Square Yards)

	1980 Production	1981 Production	% Change '80-'81	% '81 Total	Peacetime Demand	% '81 Volume
Cotton Duck & Allied Fabrics, including Combed Duck (22111)	93.0	94.5	1.6	.6	9.3	9.84
Cotton Sheeting & Allied Fabrics, Coarse & Medium Yarn (22112)	752.8	724.7	(3.7)	4.5	10.9	1.50
Cotton Print Cloth Yarn Fabrics (Carded Yarns 28's to 42's)(22113)	1,720.5	1,440.1	(16.3)	8.9	11.9	.83
Cotton Colored Yarn Fabrics Toweling, Napped, Blanketing (22114)		1,180(est.)			3.8	.32
Fine Cotton Fabrics, Combed & Fine Carded (22115)	111.4	64.8	(41.8)	.4	4.8	7.41
Other Woven Cotton Fabrics & Specialties (22116)		600(est.)			.03	.005
Manmade Fiber - 100% Filament Yarn - Chiefly Rayon and/or Acetate and/or Nylon Fabrics (22211)	1,206.9	1,033.2	(14.4)	6.4	23.8	2.30
Manmade Fiber - All Other Filament Yarn Fabrics (22212)	2,773.6	2,859.5	3.1	17.7	5.0	.18
Manmade Fiber - 100% Spun Yarn, Polyester Blends with Cotton (22214)	4,342.9	4,503.5	3.8	27.9	14.4	.32
Manmade Fiber - All other Spun Yarn Fabrics (22215)	1,121.0	1,330.3	18.7	8.2	45.4	3.41
Combinations & Mixtures of Filament & Spun Yarn Fabrics (22216)	763.9	970.0	27.0	6.0	3.2	.33
Woolen & Worsted Fabrics (22312)	202.9	188.6	(7.0)	1.2	10.1	5.36

understanding that the development of aggregate textile demands came primarily from data obtained. The total demands for each scenario were calculated using the formula in Appendix I.

The comparison of total military broadwoven demand in peacetime to 1981 reported production is contained in Table 36. The same broadwoven categories listed in Appendix S were used to illustrate major segments of broadwoven production. This appendix illustrates peacetime demand totals for each SIC category. For the 120 military fabrics involved in the study, each was analyzed according to the specification and placed in one of the SIC groupings. This analysis was performed by KSA's textile group and improves the comparison to domestic production. As can be seen in Table 36, there are only three categories of broadwovens that demonstrate greater than a five-percent demand against industry-reported production.

S.I.C. Code		Category
(22111)	—	Cotton duck and allied fabrics including combed duck.
(22115)	—	Fine cotton fabrics, combed and fine carded.
(22312)	—	Woolen and worsted fabrics.

Two of these three areas were anticipated, the cotton duck and woolen and worsted industry segments, yet all three do represent potential problem areas because they are the three smallest categories of broadwovens under consideration, the smallest being the fine cotton fabrics' segment at 64.8 million square yards.

The cotton duck segment is understandable due to the fact that many duck fabrics for commercial items are synthetic blends. The military does procure some blended duck fabrics, but the majority of annual procurement is still cotton duck. Table 37 lists DPSC 1983 forecasted procurements for duck fabrics, and shows the percentage relationship to total GFM yardage projected for procurement. It is clear that cotton duck procurement far exceeds synthetic duck fabrics, 98 percent to 2 percent. It is also interesting to note that total duck fabrics will make up approximately 12 percent of total GFM procurements for 1983.

The woolen and worsted industry segments are shrinking rapidly as the imports discussed earlier have an impact. Consolidation will continue to reduce the total number of

The military demand for wool and worsted products is a function of two areas—dress uniforms and blankets. There are other products with a wool or worsted content, but those are the major items which generated the study demands. Because for this study, dress uniforms were not considered at full mobilization, the demands on that product segment are not as large as might be expected.

To look at the same relationship of peacetime production to the demands represented by the full mobilization scenario, Table 38 was generated. The same three categories are, of course, the most demanded, yet the factors of demand are not as significant as the direct increase in manpower developed in that scenario. Only one other category represented a demand against peacetime production greater than five percent, manmade fiber - all other spun yarn fabrics (22215) at 6.58 percent. This particular category is partially a function of market demands for specific fabrications, and its volume could easily be increased by shifting mill capacities.

Though the demands represented by the study scenarios do not represent significant problems for the textile broadwoven industrial base to respond to, it is educational to look at the textile industry in terms of general capacities for broadwovens. If the roughly 260,000 broadwoven looms in the U.S. are considered in terms of production flexibility, some interesting values for broadwoven productive capabilities are obtained. Table 39 on the following page lists looms in place and loom hours.

First consider the basic relationship of fly-shuttle and shuttleless looms, which is undergoing a virtual revolution in the industry today. The figures below give some indication of how shuttleless weaving has impacted the industry, with productivity increasing 26 percent in the 1970 to 1980 time frame with a corresponding reduction in looms in place of 27 percent.

	1970	1980	Change (%)
U.S. looms in place (000)	336	246	- 27
Production (billions)			
linear yards	11.3	10.4	- 8
square yards	14.1	15.4	+ 9
Productivity (yard/loom/week)	672	846	+ 26

domestic participants in this sector. In some cases, some U.S. wool textile mills are operating below 50 percent, and only the upper end of the wool fabric market shows strong demand. As of October, 1982, there were 169 wool textile mills employing roughly 20,000 people, with the two southern states of South Carolina and Georgia producing over half of the total U.S. production, about 93 million square yards in 1981.

TABLE 37. DPSC FORECASTED PROCUREMENTS
FISCAL YEAR 1983

DUCK FABRICS

MIL Spec	Category	Weight	Total Yards	% Total GFM Yards
	Cotton Yard Goods			44,545,000
CCC-D-950		6.10	23,000	
MIL-C-43605		7.50	714,000	
CCC-C-419		8.25	278,000	
MIL-C-7214		8.75	21,000	
MIL-C-4180l		9.85	2,638,000	
CCC-C-419		9.85	84,000	
CCC-C-428F		12.29	18,000	
CCC-C-419		14.35	400,000	
CCC-C-419E		20.74	13,000	
CCC-C-D-950		20.74	90,000	
CCC-C-419		23.93	42,000	
CCC-C-419		28.71	14,000	
			4,335,000	9.73%
	Synthetic Yard Goods			2,875,000
MIL-C-7219		7.25	44,000	
MIL-C-10799		9.85	5,000	
CCC-C-419		11.16	20,000	
			69,000	2.40%

The major issue for the woolen industry, however, remains survival. Two major integrated woolen system mills discontinued operations in 1982, though one was considered a very progressive company by continually upgrading machinery and equipment. Woolen manufacturers are remaining competitive by using the flexibility of their machinery to produce blended fabrications, but the imports from Japan, Italy, and Korea have increased significantly and threaten the U.S. industry. Total 1981 imports of woven wool fabrics in the category "chief value other fibers combined with wool" from Italy alone amounted to 86.9 million square yards, over one-half of U.S. wool apparel fabric production.

TABLE 39. LOOMS IN PLACE AND LOOM HOURS OPERATED IN BROADWOVEN FABRIC MILLS

		Looms In Place	Loom Hours Operated (000)	Hrs./Loom
1979	1st Qtr.	276,450	456,247	1.650
	2nd Qtr.	275,776	453,805	1.645
	3rd Qtr.	268,377	415,131	1.547
	4th Qtr.	268,296	461,346	1.608
1980	1st Qtr.	265,756	446,926	1.682
	2nd Qtr.	262,326	418,848	1.597
	3rd Qtr.	260,267	377,343	1.449
	4th Qtr.	255,754	397,349	1.554
1981	1st Qtr.	262,506	394,369	1.502
	2nd Qtr.	260,199	388,372	1.493
	3rd Qtr.	255,837	374,478	1.464
	4th Qtr.	250,966	348,858	1.390
1982	1st Qtr.	246,075	341,351	1.387
	2nd Qtr.	240,157	326,958	1.361

TABLE 38. BROADWOVEN DEMAND VS. PRODUCTION

(MM Square Yards)

	1980 Production	1981 Production	% Change '80-'81	% '81 Total	Maximum Scenario Demand	% '81 Volume
Cotton Duck & Allied Fabrics, including Combed Duck (22111)	93.0	94.5	1.6	.6	14.1	14.92
Cotton Sheeting & Allied Fabrics, Coarse & Medium Yarn (22112)	752.8	724.7	(3.7)	4.5	16.4	2.26
Cotton Print Cloth Yarn Fabrics (Carded Yarns 28's to 42's)(22113)	1,720.5	1,440.1	(16.3)	8.9	16.8	1.17
Cotton Colored Yarn Fabrics Toweling, Napped, Blanketing (22114)		1,180(est.)			6.0	.51
Fine Cotton Fabrics, Combed & Fine Carded (22115)	111.4	64.8	(41.8)	.4	7.3	11.27
Other Woven Cotton Fabrics & Specialties (22116)		600(est.)			.03	.005
Manmade Fiber - 100% Filament Yarn - Chiefly Rayon and/or Acetate and/or Nylon Fabrics (22211)	1,206.9	1,033.2	(14.4)	6.4	40.5	3.92
Manmade Fiber - All Other Filament Yarn Fabrics (22212)	2,773.6	2,859.5	3.1	17.7	10.1	.35
Manmade Fiber - 100% Spun Yarn, Polyester Blends with Cotton (22214)	4,342.9	4,508.5	3.8	27.9	17.7	.39
Manmade Fiber - All other Spun Yarn Fabrics (22215)	1,121.0	1,330.3	18.7	8.2	87.5	6.58
Combinations & Mixtures of Filament & Spun Yarn Fabrics (22216)	763.9	970.0	27.0	6.0	4.7	.4
Woolen & Worsted Fabrics (22312)	202.9	188.6	(7.0)	1.2	18.8	9.97

TABLE 40. FLY-SHUTTLE LOOMS BROADCLOTH CAPACITY

Loom Width	Number of Looms in Sample	Percent By Width	Total Looms Estimated By Sample	Probable Maximum Width	(X 1,000) Linear Yards/ 24 Hours	(X 1,000) Square Yards/ 24 Hours	(X 1,000) Square Yards/ 7 Days	(X 1,000) Square Yards/Year (50 Weeks)
44"-46"	3,791	9.0	14,979	44"	1,825	2,231	15,617	780,850
50"	23,613	56.3	93,700	48"	11,417	15,223	106,561	5,328,050
52"	1,515	3.6	5,992	50"	742	1,031	7,217	360,850
54"	597	1.4	2,330	52"	284	410	2,870	143,500
56"	417	1.0	1,664	54"	203	305	2,135	106,750
58"	30	0.1	166	56"	20	31	217	10,850
60"	593	1.4	2,330	58"	276	445	3,115	155,750
64"	9,436	22.5	37,447	60"	4,436	7,393	51,751	2,587,550
68"	1,166	2.8	4,660	64"	520	924	6,468	323,400
70"	226	0.6	998	66"	111	203	1,421	71,050
72"	553	1.3	2,164	68"	242	457	3,199	159,950
Totals	41,937	100.0	166,430		20,076	28,653	200,571	10,028,550

Assumptions:

- Fabric Construction calculated at 52 filling ends per inch.
- Weaving efficiency estimated at 88 percent.
- Loom speeds 44" to 56" 180 P.P.M. - 58" to 64" 175 P.P.M. - 68" to 72" 165 P.P.M.
- Excludes bed sheeting, toweling, plush and jacquard, tire cord and worsted and woolens.

The above square yards per years includes capacity for weaving 4,000,000 square yards of wool blanketing.
The number of looms by width was determined by sampling 30 textile companies.
Not included in the above is approximately 28,000 fly-shuttle and shuttleless looms producing 1,600,000,000 square yards of bed sheeting per year.
Not included in the above is approximately 11,500 fly-shuttle and shuttleless looms producing 500,000,000 square yards of toweling per year.

There is no question that the U.S. industry is moving toward shuttleless weaving, and a corresponding trend is toward wider fabrications that these looms can accommodate. The majority of these shuttleless looms are foreign-made, and Appendix V is Textile World's latest chart on available shuttleless weaving machinery.[16] A few facts for consideration on the four major weft-insertion categories: air-jet, rapier, missile, and water-jet:

- U.S. weavers currently have about 8,300 air-jet weaving machines in operation or on order;
- There are now 8 different companies which market 10 different air-jet machines;
- About 25,000 rapier looms are operating in U.S. plants or on order;
- Rapier versatility enables weaving filament/spun combinations, woven textured polyester, corduroy, printcloth, denim, bottomweights, and upholsteries;
- Sulzer alone has installed 20,000 missile weaving machines in the U.S;
- Missile looms of the 130-inch and wider models control the wide sheeting market and can weave double widths of denim greater than 60 inches;
- Air-jets are the fastest and most economical but are currently limited to hydropholic filament yarns.

If we consider fly-shuttle loom capability only, given the fact that the majority of looms in place in the U.S. are in that category, Table 40 is one illustration of capacity based on a sample of domestic manufacturers. That breakdown alone, by loom width and estimated production variables, gives the capacity of over 10 billion square yards for broadwovens. Due to the flexibility of these fly shuttle looms, it can be assumed that they will be available for conversion to military fabrications in the event of an emergency. Since total broadwoven demand represented by the maximum study scenario was 750 million square yards, that demand equals 7.5 percent of the broadwoven production capacity represented by fly-shuttle looms alone.

TABLE 42. SHUTTLELESS LOOMS WORSTED AND WOOLEN CAPACITY

Type Shuttleless Loom	Assumed Fabric Width	Number of Looms	Loom Speed	Linear Yards/ 24 Hours	Square Yards/ 24 Hours	Square Yards/ 7 Days	(X 1,000) Square Yards/ Year (50 Weeks)
Projectile	60"	2,200	225	332	553	3,871	193,550

Assumptions:

- Fabric construction calculated at 56 filling ends per inch.
- Finished width on all fabrics 60".
- Weaving efficiency estimated at 92 percent.
- Excludes all other fabrics except worsted and woolens.

TABLE 41. SHUTTLELESS LOOMS BROADCLOTH CAPACITY

Type Shuttleless Loom	Assumed Fabric Width	Number of Looms	Loom Speed	(X 1,000) Linear Yards/ 24 Hours	(X 1,000) Square Yards/ 24 Hours	(X 1,000) Square Yards/ 7 Days	(X 1,000) Square Yards/ Year (50 Weeks)
Projectile	60" + 60"	6,250	225	1,989	3,315	23,205	1,160,250
Rapier	60"	24,600	225	3,914	6,523	45,661	2,283,050
Waterjets	60"	6,420	550	2,499	4,165	29,155	1,457,750
Airjets	60"	4,830	450	1,538	2,563	17,941	897,050
		42,100		9,940	16,566	115,962	5,798,100

Assumptions:

- Fabric construction calculated at 52 filling ends per inch.
- Finished width on all fabrics 60".
- Weaving efficiency estimated at 92 percent.
- Excludes bed sheeting, toweling, plush and jacquard, tire cord and worsted and woolens.

the highest weight per square yard fabrics, with a #4 duck having a weight of 24.5 ounces per square yard, and a #12 duck 11.4 ounces per square yard. If the assumption can be made that there are three general weights ranging from 6 to 26 ounces per square yard, and that any duck fabrication in the light (6-10) or medium (10-16) range could conceivably be produced on a loom which normally weaves a heavy denim or upholstery fabrication, then a significantly greater capacity exists in the industry for the manufacture of duck cloth. The range of duck fabrics heavier than 16 ounces per square yard would require the heavier looms which are in place and currently represent a portion of the peacetime production level of 94.5 million equivalent square yards. Table 44 takes a look at how much duck fabric of each weight range is procured by DPSC, and the results are that the heavy range of duck fabric represents less than 5 percent of the total duck yardage projected for procurement in 1982 and 1983. How closely these procurements reflect actual duck usage in military items is not known, but it is assumed that since the study items contained 15 tents and 3 tarpaulins of duck manufacture, that this procurement relationship is fairly accurate.

TABLE 44. DPSC FORECASTED PROCUREMENTS FISCAL YEARS 1982 AND 1983 DUCK FABRICS

	Volume (ESY)			
Duck Weights	FY 1982	(% Total)	FY 1983	(% Total)
Light (6-10 oz/sq yd)	3,552,000	(83.1)	3,807,000	(86.5)
Medium (10-16 oz/sq yd)	491,000	(11.5)	438,000	(9.9)
Heavy ($\geq$ 16 oz/sq yd	233,000	(5.4)	159,000	(3.6)
Total	4,276,000		4,404,000	(+3.8%)
Cotton Yard Goods	4,205,000	(98.3)	4,335,000	(98.4)
Synthetic Yard Goods	71,000	(1.7)	69,000	(1.6)

There are other considerations for a reduced dependency on the heavy cotton duck fabrics, some areas of which NLABS is involved. Blended duck fabrics have increased in their acceptance for military products due to weight reduction and durability. These fabrics are capable of accepting the finishes associated with tentage specifications, and certainly represent the ability to be produced on a volume scale by the textile industry. The other interest area as an alternative to duck for tent fabrication is nonwovens, such as the "EVOLUTION 3" product now being tested at Natick.

The same analysis can be made for shuttleless loom broadcloth capability as illustrated by Table 41. Given the four methods of shuttleless weaving mentioned and an expanded industry sample, the square yard capacity is 5.7 billion square yards, again sufficient to satisfy the total military broadwoven demand in the study scenarios. Shuttleless loom production, however, is not completely acceptable for production of all military specification fabrics, the most notable exception being parachute cloth. NLABS is involved with testing 60" fabric produced on shuttleless looms for aerial delivery equipment. An acceptance of this fabric would greatly improve the industry's capability to satisfy parachute cloth requirements.

The woolen and worsted capacity of shuttleless weaving equipment is represented in Table 42. The total capacity of 193.5 million square yards is also sufficient to satisfy the study demands of 18.8 million yards of full mobilization. Again, this analysis only considers the capacity for woolen and worsted production with those shuttleless looms considered acceptable for that production.

The final comparison of industry capacity to military demands is a look at duck fabrics, which may represent the greatest problem for the textile industry to respond to. Table 43 illustrates the estimated capacity for the various duck fabric categories, totaling 129.6 million square yards. The maximum scenario demand of 14.1 million square yards equates to 10.8 percent of that productive capacity.

TABLE 43. DUCK FABRIC CAPACITY

Fabric	Estimated Number of Looms	X 1,000 Estimated Annual Square Yards
Army Duck (Plied Filling Only)	500	22,800
Plied Warp Duck	1,350	66,000
Single Warp Duck	825	40,800

Though the concern about duck fabric was very evident in Dr. Kennedy's report in 1973, much has changed in the industry in terms of product flexibility and productivity. Another way to look at the duck situation is to consider that the plain weave duck fabric does not represent significant problems for a great majority of the fly-shuttle looms already operational.

The duck question is really a function of weight, and duck fabrics are numbered accordingly. Lower numbered ducks are

Though finshing plants are very capital intensive and require equipment and machinery that lasts on the order of 20 or more years, there is a degree of convertibility associated with some of the equipment.

Regarding specific military finishing requirements, industry members felt that there were no problems with the availablity of fluorocarbon water repellent finishes, with at least two major domestic suppliers. Additionally, the technology related to this finish process has been around for a while, as synthetic outerwear has received this finish for years. The equipment associated with water-repellent treatments is convertible to other finishing processes.

For infrared reflectance properties, there is basically one standard approach and, therefore, a more limited industry potential for satisfying increased military demands. However, it was agreed that sufficient capacity either existed or could be converted to accommodate demands. Vat and acid dyes are used to maintain the IR standards on cotton/nylon blends. There are only one or two dyes in the correct acid ranges that meet the government IR specification, and it takes upwards of three months to build up dye inventory.

Energy availability is considered a major factor in finishing operations. Recent EPA water standards actions have created some apprehension within the industry, as the Federal Government has directed that individual states should enact water regulations.

Sources for a considerable portion of dyestuffs for vat dyeing are located outside the United States, primarily in European countries. This subject of sources is discussed also in a later section. The vat dye requirements are, to a great degree, related to fabrications involved in dress clothing, and are, therefore, not as critical an issue for mobilizaton.

From the Defense Department perspective, a potential problem area involves the camouflage printing on the Battle Dress Uniform (BDU). If the fabric is woven on shuttleless looms and the tension across the cloth is not maintained, tight centers and loose selvaged edges could result in different dye sets. With regard to woolens, there are not too many problems, mostly concerns associated with woven end wastes in the cloth. There are also some shading and streaking problems on certain poly/cotton blends for specific end-use items requiring good colorfastness.

Nonwovens have the appeal of weight reduction, disposability if required, and the most significant advantage over a woven fabric of volume production consistent with the NLABS' aim for item mass production.

H. Finishing Production

The last segment of the textile industry is finishing, and that area is almost a complete industry in itself if consideration is given to all the different finishing processes involved. Appendix W is a listing of the major finishing processes broken down into primary categories, and Appendix X is a listing from Davison's Blue Book of finishing mills in the U.S. by major process.[17]

The following terms are used to categorize finishes: wet, dry, durable, nondurable, physical (or mechanical), chemical, pure (unassisted, mechanical), additive (assisted), subtractive, chemically modified.

It would be very difficult to establish specific industry capacities against the military demands represented by this study. The basic definition of finishing lends itself to a wide range of processes and operations: any operation for improving the appearance and usefulness of the fabric after it leaves the loom or knitting machine.

There are three primary chemical areas to consider for finishing processes: auxiliaries; lamination; and polymers and resins.

- Auxiliaries are finishing aids related to softness. They are wetting agents which help process the fabric and provide aesthetics.

- Lamination uses solvent chemicals as the process is organic.

- Polymers and resins. Polymers are derived from organic ethylene, which is achieved at the first crack of oil refining. Resins are used primarily for permanent press processes.

Finishers were questioned regarding the capacity of their industry and problems associated with meeting government specifications related to finishing. There were some responses related to problems, but the primary issue of meeting mobilization demands was not considered to be a problem.

Industrial capability relative to military needs can be illustrated in much the same way that textiles were. The study items can be divided into general apparel categories relative to U.S. production as reported by the Department of Commerce (DOC). An attempt was made to categorize as many items into major groupings as possible to simplify the relationships between military items demanded and commercial items produced. Some categories correlate very well, while others are a result of specialty military equipment items that have no commercial counterpart.

This category breakdown is illustrated in Appendix Y, indicating the number of study items in each category. As much as possible, study items were grouped according to construction methods and not necessarily by item description. Each category in that Appendix contains a listing of study items. This facilitates comparison to reported apparel production by Standard Industrial Classification (SIC) codes, and also enables comparison in a general way to apparel industry capabilities.

To establish a basis for comparison, Appendix Z outlines the domestic apparel industry in terms of SIC codes and number of establishements by product description. This chart gives some idea of how production is grouped for reporting purposes, and the number of manufacturing facilities involved with each product. The next step in comparison of production to military demand is an estimate of domestic production by grouping SIC code elements into categories comparable to those representing the study items listed in Appendix Y. Appendix AA relates production to these apparel categories.

The military demands for apparel and equipment items were generated by the same formulas used to develop total textile component allowances by individual product. The formula calculated a unit demand for each scenario increment before it multiplied each with an allowance to generate the textile demands.

Therefore, these item demands are subject to the same variables discussed in an earlier section regarding service growing factors, item replacement factors, etc. The most important consideration for total apparel item demand is that dress uniforms are not calculated in the full mobilization scenario, resulting in two categories to zero out completely as far as a requirement. Table 45 is a printout which quantifies these apparel and equipment category demands for all scenarios. The quantities in Scenarios B, C and D represent approximate annual category demands, as the largest incremental scenario demand would indicate only a six-month figure, and they were therefore doubled.

I. Apparel

The 261 study end-items prepared by NLABS are the result of the entire textile process. The apparel industry represents the last link in this chain and is as critical to the military system for products as the textile industry. Though not all end-items are by definition apparel, there is no sub-set of the apparel industry with specific definition as "equipment manufacturers."

The value of shipments of the apparel industry in 1981 was $50.7 billion, an increase of 8.6 percent over 1980, but an increase of only 0.5 percent after inflation adjustment. This industry employed 1.25 million people (6th in manufacturing employment) at the end of 1981, but total employment has been declining since 1972 at a compound annual rate of 0.9 percent. The apparel industry is the country's major manufacturing employer of women, who make up 78 percent of the total work force. Wage rates of this industry are among the lowest of all the U.S. manufacturing sectors. Imports have seriously affected this industry as well; the value of apparel imports increased 15.4 percent in 1981 while industry shipment value increased only 8.6 percent.

The apparel industry is composed of many different types of manufacturers that are defined to a great degree by their concentration in major market segments. Trends change from year to year and shift performance of these apparel segments, resulting in many companies going out of business. There are roughly 31,000 apparel manufacturers in the U.S., all affected to some degree by demographic patterns, styles, and fashions, and most of all consumer interests. There is a trend toward consolidation into larger and fewer apparel companies to take advantage of marketing strength, management, financial resources, and lower costs.

International trade issues regarding the apparel industry were established by the Multilateral Tariff Negotiation (MTN) in 1979 and scheduled to begin in 1982. However, the renewal of the Multi-Fiber Agreements (MFA) has delayed these international trade guidelines, with domestic apparel manufacturers relying strongly on their extension. U.S. apparel exports also rose in 1981, but only at a 9.8-percent rate compared to 30.0 percent from 1979 to 1980. The apparel trade deficit increased at a compound annual rate of 14.1 percent from 1972 through 1980. The industry is clearly in a survival position similar to textiles' position with respect to imports and trade deficits.

Those three appendices (Y, Z, AA) do not represent exact comparisons, however, due to the necessity of combining SIC code groupings and military items into categories. They do represent a reasonable effort to quantify military end-item demands for more than just peacetime. Despite all the assumptions which were made either by KSA or NLABS regarding the accuracy of available logistical data on end-items, this relationship, as a minimum, is the best available approximation of how various mobilization scenarios might impact on apparel demands.

Table 46 completes the analysis by comparing the domestic production to peacetime military demand, and showing the percent of domestic production involved. There are only two categories which indicate any cause for concern--double-needle shirts and tents. The shirt category indicates a military peacetime demand of 10.5 percent of domestic production. When this same comparison is made to the largest demand for double-needle shirts at M+30 of scenario D, the military demand represents 72 percent of the indicated peacetime production. This is a significant demand on those apparel manufacturers with that capability, but not beyond even the reported peacetime capacity. Figure 11 charts the demand for study item double needle shirt products for the four scenarios.

The other area of concern strictly from the standpoint of comparison to peacetime production is tents. The peacetime military demand represented by this study is 18.4 percent of the reported domestic tent production. When the same production figure is compared to the much greater demand for tents at M+30 of the full mobilization scenario, the demand represents 108 percent of production. Again, this relationship is cause for concern on the part of NLABS and industrial mobilization planners, but there is some explanation to go with the numbers. First of all, Dr. Kennedy's report went into detail about tentage demands of the Quartermaster Corps in World War II and Korea, and production shortage conditions did prevail.

It is true that tent manufacturing is not similar to a standard apparel construction product, and in some cases special industrial sewing equipment is required. However, domestic production figures are related to two very distinct markets, those of recreational and camping tentage, and the rental tent segment. What has not been done is an exhaustive survey to calculate the total capacity of all segments of the apparel industry to produce tentage items. The issue of conversion becomes very important if that capacity is not found to exist with a production potential greater than reported.

TABLE 45. ITEM DEMANDS APPAREL/EQUIPMENT CATEGORIES

Product Category	Number of Study Items	Scenario A	Scenario B	Scenario C	Scenario D
1	11	3,102,036	9,403,386	4,643,59t	1,787,190
2	6	4,501,400	7,644,796	7,328,694	30,939,988
3	5	173,340	,389,854	,214,662	0
4	6	925,980	2,518,776	1,238,544	0
5	12	5,679,842	16,212,104	8,669,644	37,075,100
6	5	6,526,364	21,061,196	11,414,100	47,722,696
7	4	4,837,500	14,082,510	1,658,298	32,135,304
8	1	1,455,876	4,099,928	2,050,866	9,723,966
9	19	2,061,735	5,389,892	2,896,454	11,774,044
10	9	1,170,024	4,760,102	2,669,136	10,520,180
11	12	1,004,700	2,726,290	1,490,866	6,354,170
12	3	8,948,928	28,282,164	15,185,558	43,004,498
13	17	3,843,086	13,869,638	7,155,242	22,594,742
14	19	2,490,096	3,657,866	2,000,780	7,694,266
15	18	3,143,580	7,235,014	3,936,280	16,380,410
16	39	4,123,426	15,984,498	8,857,742	35,751,416
17	10	2,226,476	5,807,212	3,154,170	13,152,752
18	15	221,364	590,428	331,884	1,306,680
19	1	41,580	103,156	48,950	295,042
20	1	261,660	635,274	343,968	1,451,964
21	1	635,352	1,993,148	1,053,416	4,696,668
22	9	555,096	3,320,870	1,728,632	343,302
23	7	5,271,664	16,348,066	8,099,306	43,736
24	1	427,044	1,002,214	501,332	2,377,018
25	1	2,050,296	5,809,438	3,145,574	13,277,748

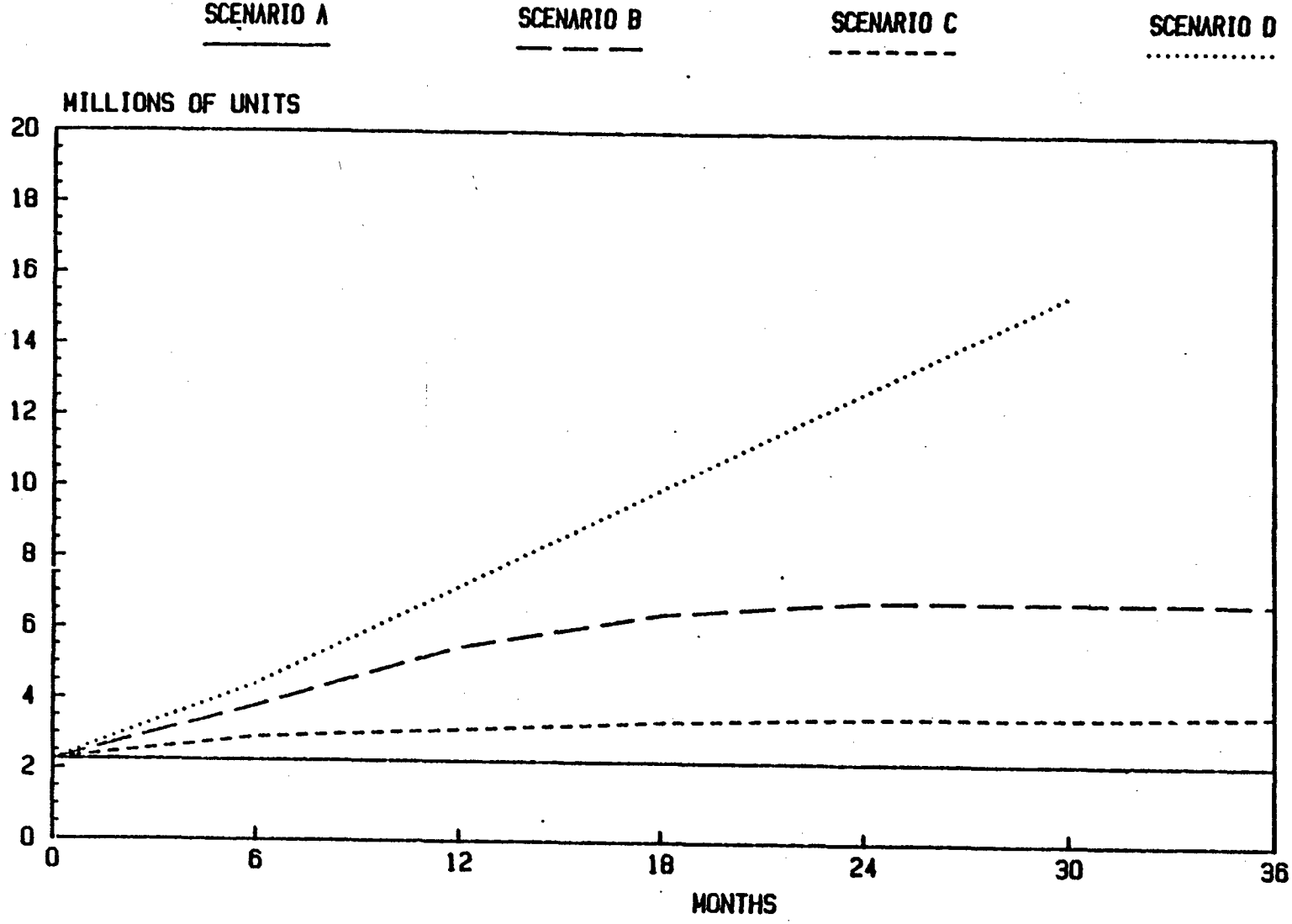


FIGURE 11. APPAREL CATEGORY DEMAND
DOUBLE NEEDLE SHIRTS BY SCENARIO

TABLE 46. GENERAL APPAREL CATEGORIES MILITARY DEMAND VS. PRODUCTION

Product Category	Domestic Production (000)	Peacetime Military Demand (000)	Percentage
1	521,064	3,102	.59%
2	42,720	4,501	10.5%
3	70,152	173	.25%
4	413,374	925	.22%
5	331,994	5,679	1.71%
6	780,190	6,926	.89%
7	785,280	4,838	.62%
8	63,072	1,456	2.31%
9, 10	385,572	3,232	.84%
11	56,892	1,005	1.8%
12	1,833,648	8,949	.49%
13	90,000	3,843	4.3%
14	338,172	2,490	.74%
15	--	3,144	--
16	--	4,123	--
17	--	2,226	--
18	1,200	221	18.4%
19	22,795	41	.18%
20	61,388	261	.43%
21	31,302	635	2.02%
22	77,082	555	.72%
23	--	5,271	--
24	208,944	427	.20%
25	539,172	2,050	.38%

is to give NLABS some idea of how current government construction techniques are viewed strictly from the perspective of alternative methods available to the industry. The analysis did not recommend alternative methods which would reduce the function or fashion of the seam or garment in any way. The analysis was also performed without full awareness of which individual construction procedures applied or contributed to the technical requirements of CRITICAL, ESSENTIAL, AND DESIRABLE, categories assigned to individual government items of CIE.

Though there are numerous views from industry regarding the actual specification document which governs the manufacture of any apparel product, the analysis was made strictly from the standpoint of compliance with industry established or available technology and procedures. In general, the military specifications reviewed are beneficial as written to apparel manufacturers and do not violate common construction techniques.

KSA is aware of the Value Engineering Change Program (VECP) program available to manufacturers on most apparel contracts, and in no way intends for comments regarding construction alternatives on the analyzed garments to influence that program. The point of the exercise, and of the entire VEC program, is to at least consider improvements to item manufacture and performance. It would be highly unlikely that any single group of apparel-experienced individuals could maximize the total construction possibilities and raw material utilization for an apparel product the first time around. Even though all products go through extensive prototype and field testing where changes occur and even construction or material specifications may be altered, there is almost always room for some improvement when it hits the industry on a bid. It is NLABS' responsibility to support such a VEC program and consider it an attempt on the part of industry to assist with product improvement.

Appendix BB contains the comments relative to the apparel and equipment items reviewed. This type analysis by an agency not familiar with specific product properties or requirements might be valuable to any specification-preparing agency purely as another source to assist in having the best product appear in the original specification. Another alternative for an accurate first-time product specification would be to involve apparel industry representatives at an appropriate point in the product development stage where garment criteria are required. This would benefit both the apparel industry and DoD. DoD would benefit by having the best possible product in its initial specification and avoid costly

The tentage market, as far as military demand is concerned, is very stagnant. Tents are not commonly used items in peacetime, are constructed of heavy, coated fabrics and are not disposable in nature. Tents have, therefore, a very low demand in peacetime, and there is no incentive on the part of the apparel industry to generate significant capacity and commit assets toward tent manufacture. The market for tents, therefore rests with the outdoor recreational demand, which is being severely impacted by imports and losing ground.

The other market segment, the rental tent market, is limited to about a half dozen primary manufacturers who produce the huge tents used for outdoor social activities, county fairs, and circuses. There is no question that both of these apparel segments could convert rather easily to military production, but at the same time they are almost guaranteed to not have had much experience with military specifications for tent construction.

Tentage, therefore, does represent a potential problem area for meeting military needs, but only in a full mobilization situation as exemplified by this study. It must also be remembered that the study items list considered 15 tent products and there are more than that in the total military supply system. Those 15, however, would probably be the most demanded tent items in any mobilization, or at least the tent items requiring the most fabric for construction.

Because the apparel industry is so large and labor intensive rather than capital intensive, the total industry response to mobilization requirements for clothing and equipment would be favorable. The conversion factor in apparel is much more flexible than certain areas of the textile industry, such as fiber manufacturing and specialty finishing processes. The basic element of any item construction is the industrial sewing machine along with a skilled operator that is plentiful in the needed specialty. Conversion time is a factor which is hard to predict, yet many segments of the industry are similar either with respect to basic equipment or type apparel construction techniques.

The major factor for conversion to produce all military items for mobilization would be specialty equipment for items such as tents. However, industrial sewing equipment is very flexible and any product could be constructed with existing equipment. The need for special equipment would increase production and reduce conversion times.

In the course of this study, KSA reviewed several apparel and equipment items from the standpoint of construction features and compatibility to commercial production. The main purpose

best available in the industry. There is also no question that du Pont went to considerable effort and expense to demonstrate that their fiber had properties which satisfied or exceeded the specifications. The point is that the fabric specification, by which bidders bid and contractors must obtain their piece goods, specifies a fabric with properties that can only be achieved by use of one nylon fiber source.

During calendar year 1982, the Army experienced a greatly accelerated logistical transition with a specific product line involving this nylon fiber, the Battle Dress Uniform (BDU). With specific regard to fiber capacity, this increased military demand did in fact temporarily tax du Pont's special production facility to produce the 420 nylon fiber. However, the present du Pont capacity is considered in excess of the government's predicted normal peacetime demand requirements, which have been derived by du Pont from forecasted government procurements over a five-year period. These procurement forecasts for the BDU become very significant for du Pont in determining nylon 420 capacity, as du Pont has no existing comparable commercial market for that fiber. Therefore, major du Pont decisions relative to capitalization and capacity for this fiber are directly related to government inputs.

In this regard, du Pont is acutely aware of the sole-source concern and has made requests to the appropriate government agencies to receive updated projected demands. In addition, du Pont has expressed its readiness to participate with the government in planning to ensure adequate fiber supplies in mobilization and the high-level fiber demands which could follow. Additional Defense consideration for use of the 420 nylon in other end-use items is also a critical factor for capacity determination.

The implication of capacity shortage is only valid should a six-fold increase in end-item demand produce a fiber requirement beyond the ability of the sole-source supplier to provide. This situation could apply to the 420 nylon fiber.

Avtex Fibers, Inc. is the only source of a precursor to high-tenacity yarns which are used in carbonizing processes to produce a permanently flame-resistant fabric. The fiber is a chemically loaded rayon fiber which can be used alone or blended with other recognized flame-retardant fibers such as Nomex from du Pont. The main advantages are that this fiber produces a fabric which is breathable and absorptive as well as having

modifications, and the industry would benefit from having assisted with the development of an item which ultimately must be manufactured by them. The obvious benefit to both DoD and the industry is that the product is representative of state-of-the-art production and construction techniques, which reduces the problems associated with converting other producers in an emergency situation. In addition, this approach toward industry involvement would increase the exposure which both NLABS and government procurement receive from industry, and would possibly expand industry interest in the manufacture of government products.

The current involvement by NLABS with the apparel industry for specification coordination lacks incentive to guarantee that initial products are the best combination of apparel industry technology and military requirements.

J. Problems in Meeting Demands

The scenario printouts and graphs have adequately represented the military demand for textile and apparel products for the four-study scenarios. The various comparisons to industry production attempted to illustrate that the domestic industrial base for textiles and apparel is vast and more than adequate to satisfy projected military demands. There are no "bottlenecks" or "war-stoppers" from the standpoint of comparing aggregate military demand to domestic production, even considering that textile and apparel industrial production is running well below normal peacetime levels. These comparisons have not accounted for the obvious increase in productive capability for both industries should double or triple shifts be required to meet increased military demands.

Though there are no "process bottlenecks" which appear in a direct comparison of aggregate military demand to domestic production, there are several considerations which deserve mention and NLABS' attention. All of these comments are made relative to establishing and maintaining a mobilization capability for textiles and apparel.

1. Sole-Source Fiber Producers

The most significant concern involves the procurement system dependency on sole-source suppliers for raw materials (fiber) or products (parachutes). With respect to fiber, the most heavily procured fabric today is a 50/50 cotton/nylon blend used for the new camouflage battle dress uniform. The 50 percent nylon staple is a fiber developed by du Pont for which there is no other domestic source. There is no question that the fiber has properties which NLABS feels are the most appropriate for the finished fabric requirements or the

For instance, the basic chemical used in the manufacture of the Avtex carbonized fiber described earlier is obtained from Japan. Avtex does have patents on the chemical and is considering its own production. There are other cases of fiber companies and textile finishing companies that report that some chemicals are sourced off-shore. These examples do not necessarily reflect immediate mobilization problems, as some fibers are not yet found in military CIE items.

- For Hoechst Fibers Industries, minor finishes and additives are imported from Europe, and a flame-retardant chemical is also obtained off-shore.

- du Pont sources cobalt from Africa, though it states that cobalt is listed on the Strategic and Critical Materials Stockpile.

- Some chemicals involved with the infrared reflectance requirement are not produced domestically. Some substitution of dyes can be used with a resulting minor loss of reflectance capability.

- Specific vat dye chemicals are not available domestically.

The issue involved is availability of specific chemicals required for fiber producers and finishers of military fabrics. For instance, it takes approximately 90 days to produce the dyestuffs for the [illegible], and 6 months for the Army dress green uniform. Availability of chemicals is critical. Additional in-depth research would be required to determine specific chemical shortages and domestic chemical industry capabilities. NLABS is in a position to resolve some of these sourcing considerations in the R&D stages. To accomplish this, increased industry coordination would be recommended, primarily from the standpoint of avoiding production bottlenecks in mobilization. It is recommended that NLABS sponsor a project to identify the major chemical needs for satisfying military technical specifications in clothing and equipment items. Such a study should consider the mobilization demand and domestic availability.

3. <u>Petrochemical Feed Stock Distribution</u>

Observers of the fiber/textile industry note that the raw materials from which noncellulosic manmade fibers are derived are petroleum based. This implies these fibers are subject to problems involving disruption of crude oil supplies, especially those originating from Mideastern/African sources.

improved aesthetics. Current government dependency on this fiber is unknown since most flame retardant materials use the du Pont fiber Nomex. In addition, this fiber has not experienced the commercial availability as has Nomex.

These two illustrations of sole-source fiber potential may not be the only cases with respect to all goverment procurement textile items. Celanese has developed a fiber called polybenzimidazole (PBI) which has a unique set of high performance properties. It is used in the NASA program and is expected to replace asbestos, but there are limitations, such as price and dyeing range, which prevent PBI from large scale use for CIE items. Another new specialty fiber which has potential military applications is Ryton® from Phillips Petroleum Company. Its features include outstanding heat resistance, excellent chemical resistance, and self-extinguishing flame retardancy. Possible applications range from woven and nonwoven filter fabrics to protective clothing. The point is that once an increased demand beyond existing capacity is reached, the procurement system has no choice but to accept an alternate product, thus, not remaining within the product specifications. If this condition is acceptable in a period of increased need for a product to perform as specified, some consideration should be made in peacetime for exactly what alternative products would be acceptable. The ideal solution would be for NLABS in the R&D stage of product development to establish specification requirements for which there is ample industry capacity, then agree to alternate products that meet or exceed these original specifications, but for which there is limited capacity.

2. Fiber Chemical Sourcing

The next bottleneck concern also relates to fibers, but involves the chemicals required for fiber production. A later section discusses the petrochemical feedstock issue as it relates to fiber production. The concern here is for other chemicals required in the fiber manufacturing process. The U.S. chemical industry is a vast industry covering an entire spectrum of chemical needs. It procures and produces according to market demand as does any other industry. The fiber industry requires specific chemicals for their own production, some of which are not obtained domestically. This does not mean that there is not sufficient capacity within the U.S. chemical industry to meet the needs of fiber producers for specific chemicals. It also does not mean that there is no domestic production of those chemicals, but rather not of sufficient quantity to satisfy demand.

supplies in an emergency. The President directed the Justice Department with Department of Energy (DOE) oversight to determine the legal authority of the Executive Branch to act in such an emergency. This activity was part of the Energy Emergency Preparedness Act of 1982.[18] Another activity of this Act is to review how the crude oil stored in the Strategic Petroleum Reserve (SPR) would be distributed. The development, concept, or administration of the SPR is presented in the National Petroleum Council's report, "Emergency Preparedness for Interruption of Petroleum Imports into the United States."[19]

The National Petroleum Council (NPC), an advisory committee to the Secretary of the DOE, is composed of members from all aspects of the petroleum or petroleum-related industries including labor, consumers, and government. As such, it has advised the federal government on many occasions. In June of 1980, the NPC was asked to analyze various issues relating to emergency preparedness for a disruption of crude oil imports. The report mentioned above was the result of this analysis.

In the NPC study, the DOE has chosen scenarios lasting from 6 to 12 months with import disruptions of 1.0 million barrels per day (MMB/D) to 4.6 MMB/D. Disruptions of less than 2 MMB/D were judged to be best handled by competitive market mechanisms to allocate available crude oil. In disruptions greater than 2 MMB/D, a stand-by program for allocation should be used, administered by the Federal Government on the refinery level. Figure 12 gives an indication of the range of possibilities envisioned by the NPC to meet demand shortfalls.

In the less severe disruptions, the NPC concluded that the competitive market mechanisms would be the most efficient means for allocating crude for refineries. Since various refiners, spread geographically across the U.S., have different dependencies of imports, the use of the free market to allocate supply would mean that some refiners would bear more of the impact of a disruption. A combination of a market clearing price, SPR supplies, and conservation would eventually stabilize demand among refiners, and ultimately the public. One could expect the market-clearing price to reach very high levels as the amount and duration of a disruption increased.

In severe disruptions (greater than 2 MMB/D), a stand-by allocation program is recommended to spread the loss of crude among all refiners. This program would seek to spread oil geographically with a market clearing price to achieve a common national crude oil run ratio.

In 1970, 10 percent of crude oil imports into the U.S. representing 2 percent of domestic consumption came from the volatile Mideastern/African sources. By 1980, this area supplied 50 percent of U.S. crude oil imports representing 25 percent of consumption. This situation has been mitigated by the current worldwide recession, shifts of U.S. imports to Latin American/Caribbean sources, and conservation efforts.

U.S. crude oil imports of this magnitude put the nation in a position of dependence and vulnerability. The degree of dependence is self-explanatory. The vulnerability comes from the strategic, economic, and social consequences/damage of a supply disruption. U.S. dependence on imports of crude oil is projected to continue for the next 10 to 20 years.

A disruption of crude oil suppliers has an impact in three significant ways:

1. The absence of petroleum products reduces activity of all kinds.

2. An upward price surge occurs creating wealth transfers, loss of productivity, and increased inflation.

3. The nation is subject to military threats and political coercion as countries supplying crude attempt to influence foreign policy.

In the last 10 years, the United States has experienced two major economic disruptions in crude oil supplies from the Mideastern/African area—1973/1974 and 1979. In response to the first disruption, a government designed and administered allocation system was developed. Military requirements are covered by the Defense Production Act.[18] Should a mobilization be necessary, contractors of materials to DoD would fall under the Defense Production Acts provisions for rated orders, allowing fiber companies to receive the petroleum feedstocks for the production of defense-related fibers.

However, in a nonmobilization situation, fiber companies would not have this status. In 1982, the executive authority to allocate petroleum supplies in an emergency (which was developed in response to the previous disruptions) was not renewed. The Emergency Fuel Allocation Bill[18] was passed by Congress, vetoed by the President, and the veto was sustained. This does not mean, however, that there is no planning in place to allocate

Priority users of an individual refinery's products would receive some special consideration. Priority users are those required for protection of national defense, public health, and safety. As such, priority customers would be assured of only their base period volumes.

Availability of petrochemical feedstocks is more of a concern for fiber producers than available fiber production capacity, should substantial increases in demand for military products occur. Discussions with several fiber companies about the effects of a disruption in crude oil imports have indicated that all are adopting a variety of contingency plans. Figures 13 and 14 provide graphically the complexities and interdependent alternatives of producing the aromatics and aliphatics utilized in making manmade noncellulosic fibers.

Given that present petrochemical/petroleum industry and government planning is on the level of crude oil allocation to refineries, fiber companies have developed responses to handle the potential risk of loss of supply. These responses range from backward integration by du Pont into controlling a captive source of crude and refineries (purchase of Conoco) to entering the product stream at various levels to reduce dependency on the petrochemical industry. Several fiber companies have spread their purchasing of feedstocks among several refiners to minimize the impact of a disruption of crude. Some fiber companies restructured their supplier relationships with Conoco following its purchase by a competitor (du Pont). Those fiber companies without a strong relationship with an oil company (source of crude) would be in a weak production as well as competitive position in a less severe disruption where competitive market mechanisms were allocating available crude. The impacts of a disruption would occur quickly in the first few months before any emergency management measures would be fully effective. du Pont, a sole-source supplier of several fibers critical to military clothing and equipment, is in a relatively secure position for fiber feedstock availability.

For the other fiber producers, planning as follows is in place to handle a disruption.

1. Multiple sources exist among several refiners.

2. Bulk purchases are made of raw materials and monomers to reduce exposure to refinery mix shifts in times of shortage. For example, NPC predicts in its study that refineries would reduce gasoline

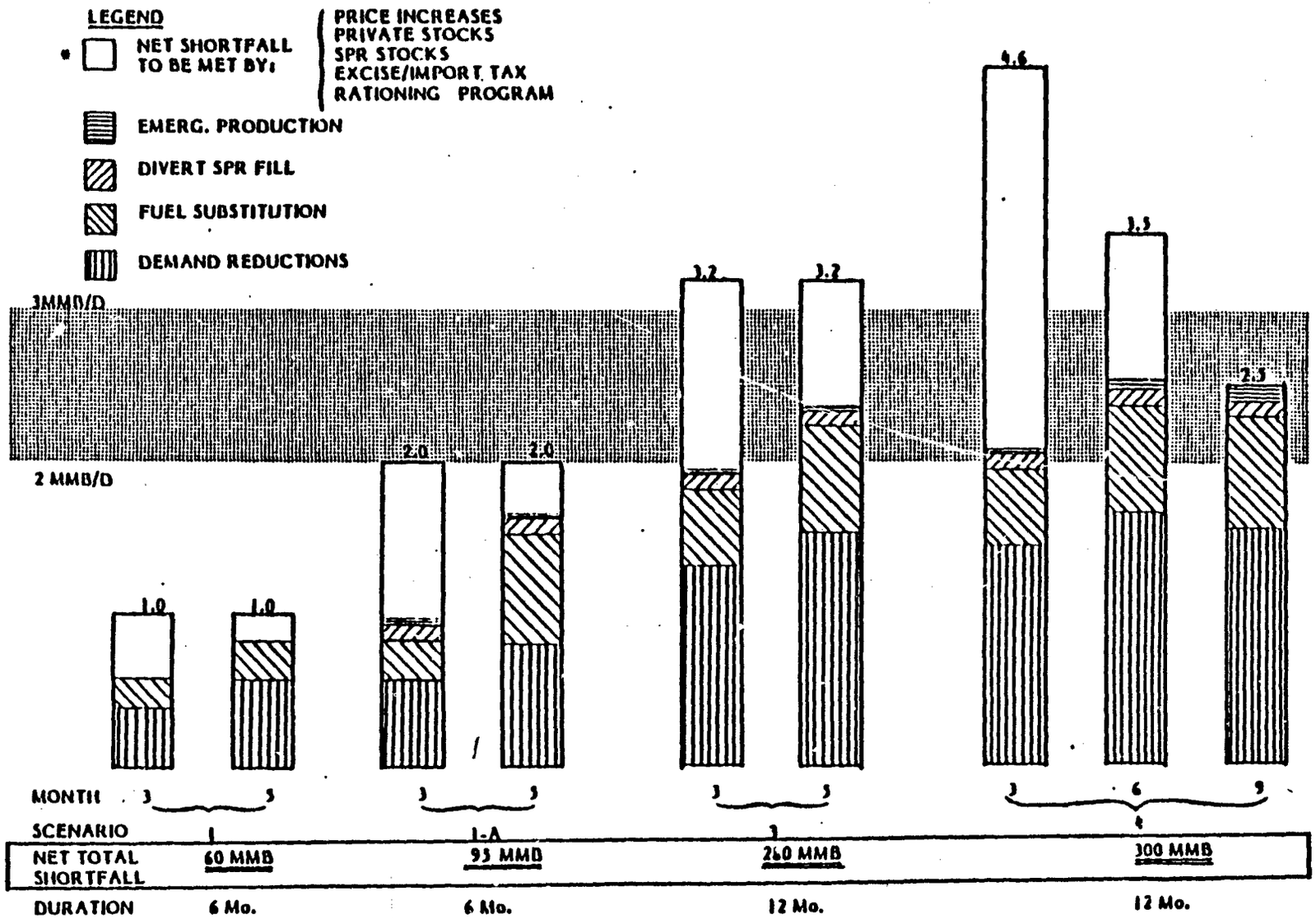
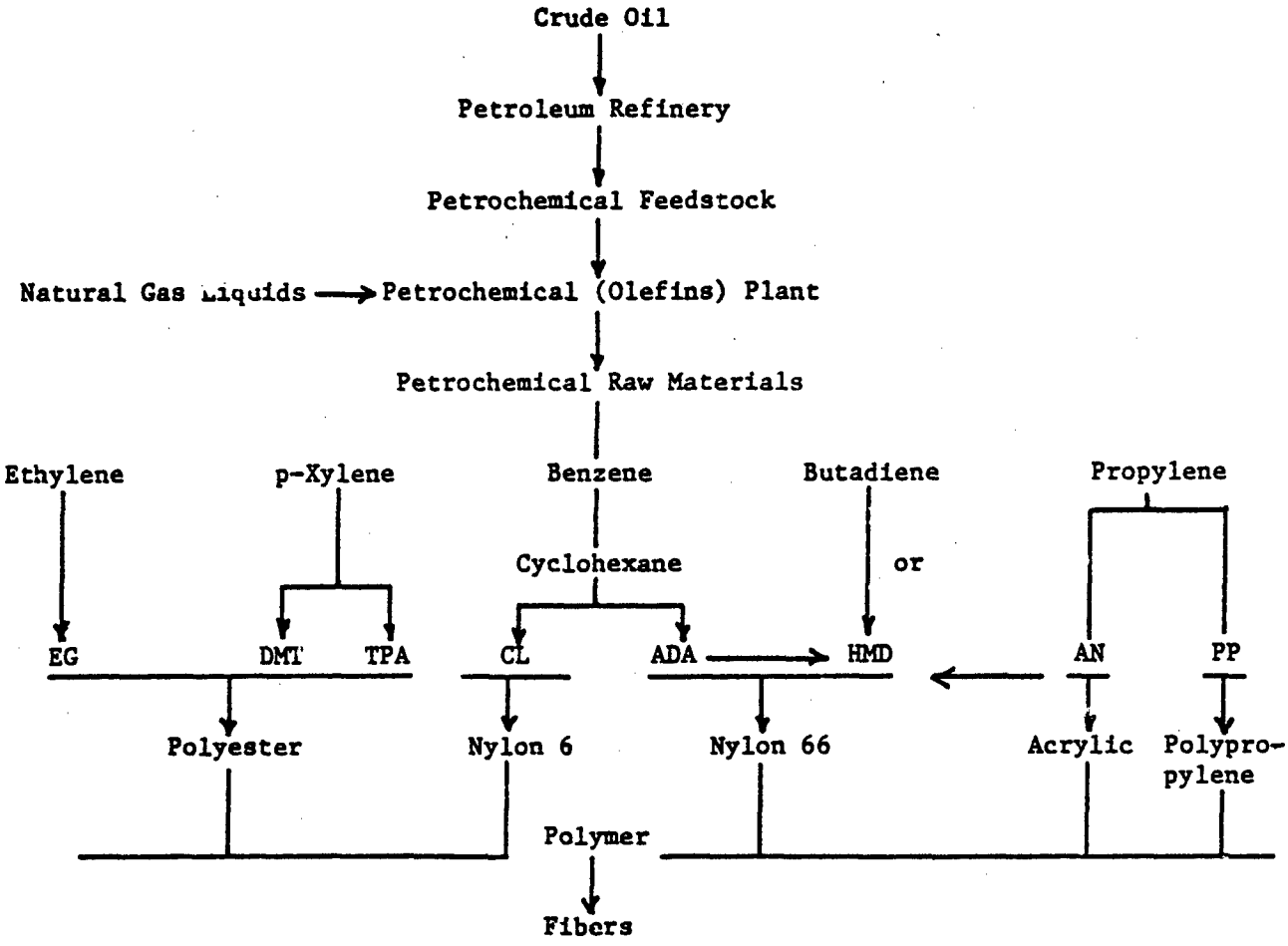
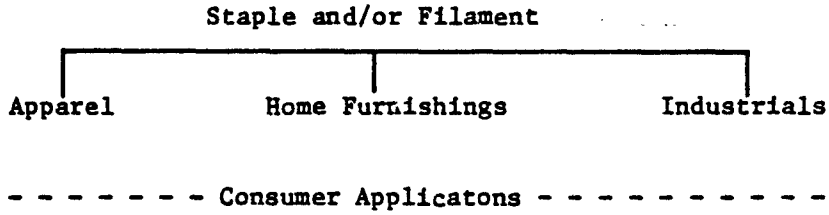


FIGURE 12. EMERGENCY SUPPLY DEMAND MANAGEMENT--DOE SCENARIOS, 1985,(MMB/D).

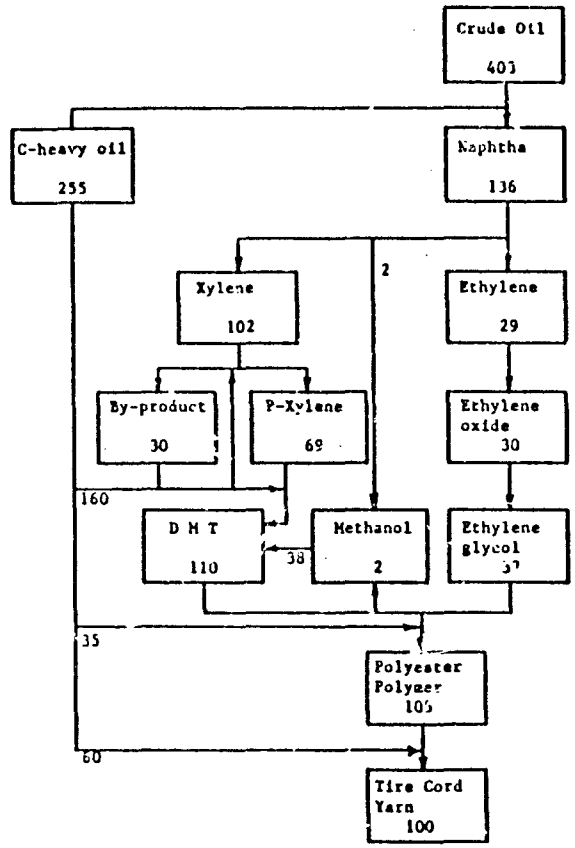




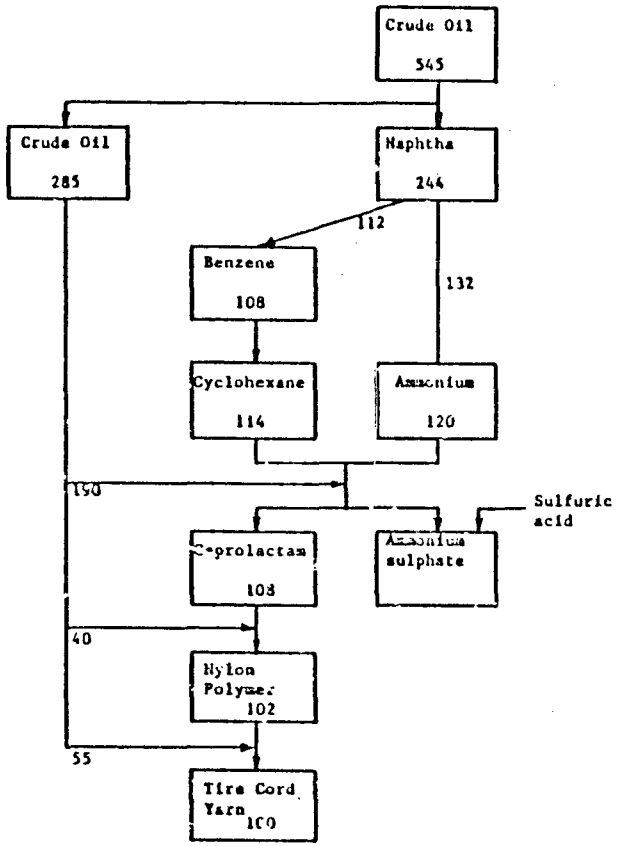
EG = Ethylene Glycol
DMT = Dimethylterephthalate
TPA = Terephthalic Acid
CL = Caprolactam
ADA = Adipic Acid
HMD = Hexamethylenediamine
AN = Acrylonitrile
PP = Polypropylene

Source: Arthur D. Little, Inc.

FIGURE 14. PETROLEUM TO FIBER PROCESS SEQUENCE



POLYESTER PRODUCT UNITS
(DMT METHOD)



NYLON PRODUCT UNITS
(BASIC METHOD)

FIGURE 13. POLYESTER/NYLON PRODUCT UNITS

4. Finishing Specifications

Another area of concern for mobilization is the finishing specifications for military fabrics. The concern is that the testing procedures and acceptable levels are not firmly established to guarantee equivalent results.

Though NLABS was involved with the development of a standardization procedure for color measurement, there were instrumentation decisions made which have made it more difficult for finishers to meet some specifications. NLABS is in the position to establish finishing standards which both meet design specifications and enable industry to be flexible enough to convert expanded capacity in the event of a mobilization. Infrared requirements and dye colorants become more critical in combat than peacetime.

5. Procurement System Management

Conceptually, one would expect the design of a procurement system to supply the world's major military establishment to be logistically efficient, with procedures in place to quickly bring the country's industrial capability to bear in time of need. Structurally, the military procurement system is fragmented among each service, with DLA having the broadest authority. The Defense Production Act covers, in general terms, procedures for supplying the military requirements in a mobilization.

It is the management of the peacetime procurement system which is under question in this section. Congress has established a politically popular program to support small businesses through a set-aside program, allocating portions of procurement contracts exclusively for small businesses "at competitive disadvantage" to bid on. The original social goals of this program are difficult to ascertain now. The impact of administering the small business set-asides has a considerable influence on the apparel industry's capability to meet military requirements in a mobilization.

The OMB has lumped together textiles and apparel related items in determination of a category for a dollar amount of procurement to be set aside for small businesses. As most textile companies with the capability to produce the fabrics required are not small businesses under the rules of the Defense Acquisition Regulations, the preponderance of the dollar amount falls into the apparel-related item section.

production by 22 to 38 percent. Post-gasoline production can be shifted to emphasize aromatics (benzene) from the remaining reduced product stream. This would dramatically increase the market clearing price for the material utilized in the production of nylon.

3. Fiber companies use flexibility in allocating chemicals among the various end-use products they produce. This would allow fiber companies to meet military fiber needs by internal allocations at the expense of nondefense customers.

4. In the absence of a military priority, allocation of chemicals is done based on economics of each individual plant. Individual plants are not tied to specific refineries, exempting them from the disproportionate geographic impact of a disruption in crude oil imports.

5. Judicious stockpiling of feedstocks and bulk purchases to reduce price shocks.

In all the scenarios involving disruptions of crude oil imports, the NPC's recommendations involve substantial price increases to clear market demand. This aspect should be incorporated in DLA planning for long-term procurement of GFM involving noncellulosic manmade fibers. Contractors' agreements would necessarily require clauses to pass along fiber increases forced by an emergency.

The present administration's planning for a disruption of crude oil imports (and therefore a potential reduction in petrochemical feedstock availability for manmade fibers) is to let the petroleum industry's competitive market mechanisms handle allocation. Administrative simplicity would be achieved by dealing at the refinery level, rather than repeat the problems of the past in allocating end use products.

Since the fiber companies are dependent upon intermediate materials in this chain, they have developed plans to minimize risks of a loss of raw materials. Present DoD planning does not incorporate problems of supply of components utilized by contractors producing finished uniforms and equipment. In mobilization situations the Defense Production Act will have jurisdiction. In non-mobilization scenarios, DoD planning for contractors is not developed, with this responsibility left to the contractors. Fortunately, the manmade fibers industry has met its planning responsibility and has developed contingencies to adjust to a disruption of supply.

PCO may choose to withdraw his referral and award the contract. Table 47 shows the recent history of the COC referrals and their disposition for the years 1979 to 1982 (partial). Where the small business decided to refer its contract to the SBA, the majority receive a COC (85 percent in 1980, 88 percent in 1981). This process has numerous disadvantages.

a. Causes lengthy delays in delivery of procurement contracts.

b. Process time can reach up to 60 days.

c. Awards of contracts to contractors unable to perform denies production to qualified, experienced contractors with capacity and ability. This capacity frequently is withdrawn from the military procurement system if sufficient production is not maintained.

d. The lowest price must be given first consideration.

Other aspects further confusing this procurement process involve the Maybank Amendment and the Walsh-Healey Act. While not getting into details, these regulations add more complexities to getting items into the logistics system, involving additional agencies in the decision of responsibility.

Prior to 1974, a Qualified Manufacturer's List (QML) was in use. Its function was to eliminate marginal producers for quickly awarding contracts. Manufacturers made application to be on the list. Their facilities were inspected. Their continued performance on meeting criteria was reviewed by a Board. The QML lost favor because critics felt it worked against competition favoring existing companies.

New, struggling companies, generally would not survive the determination of responsibility. Therefore, the set-aside program focuses on "going concerns" making similar products. The primary barrier to entry for a small business joining the military procurement program is understanding the complexities of the process. Thus, the vast majority of contracts are awarded to contractors whose business is dedicated to military procurement.

A curious twist of this system involves product improvements. Contractors make VECP's to improve the construction or manufacture of an item. The first level of

Typically, 85 to 95 percent of CIE contracts, in aggregate, are set-asides for small businesses (under 500 employees). This eligibility requirement encompasses over 15,000 firms out of some 31,000 in the U.S. There 15,000 firms are on DPSC's bidder list. Actual contractors regularly supplying the CIE items procured by DPSC number 150-200. The firms typically have been doing business with the government for many years, having almost all of their production capacity dedicated to military requirements.

While the intent of Congress may have been to assist struggling firms at a competitive disadvantage to become part of the military procurement system, this is not the case in practice. The Primary Contract Officer (PCO) puts a contract out to bid with a small business set-aside. He seeks a competitive award if at least two small businesses would be eligible and interested. At any time, the Items Lacking Competition List has several items for which a qualified bidder cannot be found. Awards of a competitive bid are to the lowest price. The winning contractor must submit to an assessment of his responsiveness and responsibility. The PCO makes a determination assessing the contractor's experience by conducting a pre-award survey. This on-site survey is not done by DPSC. Instead it is done by the DCAS, whose responsibility includes monitoring of defense contractor compliance and performance. These pre-award surveys are required within seven days of award and each time an award is made, even if the contractor has an extensive history of satisfactory performance.

Should the PCO believe the winning bid contractor is not responsible and rule accordingly, the contractor can appeal the PCO's decision by referring the case to the Small Business Administration (SBA) for issuance of a Certificate of Competency (COC). The SBA resolves these "responsibility determinations" through another plant survey which focuses primarily on the financial position of the contractors. Logically, a contractor's ability to perform on a contract involves technical ability, appropriate technology, sufficient capacity to meet delivery, and necessary financial resources to maintain operation. The progress payment provisions of small business contracts usually allow contractors to meet the working capital requirements of the contract. Hence, a COC may be issued for award to a contractor lacking the technical capability to perform.

A PCO receives notification from the SBA of "intent to award" within 15 days of referral. At this point, the

VI. CHANGES TO INDUSTRY CAPABILITY

The study requirements were to evaluate what impact military textile demands would have on the industrial base of the textile and apparel industries. The previous sections have defined how KSA generated that military demand over four scenarios, and described how the industries would be affected by relating demand to peacetime production. As stated previously, there is not sufficient indication from the demands in the four scenarios that either the textile or apparel industries would be severely impacted by mobilization.

That premise, however, is certainly based on the fundamental assumptions that the domestic industries would maintain viable industrial capacities. There are numerous situations of mobilization which would impair the ability of those industries to function, but they would involve strategic-type engagements with possible nuclear exchange, and KSA is in no position to evaluate what industrial base capability would remain viable and whether all peacetime degrees of transportation and domestic marketing would remain stable. However, worst-casing the conventional scenario would limit imports and exports except to allied countries, which may not be as predictable as we think in our standard scenarios.

There are changes to those industries which are occurring and have the potential of creating major bottlenecks or war-stopping factors. Several of these will be briefly mentioned to either generate thinking along the lines of "what do we do if?" or emphasize those areas where problems may occur. Some of these conditions are obvious to any industry participant, but their mobilization implications may not be as obvious.

A. Textile Machinery Availability

The basic message here is severe market loss to foreign manufacturers. This movement is in fact a revolution in the textile machinery industry, and includes all segments from fiber to finishing. Suffice it to say that a textile mill today could not be equipped with all U.S.-made machinery, regardless of the process involved.

In 1981 a massive study was completed for the DOC on the opportunities and strategies for U.S. textile machinery manufacturers in foreign and domestic markets.[20] It was recognized that the U.S. textile machinery industry had not heeded the veritable technological revolution involving all aspects of their industry, and rapidly have lost ground to foreign manufacturers. Their position is now basically one of

approval comes from DCAS. The result of an approved VECP is a monetary reward to the contractor for every item produced for a period of time in the future. The DCAS has an annual quota for VECP's. They therefore have an administrative incentive to push for DPSC approval. The appropriate PCO has authority to approve or deny, getting technical confirmation from NLABS or the applicable specification creating agency. As a VECP can involve hundreds of thousands of dollars, it is carefully scrutinized. There is no appeal process for a denied VECP. The present structure places the specification creating agency and the PCO in the position of accepting that their present item can be improved and rewarding the contractor. The only advocate is the agency with the role of monitoring contractor compliance.

Throughout the procurement system is the implied feeling of distrust; that without constant monitoring, contractors would cheat the government at every opportunity. This is not the case. The massive commercial market for textiles and apparel could not function daily if it operated at the extremes of caveat emptor. The peculiarities of the system, its rigidities, even protect incompetent, dishonest contractors—in some instances even allowing them to continue to bid on new contracts while being sued by the government for nonperformance on a previous contract.

The system and its management are significant barriers to extending apparel industry participation in military procurement. This restricts experience to a limited number of producers representing a small proportion of industry capability. This ensures confusion and delay in responding to the needs of mobilization. The actual results of the small business set-aside program should be carefully evaluated in light of their effects on mobilization capability management.

TABLE 47. COC REFERRAL DLA CLOTHING AND TEXTILE DIVISION

	1979	1980	1981	1982 (To Date)
1. COC cases referred SBA.	57	84	82	49
2. Disposition of COC cases				
a. Small Business Elected Not to File.	30	57	39	28
b. SBA declined to issue.	10	4	5	7
c. PCO withdrew referral and made award.	6	6	13	1
d. COC issued, accepted, and award made by PCO.	11	17	25	5

What is happening is that the U.S. textile industry is literally passing the domestic machinery industry. There are definite economic and international market forces which of course affect the U.S. textile industry as well, and the response has been to modernize plants at an accelerating pace to increase productivity, de-skill operations, seek energy cost reductions, consume alternate fuels, and comply with Occupational Safety & Health Administration (OSHA) and Environmental Protection Agency (EPA) regulations.

Figure 15 gives some indication of the complex nature of the textile industry, and also a clear picture that there are hundreds of different equipment types required to process fiber into a finished fabric. The U.S. textile machinery industry grew out of the need to fuel that domestic industry, and for many years we ignored the necessity to either expand our presence in international markets or develop the R&D necessary to create or take advantage of new technology.

The result has been drastic and not comfortable for U.S. machinery manufacturers. At the ATME-1-80 machinery show in October of 1980—which was a show primarily related to finishing, knitting, weaving and dyeing—55.8 percent of the total square footage was occupied by foreign manufacturers, and the top five foreign countries had 114 exhibitors, or 27 percent of the participation. In 1982, at the ATME-1-82 show, 64 percent of the exhibition space was occupied by foreign manufacturers, and this show involved only fiber and yarn preparation. These numbers do not even reflect the fact that a portion of the floor space occupied by U.S. companies involved companies that have merged with foreign manufacturers to provide both an entry for the foreign manufacturers into the U.S. market and a better position with respect to international markets.

The most dramatic machinery activity has been in the weaving sector, where the number of shuttleless looms being purchased by U.S. manufacturers is growing almost daily. The looms being purchased are almost exclusively foreign-made, with only one U.S. firm offering a conversion kit for a fly-shuttle loom. Appendix V is an example of what is available on the international market.

Other primary machinery areas where there has either been a loss of domestic capability or an increase in foreign commitments are carding and printing. There is not a single U.S. machinery manufacturer who builds a complete card anymore. There are still U.S. companies that can repair cards and provide major parts, however. Printing machines are primarily made in Europe, and though there are domestic manufacturers remaining, that is another machinery area which may be lost within 10 years.

survival and it has resulted in many changes in that machinery industry even in the past two to three years. Table 48 gives some indication of how significant these changes have been since 1960.

TABLE 48. U.S. TEXTILE MACHINERY SALES

Year	Percent Domestic Market	Percent International Market
1960	93.4	15.5
1970	67.1	9.9
1979	54.5	6.6

The DOC study concluded that certain actions must be taken as soon as possible by the domestic machinery industry to remain viable. The main recommendations were:

- Encourage more government trade assistance;
- Seek government support and incentives to "metrify" the U.S. industry;
- Develop plans and promote an overseas group marketing effort with ATMA support to provide a "total installation" capability for developing countries;

There is no question that both the U.S. and European textile industries are large and mature, and that future sales will be primarily to modernize facilities and replace equipment with technologically improved machinery. The lesser-developed countries represent a large growth potential for U.S. manufacturers as they develop their own industries. The resulting efforts of U.S. machinery manufacturers toward foreign sales will then enable the U.S. machinery industry to develop a base for R&D funding to recover and maintain parity with foreign manufacturers.

The realities of the world trade in textile machinery are that in 1979 the U.S. had nine percent and all countries with a recognized textile machinery industry exported more than they used except for the U.S. The markets identified by the DOC study are expected to grow, and there are technology opportunities that exist for U.S. textile machinery manufacturers, but a joint industry and government effort is required to accelerate these export strategies.

part or substitution of another manufactured part from a competitor's machine.

Third, for every active industrial sewing machine, there must be at least one and one-half machines in storage that, despite age or mileage, could be made operational and kept running by virtually thousands of competent mechanics associated with the apparel industry.

Fourth, industrial sewing equipment is very versatile. A double-needle lockstitch machine can be used on a wide variety of garments and equipment, and the same case could be made for many other equipment styles.

Fifth, sewing machinery can be modified in hundreds of ways to perform special construction requirements. There are about one dozen solid companies in the U.S. who manufacture attachments and who compete for the thousands of gadgets which they and apparel manufacturers develop to improve a product or lower labor costs. Most of them could double production if raw materials were available in an emergency.

In summary, apparel industrial sewing equipment would not represent a significant problems in a mobilization, but attention should be paid to the availability of special equipment for certain military products, such as the 111 or 112 series heavy duty machines with compound feed or pullers used for tent manufacture. Union Special, Singer, and Adler are three major suppliers for that type equipment, which is available domestically and not scarce enough at this stage to be considered as specialized equipment requiring storage for mobilization in accorance with the Defense Industrial Preparedness Program (DIPP). The major factor involved with apparel industry response time will be the degree of specification variance with NLABS or DoD will accept regarding garment construction. The issue certainly deserves more attention than this study provides, but the situation is analogous to the fiber discussion of alternative sources. NLABS is in the best position to take the initiative and establish specific mobilization specification variances.

C. Industrial Sewing Needles

The U.S. needle manufacturing industry does not exist. There are no sewing needle manufacturers in the U.S. The last company was the Torrington Needle Corporation, which closed its last plant in 1980, shipped the majority of the equipment to Portugal, and started another plant there. Singer closed its industrial sewing needle plant in Elizabeth, New Jersey in 1955. As a matter of fact, the entire U.S. apparel industry is dependent on needles manufactured in Europe or

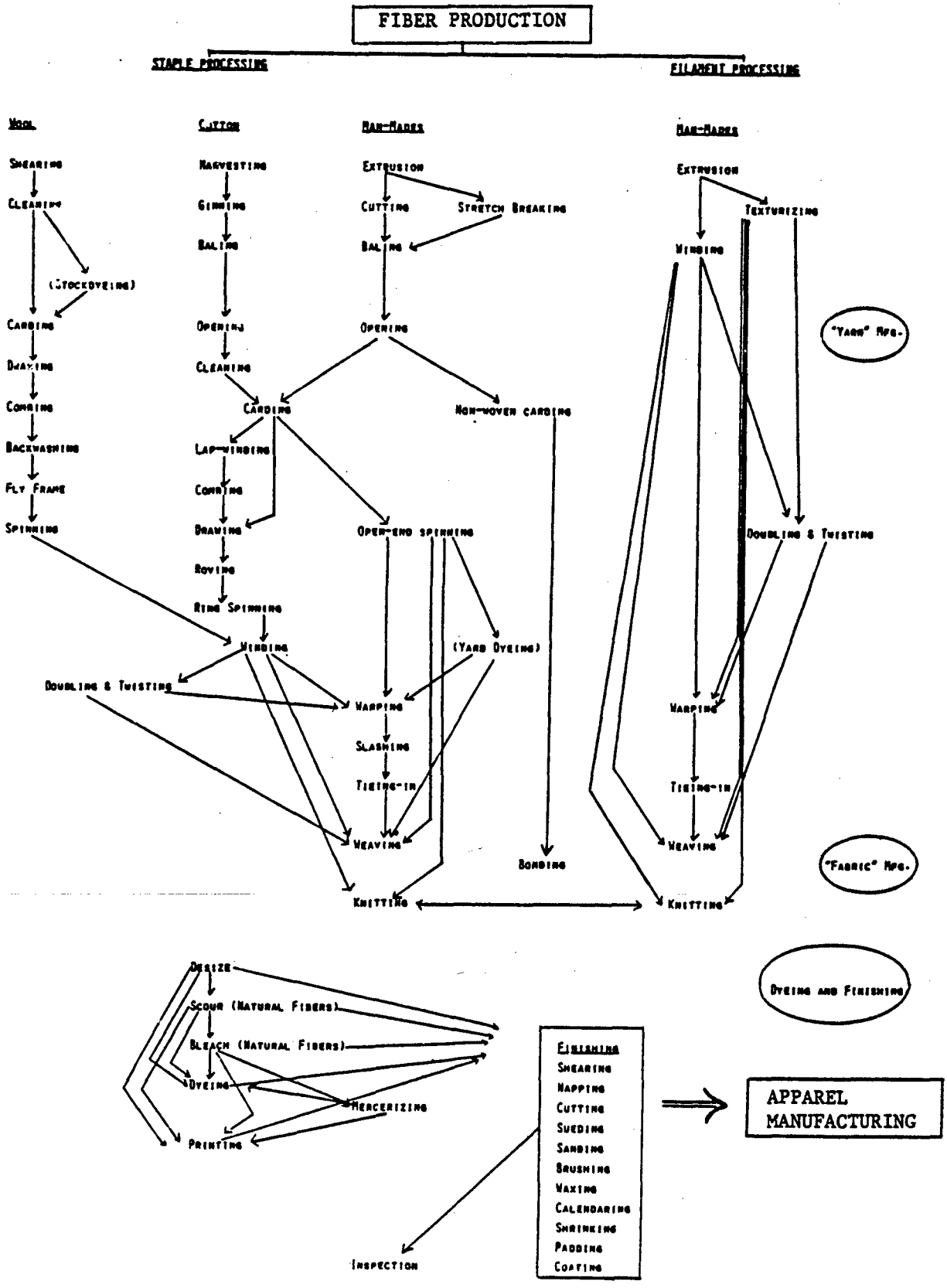


FIGURE 15. REPRESENTATIVE FIBER TO FABRIC PROCESS CHART

1. Chemicals. As previously mentioned in the fiber and finishing sections, some chemicals needed for those processes are purchased outside of the United States because of nonavailability domestically. The main reason they are not available in the U.S. may only be that OSHA and EPA regulations make it so costly for a chemical manufacturer to produce them that it is not economically feasible. This situation could be modified in a mobilization through government action to allow, but monitor, production. The worse scenario is that there is no domestic capability to produce certain chemicals, either due to the lack of technology or nonavailability of other raw materials. This condition calls for more action on the part of both industry and government to determine alternative chemicals that are acceptable substitutes, or maintain inventory levels sufficient for a pre-planned period, or jointly fund the R&D required to establish a U.S. capability.

2. Metals. Two primary ones surfaced, nickel and stibnite ore. Nickel is the metal used in surfacing rollers for printing equipment. The U.S. has one operational nickel mine in the West, but the sources of the majority of nickel are Canada and Australia. It seems that the U.S. could increase its own production, but a government arrangement was made for a guaranteed consumption of some level of nickel ore from Australia, and the U.S. is now committed to this arrangement for some time.

   Stibnite ore is used to derive antimony sulfide, used in bullets, and the chemical formulation for the FR finish. The ore is mined in the U.S. out of one location in Montana, but 90 percent of the ore used in the U.S. is imported from Bolivia, China, Canada, and South Africa.

3. Ceramic. Though a very small quantity is used as a raw material, ceramic is critical for the manufacture of yarn tension controls that are used in many stages of the textile process, anywhere the yarn is moving. Though there are U.S. plants which do produce ceramics, most used for textile products either come from England or Japan, and approximately 85 percent of all ceramics for all U.S. industrial applications come from outside the U.S. The finer quality ceramics come from England, and the lower priced ceramics from Japan. This is an interesting area for mobilization planning since ceramics are growing in industrial importance in the U.S., and there is no way of currently measuring the domestic production of the ceramic industry to meet total U.S. needs.

the Far East and distributed in the United States by a few major companies such as Ferd Schmetz or Groz-Beckert.

There are also no indications that any foreign manufacturer will start a production facility in the U.S., the primary concern is apparently labor unions and labor costs. In a very short period of time, the remaining skilled labor from the Torrington operation will be lost, and the U.S. will probably never regain that capability. There are only two places in the United States where the proper raw materials and tool and die elements are available, Massachusetts and New Jersey. Ninety-five percent of a needle cost is labor. A plant start-up would conservatively take four years with trained operators.

The entire world depends on needles made in roughly a 40-mile circle in the lower Rhine area of Germany and Belgium. This fact has serious strategic consequences for more than just the U.S. There are Japanese needle factories and one in Brazil owned by Singer, but their total producion is nowhere near the 70 plus percentage of the world market serviced from Europe.

The mobilization scenario considered as worst-case for a conventional situation would involve no imports of needles. Inventories would then be the measure of how long the apparel industry could remain operational. It is not merely a function of how many needles are available, but size is very important for garment construction, and certainly for any heavy-duty sewing such as parachutes and tents. Industry experts indicate that current inventory levels run from three to six months on most needle styles, with fewer inventories for specialty needles.

The scope of this study did not enable a complete analysis of needle requirements for specific military products, but such a project is not out of the question to assist in mobilization planning. There do not appear to be any easy short or long term solutions. The solution is probably not a master plan to have apparel manufacturers swap needles based on production requirements.

D. Raw Material Sources

This subject is not all-inclusive of every raw material required for all elements of textile and apparel manufacturing, but only an attempt to highlight several which have been recognized in the course of this study as potential problem areas for mobilization. More attention would be required for each item to determine the real bottleneck it may cause.

Exports of apparel showed the same tendency as in textiles. From 1976 to 1978, they grew at 15.2 percent AGR, then from 1978 to 1980 at 33.2 percent AGR, leveling off in 1981 in current dollars and an estimated decline of 20.2 percent in 1982. (Refer to Figure 17.) Growth of exports and the relative weakening or strengthening of the dollar versus international currencies show an interesting correlation.

There are many other facets affecting the balance of trade that must be considered in looking at this situation. The condition of the main export markets' economies, tariff restrictions, government impediments in export markets, subsidiaries and other grants for foreign exporters. It becomes a three-dimensional picture.

Textiles

Since the recession in 1975, total textile industry sales increased at a 9.4 percent AGR not including 1982. (Refer to Figure 18.) In the same period of time imports of textiles increased by 13.2 percent AGR (refer to Table 50). In 1982, imports are estimated to have decreased from 3,046 million to 2,854 million reflecting the general U.S. economic situation. Imports share of the U.S. market has risen from 5.8 percent in 1975 to 6.3 percent in 1981.

Exports of U.S. textile products have been much more volatile than the rather linear increase of imports. From 1976 to 1978 they grew at 6.2 percent AGR, from 1978 to 1980 there was a sharp increase in exports of 27.7 percent AGR (refer to Figure 19). In 1981 exports remained the same in current dollars reflecting a real decline, and in 1982 it is estimated that they will decline in both current and constant dollars. A net balance-of-trade deficit is estimated in textiles for the first time in many years. In reviewing the probable causes for the sharp turn around in textile exports, it is important to look at what was happening at the same time with the relative strength of the major western currencies; German mark, British pound, French franc, Swiss franc, Italian lira, and Japanese yen all strengthened versus the dollar. When the dollar rebounded in 1981 and 1982 against the same currencies, trade exports first leveled off, then began declining.

E. Trade Balance

Apparel

The trade situation in apparel is quite different from that of textiles. The trade deficit has been large and is continuing to increase.

Total apparel sales from 1977 to 1980 grew from 40,129 million to 45,782 million, an increase of 4.5 percent annual growth rate (AGR). (Refer to Figure 16.)

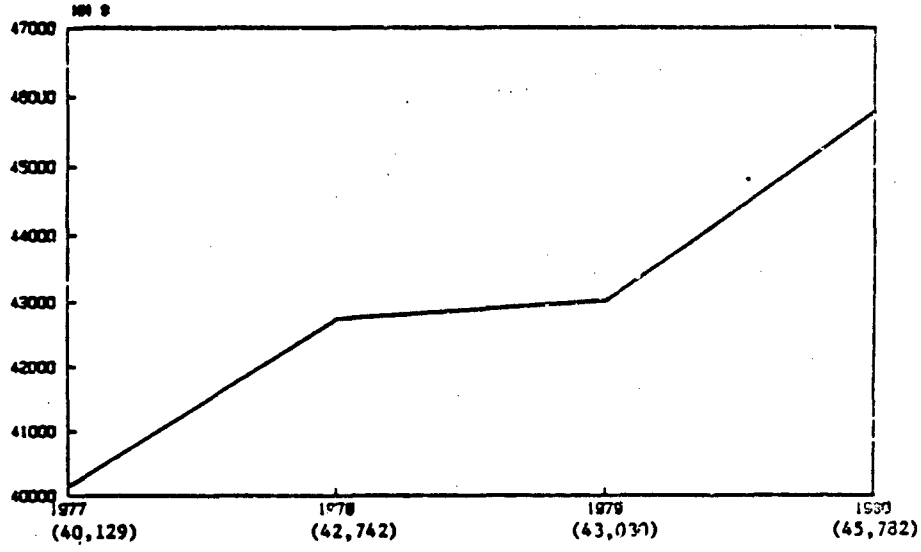


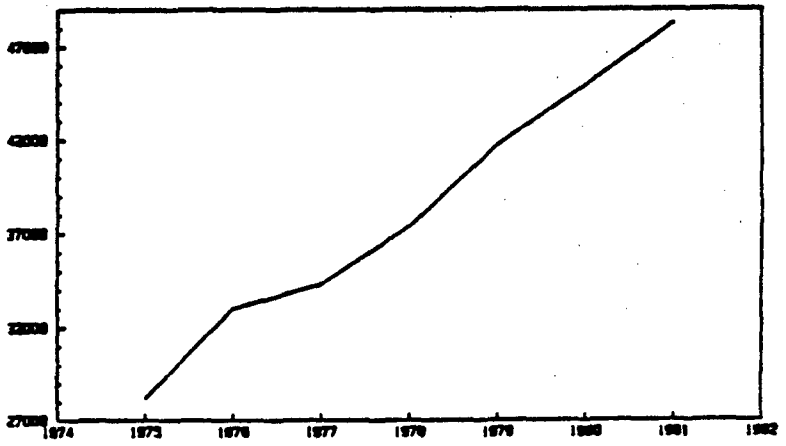
FIGURE 16. TOTAL SALES OF U.S. APPAREL INDUSTRY, 1977-1980

Imports of apparel products on the other hand have increased from 3,634 million in 1976 to 8,362 estimated for 1982. This is an annual increase of 14.9 percent. (Refer to Table 49.)

TABLE 49. U.S. APPAREL INDUSTRY BALANCE OF TRADE 1976-1982
(MM$ U.S.)

Year	Imports	Exports	Balance +
1976	3,634	510	-3,124
1977	4,154	608	-3,546
1978	5,657	677	-4,980
1979	5,876	931	-4,945
1980	6,427	1,202	-5,225
1981	7,537	1,232	-6,305
1982	8,362*	983*	-7,379*

* Estimated based on ten months 1982.
Source: U.S. Department of Commerce FT-135 FT-140, January 1983.



Source: ATMI Highlights

FIGURE 18. TOTAL SALES U.S. TEXTILE INDUSTRY, 1975-1981

TABLE 50: U.S. TEXTILE INDUSTRY BALANCE OF TRADE (MM$ U.S.)

Year	Imports	Exports	Balance +
1976	1,635	1,970	335
1977	1,772	1,959	87
1978	2,200	2,225	25
1979	2,216	3,189	973
1980	2,493	3,632	1,139
1981	3,046	3,619	573
1982	2,854*	2,846*	-8*

* Estimated based on ten months 1982.
Source: U.S. Department of Commerce FT-135 FT-140, January, 1983.

In a December 21, 1982 article in the Daily News Record, Robert Lawrence of the Brookings Institution quoting for a recent study, reported on the correlation between these two factors stating that "the major reason trade has hurt... is the exceptional strength of the U.S. dollar against many other currencies."

The strong dollar has raised the cost of manufactured goods as much as 20 to 30 percent, compared with 1980.

A point to be made is that a weak U.S. currency vis a vis the other major countries has a significant impact on the balance of trade. (Refer to Figure 20 and Table 51.)

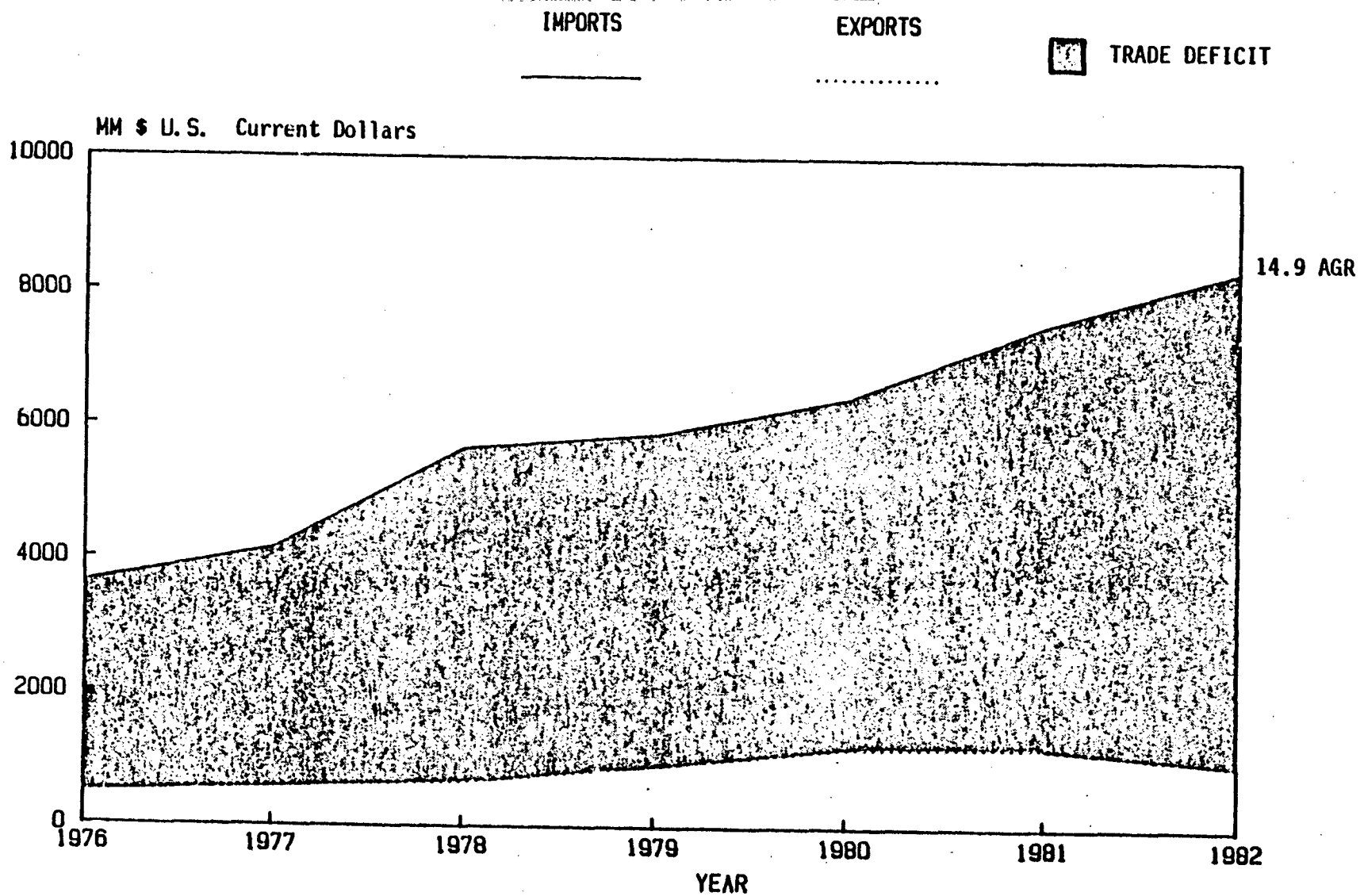


FIGURE 17. U.S. APPAREL INDUSTRY BALANCE OF TRADE

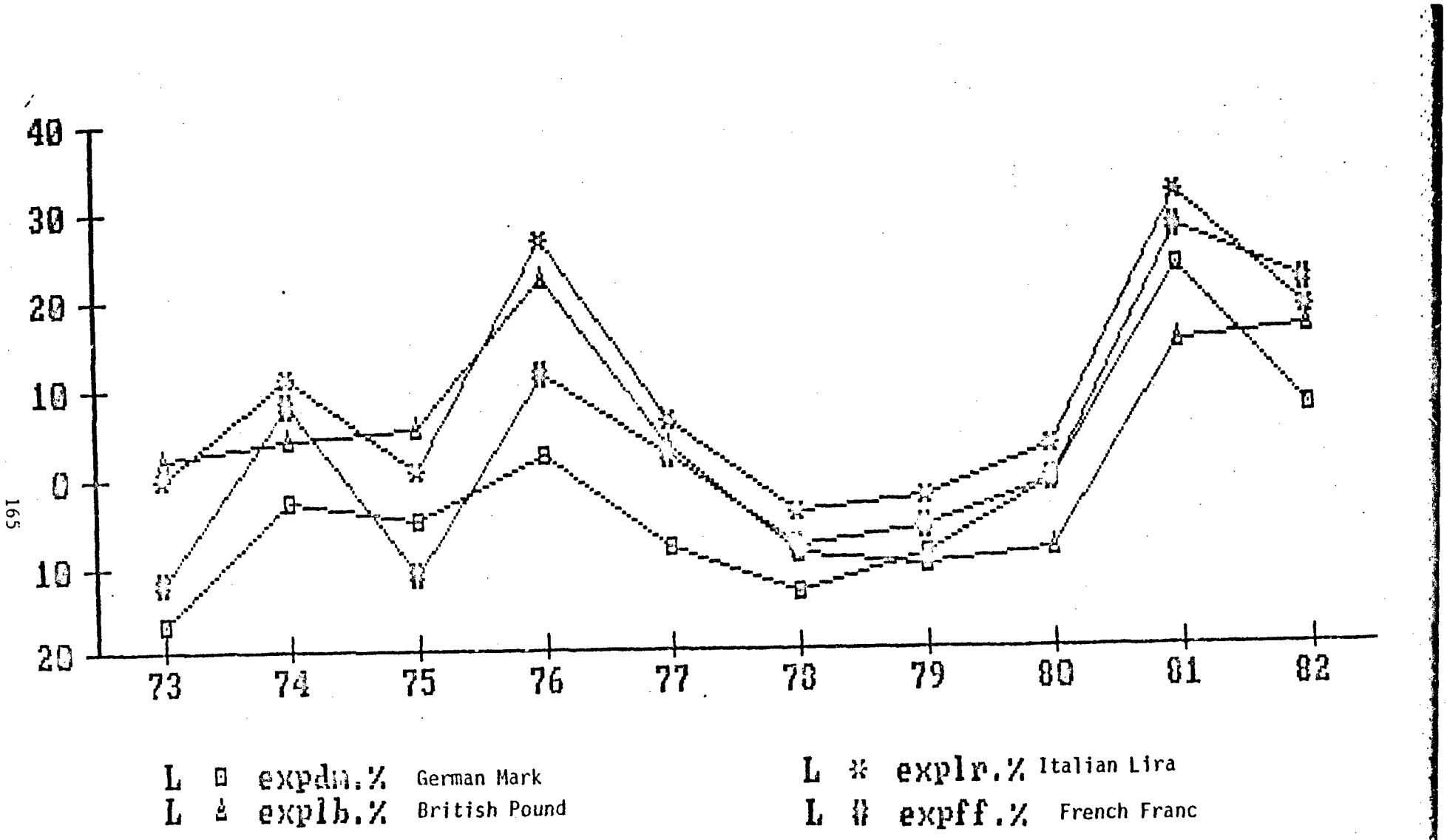


FIGURE 20. CURRENCY FLUCTUATIONS AS PERCENT CHANGE YEARLY VERSUS U.S. DOLLAR

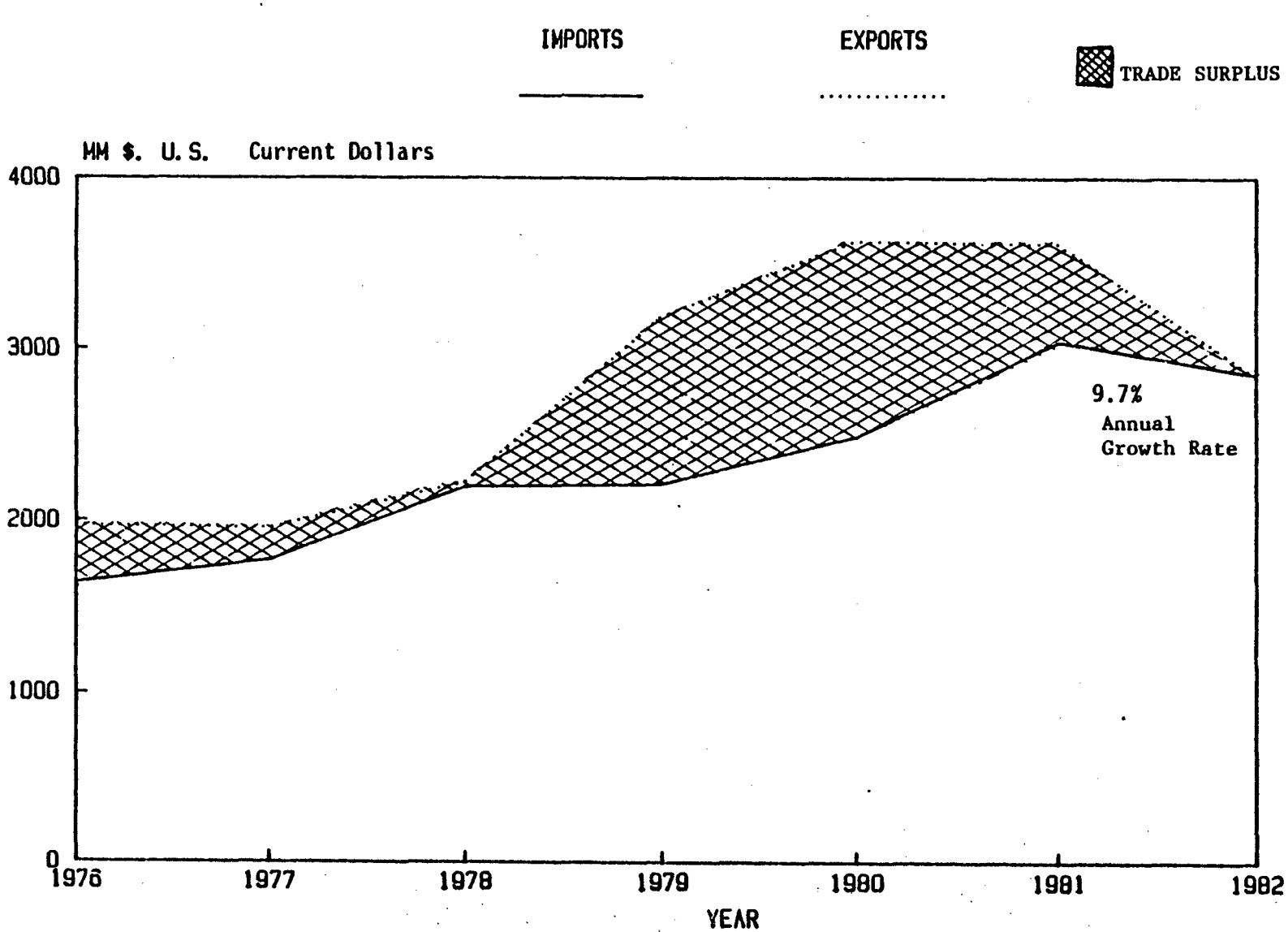


FIGURE 19. BALANCE OF TRADE, U.S. TEXTILE INDUSTRY, 1976 TO 1982

production capacity committed to commercial work. This is truly a subsegment of the apparel industry which is controlled by procurements from DPSC. There is movement in this segment, but very seldom is there any movement out of government contracting into larger activities, because the very nature of small business protection actually prevents it. Very few large businesses commit time or capacity to military contracts, as it generally does not prove to be a reasonable trade-off from commercial work.

TABLE 51: CURRENCY FLUCTUATIONS VERSUS U.S. DOLLAR

Year	German Mark	British Pound	French Franc	Swiss Franc	Italian Lira (x 000's)	Japanese Yen (x 00's)
1972	3.19	.4	5.04	3.82	.583	3.031
1973	2.66	.409	4.45	3.17	.582	2.717
1974	2.59	.427	4.81	2.98	.649	2.921
1975	2.46	.451	4.28	2.58	.653	2.968
1976	2.52	.553	4.78	2.50	.829	2.966
1977	2.32	.572	4.91	2.4	.882	2.685
1978	2.01	.522	4.51	1.78	.848	2.104
1979	1.83	.47	4.25	1.66	.828	2.191
1980	1.82	.43	4.23	1.68	.858	2.267
1981	2.26	.96	5.43	1.96	1.136	2.205
1982	2.44	.581	6.63	2.06	1.352	2.508

Source: IMF (International Monetary Fund)
Statistiches Jahrbuch 82.
First National Bank/Atlanta

F. Industry Consolidation

Consolidation is a phenomenon that is occurring in many U.S. industries, but is very real to the textile industry. Appendix CC lists mill closings in three main textile states since 1980. The fiber segment involves companies that are for the most part very large, capital intensive and specialized, resulting in not too much movement out of or into the market. The yarn preparation and weaving area is another story, with many vertical operations and independent companies, resulting in considerable shake-out during economic troubled times. Imports severely influence stability in this textile segment, where some companies close never to reopen, and thousands of jobs are lost. Consolidation is also very real in the finishing segment, where the ranks of commission printers have dwindled constantly for the past 20 years. To a certain extent, the dyeing industry is also experiencing some consolidation, and industry representatives feel that this trend will continue.

In the apparel industry, consolidation does occur, but the industry entry barriers are not as significant as in the textile areas, resulting in the size of the industry changing daily, and certainly impacted by the recession. As far as apparel contracting for the government is concerned, survival is generally based on securing continued contracts, as most of these manufacturers are small businesses and have no

VII. RESEARCH AND DEVELOPMENT ISSUES

Success on the modern battlefield will, in part, depend upon the ability of individual military personnel to perform missions. Clothing and equipment properties make a very important contribution to that goal. The correct clothing and equipment for that modern battlefield comes from continuous R&D by several DoD agencies, primarily the U.S. Army Natick Research and Development Laboratories, whose mission and composition have been previously described. This section will highlight R&D factors that the entire textile and apparel industry are involved with and that impact on future R&D activities at Natick.

A. NLABS R&D Funding

NLABS is an agency under DARCOM and receives the majority of its funding from that command. A brief synopsis of total NLABS income and expenses is presented in Figure 21.[22]

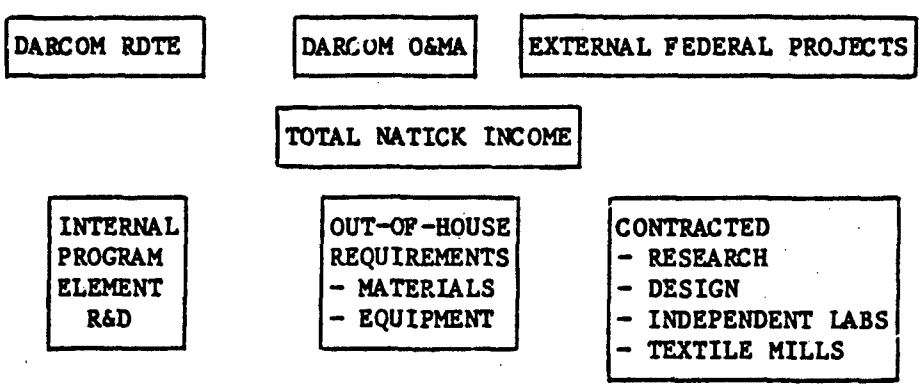


FIGURE 21. NATICK FUNDING

This total funding for the Natick Labs as a whole is presented in Table 52 for fiscal years 1981 and 1982 (FY81 and 82). This shows a total funding from all sources for FY82 as $60.3 million, with RDTE funding representing 61 percent of that total. This total funding represents a 2.2 percent increase over FY81 levels and a decrease of 1.3 percent in RDTE funding compared to FY81 expenses. Note that the RDTE funding is for six major program elements which are applicable either in total or partially to all of the labs assigned to NLABS.

A further look at NATICK funding, but from the expense side is seen in Table 53. Here the obligations to external agencies and other DARCOM and government agencies are depicted. This chart shows that of the $36.9 million for RDTE as of

TABLE 53. OUTSIDE/INSIDE OBLIGATIONS

(as of 30 September 1981)

EFFORT	Industry and Academic Contract/Total Obligations		Other DARCOM Labs Contract/Total Obligations		Other Government Agencies Contract/Total Obligations		Estimated Cost to Administer	
RDTE FUNDS	$K/$K	%	$K/$K	%	$K/$K	%	$K/$K	%
6.1	175 / 2470	7	0 / 2470	0	0 / 2470	0	29 / 2470	1
6.2	3587 / 12947	28	313 / 12947	2	897 / 12947	7	380 / 12947	3
6.3 a								
6.3 b	2125 / 7041	30	1422 / 7041	20	423 / 7041	6	478 / 7041	7
6.4	746 / 7641	10	4464 / 7641	58	320 / 7641	4	523 / 7641	7
6.5	696 / 6837	10	4 / 6837	0	45 / 6837	1	205 / 6837	3
6.7								
RDTE TOTAL	7338 / 36936	20	6203 / 36936	17	1685 / 36936	5	1616 / 36936	4
PROCUREMENT FUNDS								
DARCOM	1753 / 3000	58	292 / 3000	10	0 / 3000	0	30 / 3000	1
NON-DARCOM (Other Army)								
NON-ARMY								
A'PA TOTAL	1753 / 3000	58	292 / 3000	10	0 / 3000	0	30 / 3000	1
OMA FUNDS								
DARCOM	1241 / 15405	8	1041 / 15405	7	794 / 15405	5	300 / 15405	2
NON-DARCOM (Other Army)	0 / 58	0	0 / 58	0	0 / 58	0	0 / 58	0
NON-ARMY	0 / 189	0	0 / 189	0	0 / 189	0	0 / 189	0
OMA TOTAL	1241 / 15652	8	1041 / 15652	7	794 / 15652	5	300 / 15652	2
GRAND TOTAL	10332 / 55588	19	7536 / 55588	14	2479 / 55588	4	1946 / 55588	4

TABLE 52.

FY81 FUNDING
FROM ALL SOURCES INCLUDING CUSTOMERS
(AS OF 30 SEP 81)
($ in Thousands)

HQ, DARCOM

RDTE FUNDS	FY81 SUBTOTAL	FY82 SUBTOTAL
6.1 RESEARCH	$ 2,470	$ 2,914
6.2 EXPLORATORY DEVELOPMENT	12,947	12,090
6.3 ADVANCED DEVELOPMENT 6.3A		
6.3B 7041	7,041	6,570
6.4 ENGINEERING DEVELOPMENT	7,641	6,718
6.5 MANAGEMENT AND SUPPORT	6,837	8,687
6.7 OPERATIONAL SYSTEMS OTHER	0	0
RDTE TOTAL	36,936	36,979
RDTE FUNDS		
DARCOM OTHER	1,318	2,067
NON–DARCOM (OTHER ARMY)	509	353
NON–ARMY	1,549	1,224
TOTAL	3,376	3,644
PROCUREMENT FUNDS		
DARCOM HQ	3,000	0
DARCOM OTHER	0	0
NON–DARCOM (OTHER ARMY)	0	0
NON–ARMY	0	0
APA TOTAL	3,000	0
OMA FUNDS		
DARCOM HQ	13,862	17,487
DARCOM OTHER	1,543	1,950
NON–DARCOM (OTHER ARMY)	58	50
NON–ARMY	189	175
OMA TOTAL	15,652	19,662

TABLE 54. NATICK RESEARCH AND DEVELOPMENT
INDIVIDUAL PROTECTION LABORATORY
CLOTHING AND EQUIPMENT PROGRAM ELEMENT FUNDING
1974-1982
($000)

Clothing & Equipment Programs	1974	1975	1976	1977	1978	1979	1980	1981	1982
6.1 Defense Research Sciences	---	280	417	419	338	269	364	586	688
6.2 Clothing, Equipment, Shelters	2,193	1,450	2,075	1,571	2,197	2,676	4,527	3,832	3,599
6.3 Soldier Support and Survivability	1,025	1,461	812	667	370	1,820	1,413	2,396	1,345
6.4 Combat Feeding, Clothing, Equipment	888.5	917	1,640	957	825	2,752	1,426	916	1,168
Total	4,106.5	4,108	4,944	3,614	3,730	7,517	7,730	7,730	6,800

September 30, 1981, 20 percent was allocated to external contracts for industry and academia, 22 percent to other DARCOM labs and government agencies, and 4 percent for administration. This left 54 percent or approximately $20 million, for total NLABS RDTE funding for the labs at Natick.

The Individual Protection Laboratory (IPL), at NLABS is the lab responsible for this contract and for the total RDTE on CIE. This R&D is geared to all aspects of textiles and apparel that would reduce the hazards and threats facing the individual soldier on the battlefield. The threats include noise, flame, chemical warfare, ballistics, heat, and lasers.

The budget for the IPL for R&D activities in FY82 was $6.8 million, or 34 percent of the total RDT&E budget for the Natick Labs as a whole. Table 54 illustrates IPL R&D program element funding for the years 1974 through 1982. The 6.2 category, exploratory development, in all but one of those years represented the largest expenditure of funds, measuring 53 percent of the total in 1982. Due to data non-availability, it is not known what portions of IPL's RDT&E funding were allocated to external contracts and internal activities.

It is KSA's opinion that textiles and CIE represent as strategic a commodity to success on the next battlefield as many other combat essential items requiring expenditures for R&D. In that light, $6.8 million does not represent a reasonable appropriations level for contributing to the survivability of the individual soldier. Individual mission performance will ultimately determine the outcome of the next conflict, not necessarily the degree of technology in weaponry or detection systems. It is the soldier who operates the weapon and not the weapon which determines combat effectiveness.

The IPL R&D budget pales in comparison to any number of procurement mistakes made for weapon systems or material which is obsolete before it is ever fielded. In addition, the entire NLABS RDTE budget could have been financed for over five years for the cost of just the overruns associated with the procurement of the Army's attack helicopter. The IPL requires significantly more R&D funding for it to provide better equipment to the individual soldier. Increased funding is also needed to expand NLABS' interaction with industry and take action on recommendations made by this study. The IPL represents the best single DoD organization positioned to secure that cooperation from industry and bring together the

TABLE 54. NATICK RESEARCH AND DEVELOPMENT
INDIVIDUAL PROTECTION LABORATORY
CLOTHING AND EQUIPMENT PROGRAM ELEMENT FUNDING
1974-1982
($000)

Clothing & Equipment Programs	1974	1975	1976	1977	1978	1979	1980	1981	1982
6.1 Defense Research Sciences	—	280	417	419	338	269	364	586	688
6.2 Clothing, Equipment, Shelters	2,193	1,450	2,075	1,571	2,197	2,676	4,527	3,832	3,599
6.3 Soldier Support and Survivability	1,025	1,461	812	667	370	1,820	1,413	2,396	1,345
6.4 Combat Feeding, Clothing, Equipment	888.5	917	1,640	957	825	2,752	1,426	916	1,168
Total	4,106.5	4,108	4,944	3,614	3,730	7,517	7,730	7,730	6,800

resources of both DoD and the industrial base for procurement of the best CIE products.

B. Industry Focus

Research and development activities of the textile and apparel industries require independent assessment, as each industry handles those expenditures differently. The basic issues of how much is being done and who is doing any R&D are discussed in the next few sections. In a composite sense, both domestic industries are mature and suffering from lack of growth and increased threats from imports, both of piece goods and finished products. Technology advances related to those industries have for the most part been foreign initiated, forcing responsiveness and adaptation rather than leadership for our domestic industries.

Research and development probably require some definition to avoid confusion. If we consider the four program funding categories that NLABS uses as guidelines for describing industry R&D activities, that will assign the proper scope to the R&D issues important for this study. Table 55 lists the four funding categories.

TABLE 55. NLABS R&D PROGRAM ELEMENT FUNDING CATEGORIES

61102	Defense Research Sciences
62723	Clothing, Equipment, Shelters
63747	Soldier Support and Survivability
64713	Combat Clothing and Equipment

These categories receive R&D funding for clothing and textile programs, and include all phases of an NLABS' R&D project. This means that all stages of the product life cycle, from basic research on fiber or fabric through testing and prototype development to initial supply to the logistical system, can receive R&D funds.

If we equate that scope to the R&D efforts of the textile and apparel industries, it is not so easy to define strictly what is and is not R&D. There are, however, several basic ways to consider R&D in these two industries. In the textile industry, the last new fiber developed for U.S. production was aramid in 1967. Table 56 lists 21 generic names of the most common manmade fibers produced domestically. The two fibers that represent the bulk of manmade fiber demands for military use in this study are nylon and polyester, both of which have been produced in the United States for the last 30 years at least.

TABLE 56. U.S. MANMADE FIBERS

General Fiber	Commercial Production Initiated
Rayon	1910
Acetate	1924
Rubber	1930
Glass	1936
Nylon	1939
Vinyon	1939
Saran	1941
Metallic	1946
Modacrylic	1949
Olefin	1949
Acrylic	1950
Polyester	1953
Triacetate	1954
Spandex	1959
Aramid	1967

If development of a new fiber is pure research, then modification of the basic generic composition of an existing fiber, either chemically or physically, would be considered developmental R&D. This definition of R&D would include the activities involved with development of all the fiber variants, which currently number approximately seventy, most with trademark names. Research of this type is probably going on at all the major fiber producers, the important point being that these efforts are purely independent activities to generate a proprietary product that would yield an improved market competitive position.

With respect to other segments of the textile industry beyond the fiber producers, the technology of the past 15 years has really driven the changes. In spinning and weaving, machinery technology has been the primary issue affecting development. There is less development research and very little pure research done in these areas, and production techniques are not unique to a single company. Spinning and weaving are technology-driven as opposed to research-driven.

In the finishing area, definition of any sort is difficult due to the variation of techniques involved with fabric finishing. The standard definition of finishing is any operation for improving the appearance and/or usefulness of fabric after it leaves the loom or knitting machine. This translates to more than 20 different processes described in an earlier section. Though finishing is again another textile industry area where machinery and technology are changing capabilities at a rapid pace, this same technology

that increases efficiencies and productivity has the negative effect of reducing manufacturing flexibility. R&D therefore tends to take the form of process improvement to enhance fabrication properties. Though dependent on the chemical industry for many raw materials, very little R&D is spent by finishers for chemical research. The focus of R&D for textile finishers is again process-related and proprietary-oriented.

On the apparel manufacturing end of the fiber-to-product sequence, research and development is a luxury afforded only by the major manufacturers. This results in a very low expenditure level for the industry as a whole. What R&D efforts there are, with several notable exceptions, would be classified entirely as applications of technology produced strictly for apparel purposes. Garment design would be defined by some as R&D, but the essential ingredients for the manufacturer remains the fabric, trimming, and equipment required for construction. Any construction improvements made by a manufacturer definitely represent a proprietary advantage. Machinery modifications made by a single company are done on a product-by-product basis and seldom have universal application. Though apparel manufacturers are in fact the best source of feedback to an industrial sewing machinery company, most machinery attachments are locally produced and do not warrant basic equipment change. True apparel R&D is performed by a combination of several large apparel companies and independent companies and laboratories. These efforts are primarily related to one of two major areas.

1. Utilization of existing equipment in combination with handling devices for fully automated construction of total or partial garments. This may involve development of machinery on a limited scale from available electronic and mechanical technology. These research activities are very costly and generally result in proprietary procedures when internally funded.

2. Development of alternative apparel construction procedures. These activities will be discussed in a later section, but they probably are indicative of the major developments for that industry in the next 10 years. Machinery and apparel construction procedures have improved with time, but there just are not more innovative ways to apply a stitched felled seam than with an industrial sewing machine of some type, unless stitchless seaming techniques are considered. The technology is available now for alternatives to stitched joining--the speed they impact domestic apparel production will

be a matter of industry acceptability. Based on recessionary effects on the industry and increased import threats to remain cost competitive, the U.S. apparel industry may accept these concepts in the next five to eight years.

The research and development efforts of the textile industry can also be viewed with reference to the overall subject of investment. Investment in textiles, be it in capital assets or R&D, is impacted heavily by the financial return possible. This is based on the assumption that the primary goal of management is to maximize the wealth of its stockholders. To accomplish this, a manager must maximize the value of the firm's common stock.

The purpose of this brief section then is to review some key factors that affect this goal of maximization of stockholders' wealth and to draw some conclusions on how it relates to the industry's R&D effort.

Two of the key elements that impact the decision process of a textile company's investments are:

- Cost of Equity (COE)
- Return on Equity (ROE)

1. Cost of Equity

Cost of Equity is determined by general economic conditions and is beyond the control of individual firms. It does, however, define the rate of return that stockholders require on the firm's common stock. Expressed as a formula, the COE equals

$$R_f + B\ (R_m)$$

Where:

R_f = The rate of return required by investors on a risk-free asset (i.e., U.S. Treasury Bills).

R_m = The risk premium for the investor. This is based on the difference between the rate of return of the average stock market risk and the risk-free return.

B(beta)= The beta coefficient is the extent of a stock's movement in price relative to the general stock market, in other words its volatility.

Thus, the COE for a typical textile company in late 1982 can be estimated in a simplified example.

R_f = 8% Equivalent to the T-Bill rate.

R_m = 6% Estimated market risk premium for 1980s.

B = 0.90 The historical volatility of textile stocks is less than the general market.

COE = 8% plus 0.90 (6%)

COE = 13.4%

From this example, the main point seen is that the rate of return that investors will seek from a typical textile company should be 13 to 14 percent at the current moment in time.

2. Return on Equity

If investors seek a 13 to 14 percent rate of return on their equity, what sort of return have textile firms given historically? For the period 1972 to 1981 selected major textile companies had ROE's from 2.75 percent to 25.5 percent with most falling in the range of 6 to 12 percent (see Table 57).

TABLE 57. RETURN ON EQUITY SELECTED TEXTILE COMPANIES

Company	1972-1981	Company	1972-1981
Lowenstein	2.8	Burlington	8.3
Springs	6.4	Dan River	6.6
Pepperell	10.2	Stevens	5.8
Fieldcrest	11.4	Cone	13.2
Collins & Aikman	11.3	Graniteville	8.9
Guilford	25.5	Riegel	12.2

When the Cost of Equity is higher than the Return on Equity, a negative "spread" is created. This difference between the two affects the market value of the stock as investors seek higher rates of return for equity capital.

The net effect of this negative spread (ROE less COE) on common share stock price can be seen by comparing book value (total common equity divided by shares outstanding) to the actual market price (see Table 58).

TABLE 58. MARKET-TO-BOOK RATIO SELECTED TEXTILE COMPANIES

Company	1976 - 1981		
	Average	Low	High
Lowenstein	0.35	0.25	0.57
Dan River	.43	.34	.49
Stevens	.44	.37	.58
Springs	.44	.39	.52
Burlington	.59	.44	.81
Graniteville	.60	.50	.71
Pepperell	.61	.51	.72
Riegel	.63	.57	.71
Cone	.65	.57	.72
Fieldcrest	.71	.61	.79
Collins & Aikman	.72	.50	.99
Guilford	1.07	.45	1.74
Average (excluding Guilford)	0.56		

With the exception of Guilford, the market to book ratio shows that investors discount the value of textile equity to reflect the lower earnings stream that those assets produce. In the case of Guilford, it is important to note that their ROE for 1972 to 1981 was 25.5 percent, or almost twice the next best company in the comparison, well above COE for the period.

This historical market-to-book performance analysis separates the textile companies into two groups. The first is that group with lower market-to-book ratio. This group is characterized by diversified companies lacking product market leadership in most of their business segments. The second group has higher market-to-book ratios. They tend to be focused companies with market leadership in their core business segments.

Recently some companies have experienced significant positive changes in their market-to-book ratios based on good investment strategy. Springs invested heavily in developing the lowest cost position in sheets, which is one of their most important segments. Lowenstein divested its marginal operations and focused investments toward high potential areas.

Conversely, some companies have seen their market-to-book ratio worsen due to unwise investments. Fieldcrest invested through pricing to enter lower cost markets in their major markets. Cone followed a policy of cash retention in the maturing markets of denim and corduroy.

It is fair to conclude from these factors that if a textile company's market value is generally well below book, dollars invested in capital assets or technology are being discounted and stockholder wealth is destroyed. The incentive to management, therefore, is to make investments only in those projects with a high enough return that will improve the ROE, increase the market valuation of stock, and create stockholder wealth instead of destroying it.

With this criterion, textile companies are reluctant to invest scarce capital resources in research and development that may or may not have immediate returns to help their profits. Patents are difficult to defend and possible benefits lost to late-arriving competitors. An excellent recent example is W. L. Gore and Associates, who introduced and developed the market for polytetrafluorosthylene (PFTE), laminated, breathable fabrics. In a recent federal court decision, their two process patents were invalidated, thereby opening to competitors what had been a small and lucrative market. The invalidation was because the processes were not novel enough and too indefinitely defined.

Though not indicative of all textile patents, this very current instance of patent protection forms a message to the textile industry regarding allocation of capital resources. The tendency is to develop proprietary processes and improve products rather than risking returns for extensive original R&D. There are exceptions to this trend, but there does not emerge a dominant justification for increases in R&D expenditures in the immediate, three- to five-year time frame.

C. R & D Performance

1. Large Textile Companies

It is a more difficult task to assess industry research and development efforts for textiles and apparel than for the Department of Defense. To refine that search to identify only those industry R&D efforts that have a direct military application is almost an impossible task. To take it one step further and discuss independent industry R&D programs whose specific purpose is for military applications should be even more difficult, yet it is an easy task. The reason is that activity is limited to very few of the major textile companies, primarily integrated firms who can undertake and complete an entire R&D program that may involve fiber, spinning, and weaving considerations. KSA has not been

able to develop any specific funding level for this type R&D, but one way of considering what R&D could potentially be spent for military use would be to look at textile and apparel industry R&D statistics.

Business Week conducts an annual R&D scoreboard. The survey for 1982 covered 776 companies with annual sales of more than $35 million. A total of only 15 textile and apparel companies were included in the survey, and the industry composite for R&D spent as a percent of sales was 0.4 percent. Table 59 illustrates how this R&D ratio relates to other survey industries. Overall, surveyed companies spent 2 percent of sales for R&D in 1981, the same level of R&D as 1980. A greater percentage of profits was spent on R&D in 1981 than in 1980, 39.3 percent versus 38.2 percent. Overall industry R&D spending was to have increased in 1982 and to have continued the slightly upward trend.

TABLE 59. R&D EXPENSE SELECTED DOMESTIC INDUSTRIES

Industry	Composite Percent of Sales
Aerospace	4.8
Automotive (cars, trucks)	3.7
Automotive (parts, equipment)	2.0
Building Materials	1.2
Chemicals	2.5
Drugs	5.3
Electrical	2.9
Electronics	3.1
Fuel	0.5
Information Processing (Computers)	6.4
Information Processing (Office Equipment)	5.0
Instruments	4.6
Machinery (Industrial, Mining, Tools)	1.9
Personal and Home Care Products	2.0
Steel	0.6
Telecommunications	1.2
Textiles, Apparel	0.4

The R&D expenses of surveyed companies were funds spent on company-sponsored research and development as reported to the Securities and Exchange Commission (SEC) on form 10-K. These funds exclude any expenditures for R&D performed under contract to U.S. government agencies. This is important for the textile and apparel

industries since a great deal of R&D is contracted by the NLABS to private industry, both major textile firms and independent laboratories.

The above survey is probably representative of textile and apparel industry R&D spending, even though it covers only public companies and only a small number. Disclosure of R&D spending by privately held companies is not readily available information, but numerous discussions with industry executives reveal that this data may even be more liberal than what an accurate textile or apparel industry composite would be.

Where the R&D funding is going is an equally critical concern for future industry developments, and therefore of interest to NLABS. As was shown earlier in the report, peacetime military textile demand for broadwovens, the largest single textile component category, is less than one percent of domestic production. This production is also a reflection of a depressed industry operating at approximately 75 percent of capacity, indicating an even smaller military demand at full production. If this is the case, there doesn't exist a great incentive on the part of industry to invest large R&D dollars for such a small market. Though the military represents a constant market in that there will always be a demand placed on the industry for textile and apparel products, the military does not manage procurements on a constant basis. This results in fragmented and piecemeal procurements, making it very difficult for the textile firm to plan for return on investment against R&D expenses.

The second major consideration for a textile or apparel company to make regarding R&D expenses directly related to military application is the lack of any basic guarantee that there will be <u>any</u> return on the investment (ROI). Because military procurement of textile and apparel, for the most part, is governed by congressional statutes regarding small businesses, labor surplus areas and minority companies, combined with the competitive bidding nature of these contracts, no single supplier is guaranteed a long-term association with procurement to satisfy ROI requirements.

The textile and apparel industries therefore spend very little toward unique R&D programs that have only military applications and no commercial use. On more than one occasion has a textile firm had an idea with potential military application and sought interest and funding from NLABS. There are cases where NLABS has been able to fund jointly research programs with private

companies, but NLABS funds are generally limited to supporting projects which are already in the system and receive continuous funding through annual appropriations.

Several of the recent developments regarding textile technology for the military have not resulted from R&D efforts related to a military program. The most notable example is the du Pont nylon fiber which is in the 50/50 blend with cotton for the basic cloth used in the battle dress uniform (BDU). This fiber, which happens to contain properties no other nylon derivative can duplicate currently, was developed over 10 years ago and was used in a tri-blend fabric used for children's bottomwear products. The fact that it possesses certain elongation and tenacity properties which make it ideal for military use in this blend for the BDU was essentially a function of matching an existing product to a need rather than the result of any extensive R&D directed to develop a military fiber. The applicable government R&D that was conducted involved protection against high-energy thermal flash.

In summary, there are R&D activities in the textile industry, but most are directed at product improvement rather than pure research. R&D programs directed to military application and funded independently by industry are not widespread and those that exist are often not even known to the military R&D community until completed and successful. NLABS' budget does enable some joint funding of R&D programs with textile companies, and for the most part they are the industry's larger firms who have been conducting business in some fashion with the military for many years. Many textile companies have a corporate staff position to monitor government work and stay abreast of technological improvements that may have potential military application.

D. Technology Trends

1. Textile Industry Response

Previously in this report we have mentioned the restrictions of low profitability and uncertainties of the cash streams generated by publicly owned textile companies on investments. These restrictions are also manifested in the textile industry's response to changes in technology. The trends are away from shuttle to shuttleless weavings, more usage of manmade fibers, less energy intensive fabric formations, energy reduction in finishing and dyeing through processing and changes in chemicals, and wider widths.

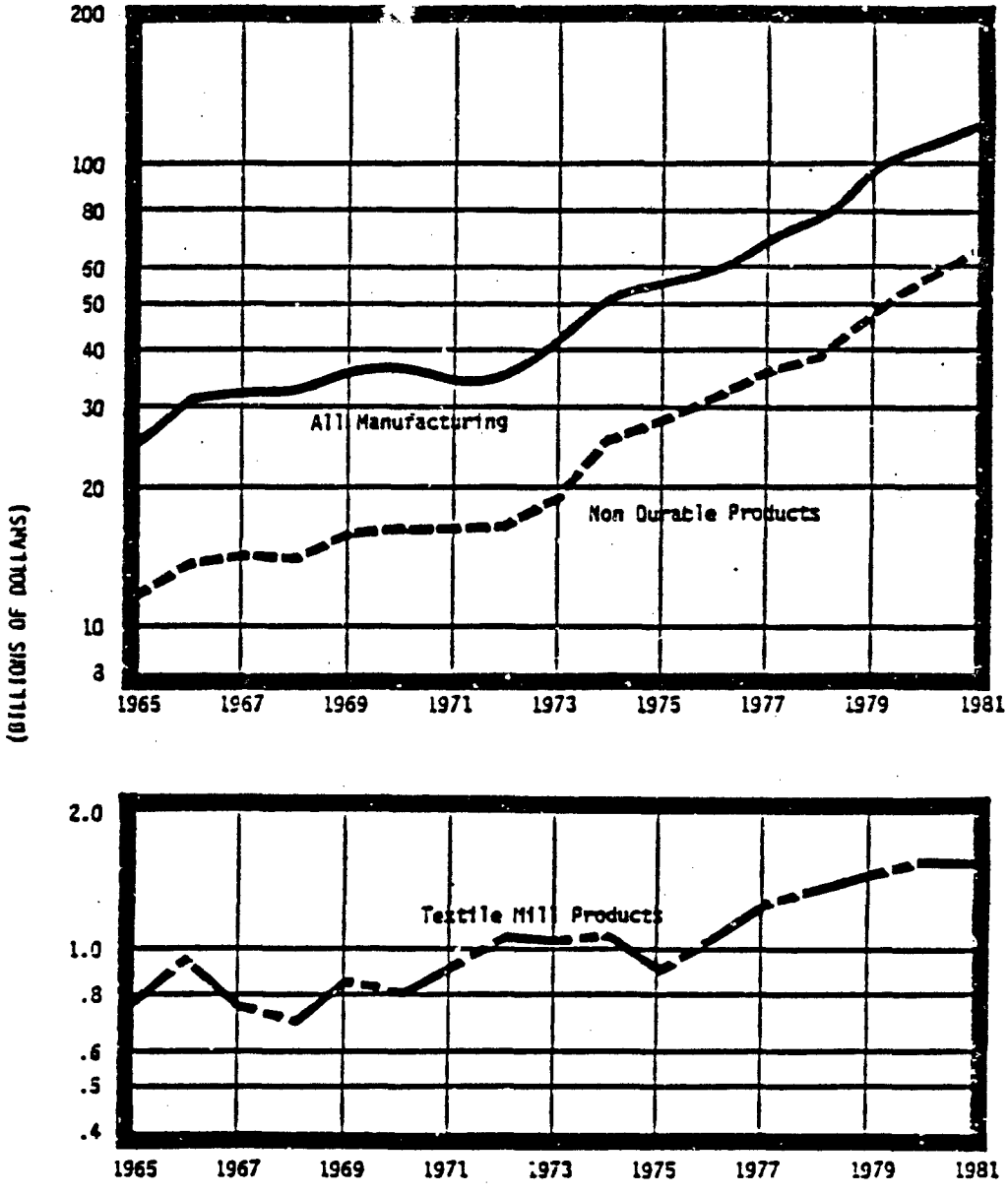
While the textile industry is less labor-intensive than apparel, the technology trends are to reduce further the labor component. As the asset intensity increases, product flexibility decreases. Recent interviews with top managers of textile firms indicate if any significant investments in technology will occur, they will be in the yarn formation areas. The first major overhauls of technology have swept through the fabric formation processes (primarily weaving). Now textile companies, capital availability withstanding, are expanding their technology improvements into yarn formation. The environmental influences of dust reduction, minimizing decibel levels, and preventing the introduction of environmentally hazardous effluents/discharges have forced many textile companies out of certain products (100 percent cotton yarn spinning, vat and acid dyeing, narrow shuttlecock looms).

Recently over 100 textile mills have closed in the five major textile producing states as a result of the recession, technological obsolescence, and workplace/environmental regulations.

During the period of 1977-1980 when the United States retained a controlled price of domestically produced crude oil and the U.S. dollar was relatively weak in comparison to the Western European currencies and the Japanese yen, a mini-boom in textile exports occurred, particularly in MMF derived from petroleum. With the strengthening of the dollar and the decontrol of petroleum, these attractive advantages have disappeared. This market decline has reduced the potential demand for textile products.

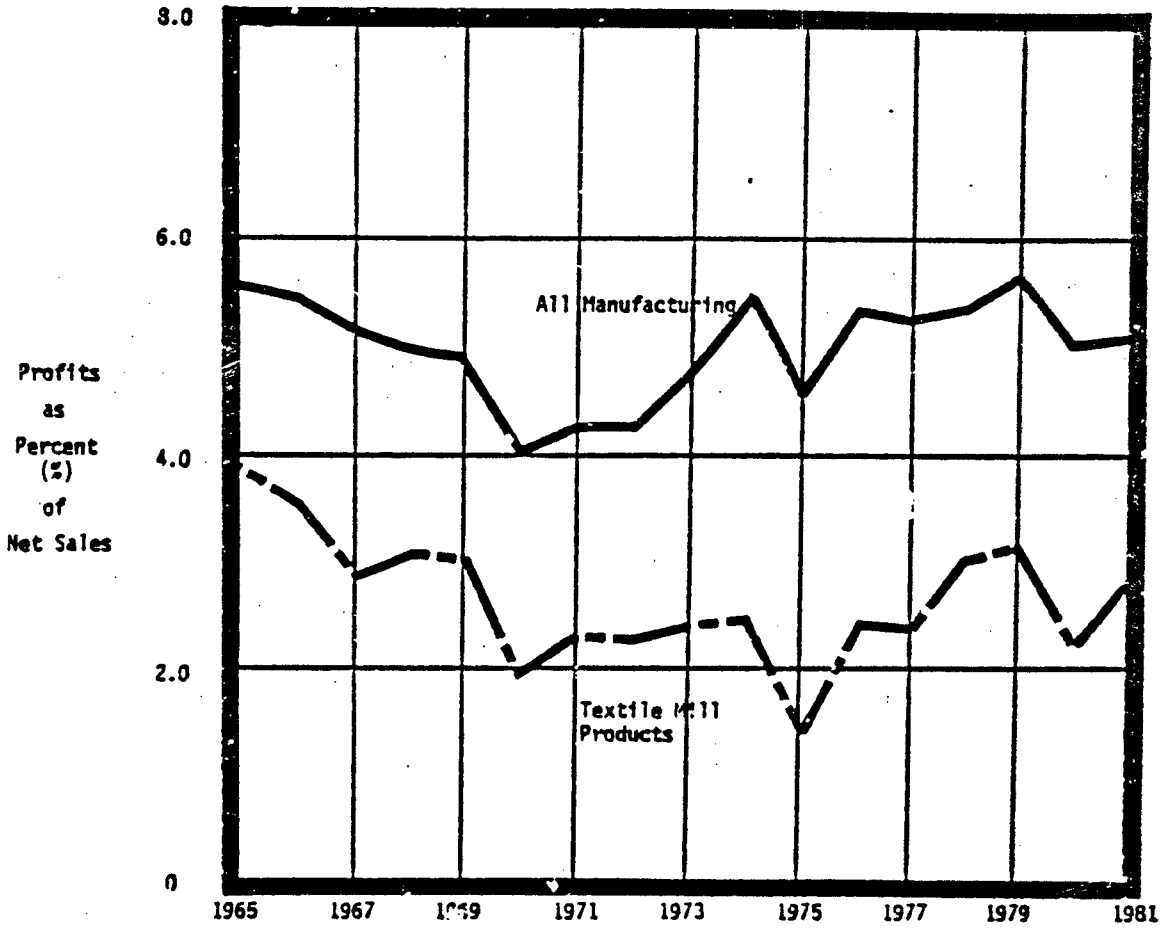
In addition, continuing high levels of finished apparel imports further reduce textile industry demand. Market losses, low value in the public capital markets, and high interest rates on long-term debt substantially reduce the capital available for investments in new technology. Still, the major textile companies are reinvesting in new equipment. Figures 22 and 23 show that despite lower profitability than all manufacturing, the textile industry has accelerated its expenditures on new plant equipment, although at a lesser rate than all manufacturing or other nondurable products.

As the majority of the production machinery being purchased in this replacement of technology is from foreign-owned companies, U.S. influence on the trend of the technology is limited. Growth in textiles is taking place in the less developed countries. A prime example is the Peoples Republic of China (PRC). This nation in



Source: DOC, Bureau of Economic Analysis
March, 1982

FIGURE 22. NEW PLANT AND EQUIPMENT EXPENDITURES



Source: U.S. Army Natick Labs report of December, 1975, 73-50-CE
American Textile Manufacturers Institute

FIGURE 23. CORPORATE PROFIT DATA

the last few years has become a potent source of 100 percent cotton products. Cotton dust standards do not apply there. The technology being used by the PRC is not state of the art, but takes advantage of the labor resource readily available.

The trends in textile technology are evolutionary, as assets do last for over 20 years. Once a company commits to a type of machinery, it cannot readily shift its focus in a short period of time. The use of shuttleless weaving is accelerating the movement to product specialization. Plants dedicated to single products provide the best competitor advantage in the cut-throat commodity markets. Cutting price cannot ensure an increase in demand. Demand is a function of market forces beyond the control of fabric producers.

Military requirements are slow in adapting to the evolutionary changes taking place in textile technology. Industry is not allowed the luxury of idle capacity set aside for sporadic military procurement. The recent decision to let multiple year contracts for worsted woolen GFM indicates the military has realized if it cannot alter its specifications to match what industry is producing for the commercial market, it will ensure that the remaining producers receive enough production to remain in business.

Because the existing specifications are perceived by industry as inflexible, it is difficult for companies to determine where new technology would be applicable. This is apparent from the example of widths in the 36- to 48-inch range with selvages required. Several years have passed since the textile industry has had to shift to 60 or more inches wide to remain competitive, but the specifications for parachute cloth are only now being considered for changes to a different width.

Industry would like to play a larger role in applying new technology to military requirements. To do so would require flexibility from both sides. The government product development process, and ultimately its procurement process, must reflect the realities of the commercial market in which the textile companies operate. Continuity of demand and predictability of orders are essential for planning purposes. With the loss of product flexibility inherent in the newer textile technologies, predictability of peacetime procurement demand is crucial.

Technology trends are determined by factors beyond textile companies control. Lack of a large cash stream restricts investments to those that can achieve a return greater than the cost of capital. The equipment manufacturers are the primary determinants of the form technology is taking. As these are primarily foreign companies, consideration of U.S. military requirements is nonexistent. Government regulations induce less than optimal technological choices to comply with environmental/safety considerations.

Given that the changes in textile technology are evolutionary, the military requirements should be able to keep abreast of the resulting changes in industry capability. Incremental changes are preferable to radical demands in the heat of an emergency. The time is now to improve and hasten the analysis of military specifications in light of changes in textile technology rather than waiting for a contract to not be filled due to lack of industry interest.

2. Apparel Industry Moves Slowly

In contrast to the textile industry, few technological changes have taken place in the apparel industry. In the last 10 years, radical alternatives to sewing fabric into garments have been developed—stitches, seaming, and molding. These alternatives remain laboratory experiments. Automated production of apparel continues to be limited to a select number of manufacturing operations. As in textiles, those developing technology for the apparel industry are not apparel manufacturers. The changes have come from equipment manufacturers. Only one sewing machine manufacturer remains with a U.S. production facility—Union Special. To fully equip a pants plant would require multiple sources (off-shore) of equipment. No single source (manufacturer) can do it all, in-house.

The low margins and high labor intensity which characterize the apparel industry do not provide the incentives to make a move to radical technology. Any changes have focused on reducing labor content (higher operating speeds with new threads resistent to increased needle heat; attachments that reduce operator movements; semi-automated processes—pocket formation, button holing) or better material utilization (computer-assisted marker making; computerized cutting; cutting room incentives).

The development of proprietary apparel products (process related, not brand name) is rare. The benefits of such R&D investment would most likely be derived from the equipment itself. Apparel manufacturers would not be likely to do such development.

While the changes in technology in apparel have moved very slowly (if at all), the alteration of military requirements (in the form of specifications) have moved even slower. Changes appear to be the results of the Value Engineering Program (previously described) where contractors offer construction and material changes to enhance or improve the product.

This type of analysis belongs with the Natick Laboratories, not in a reactive role, but anticipating through interactions with the apparel industry when specifications need to be changed. Any R&D which is taking place is at the equipment manufacturer level. Apparel manufacturers are concentrating on product applications that will generate cost savings or proprietary market positions. These manufacturers react; they are not proactive in developing new technology.

E. Robotics Applications

There are more than 100,000 industrial robots operational in Japan, which account for an estimated 70 percent of all robots in the world. A projection by PREDICASTS, INC. is that by 1995 there will be 315,000 robots in operation in the U.S.

There are no industrial robots in the U.S. apparel industry, and less than a dozen true robots operational in textile mills. There is tremendous potential for robots in both industries, but the main reason they are not present is the lack of automatic fabric handling systems for sewing processes.

Even in Japan the Ministry of International Trade and Industry (MITI) will conduct a $60-million, seven-year program to promote apparel robotization. The Government will foot the initial bill, with the hope of encouraging participation of apparel and textile manufacturers in later stages.

Robotics potential is best illustrated by the reasons Japanese management favors them:

- Robots provide substitutes for skilled labor.
- Robots neither organize labor unions nor go on strike.
- Robots can work 24 hours a day if required.
- Robots can produce products of equal quality.
- Robots can contribute to cost reduction.

Robotics applications in the U.S. apparel industry are being considered. The entire topic of robotics was featured at the 1982 Bobbin Show, where representatives from three of the top U.S. robotics companies discussed their product from several viewpoints. Given the low level of R&D spending associated with the U.S. textile and apparel industries, it is generally agreed that any major robotics application on research will result from joint government/industry programs. However, there is no collective interest yet in the U.S. apparel or textile industries.

Robotics applications in the textile industry are operational for palletizing yarn spools. There is probably more direct potential in the textile industry than apparel, where the main issue is fabric handling and positioning. The textile industry will most likely not fund any R&D for a generic application, but individual companies may hire engineering firms to assist in the design of a specific machine for a proprietary task.

The next 5 to 10 years will see some attempts to apply robotic technology to both the textile and apparel industries, and any initial successes will provide the incentive for mass interest. NLABS is in an excellent position to be involved with early R&D work in robotics, as ultimately any improvement to the mass production techniques for apparel will benefit CIE product sourcing in the event of mobilization. This is an area where NLABS should take the lead and in conjuction with industry establish a direction for the apparel industry.

F. Apparel Construction Alternatives

This topic is similar to robotics in that there is not much combined industry support for joint efforts to improve these techniques and make them available for standard garment production. However, for NLABS' concern for mobilization, these alternative construction methods could be one important aspect of obtaining mass-produced CIE items in the shortest possible time frame, thus reducing the dependency and cost associated with inventories.

These alternatives to apparel needle construction are basically stitchless seaming techniques, the primary ones being ultrasonic seaming, gluing, and molding. The technology associated with all three of these techniques is available in the apparel industry, and activity related to these techniques has occurred for almost 10 years.

- In 1974, the now disbanded Apparel Research Foundation (ARF) of the AAMA and Georgia Tech co-sponsored the First International Symposium on Molding Apparel Fabrics.

- In 1974, mattress pads were being manufactured totally threadless by an ultrasonic cut and seal system.

- Japanese manufacturers in 1974 were to market ladies' knit dresses which were completely constructed through a molding process, patented by the Germans.

- Direct spray garment manufacturing was patented in the early 1970's, with layers of fabric sprayed onto a mold and colors set with ultra-violet systems.

- Molding of complete garments was considered a trend in the early 1970's with patents on dresses and men's slacks.

The state of the art, however, does not seem to have advanced much beyond what appeared to be a very interested industry. Whatever the reasons, the technology has not been promoted by more than single companies who have deveoped proprietary stitchless joining techniques. If a complete, or 85-percent-complete, garment with exact fiber content controlled, with different finishes capable of being applied to the inside and outside, with stretch exactly where the designer wants it, could be produced with a molded process and no degradation of finished fabric properties guaranteed, one would think that there would be certain defense interest and investment in such a process. Again, NLABS is in a proper position to encourage additional work in that area, through academia or independent laboratories, or research companies. The apparel industry will most likely not take the initiative due both to cost and the implications to the structure of the industry.

G. Five- to 10-Year Needs

1. Nonwoven Applications

Traditionally, nonwovens have been used in industrial and consumer markets for disposable products. The chief market entry advantage was as a replacement item having similar performance characteristics with a lower price. The proprietary product, PAMPERS®, developed and marketed by Proctor and Gamble, is the most successful consumer product introduced in recent history. This disposable baby diaper (with a nonwoven liner) annually generates in excess of $800 million in sales for P&G, more than any other single P&G product.

Industrial nonwovens are shifting their emphasis to semidurable and durable applications. Geotextile fabrics for roadbed stabilization, erosion control, and foundations are a rapidly growing market. In the safety

market for protective clothing, nonwovens are making noticeable advances. Nonwoven manufacturing as a continuous process technology accrues its major benefits from long production runs.

The processes used currently are not new. The technology is well known with many adaptations of an evolutionary nature taking place. Combining processes, as in the spunbonded/meltblowns/spunbonded laminates, have produced some very attractive performance characteristics in new fabrics.

For manufacturers, the attractiveness of a market for nonwovens will incorporate many characteristics:

- Opportunity for proprietary products (presently in finished goods primarily, especially consumer products)
- Evolutionary product developments
- Long production runs
- Long lead times and predictable demand
- Performance specifications not defined in terms of fabric construction (i.e. warp/fill tensile strength)
- Growth.

The aspect of growth is critical for considering a market attractive for nonwovens. The technology process is limited to the type of product that can be produced. These constraints often restrict the type of manmade fiber that can be extruded. Companies in the industry must make asset purchase decisions as much as 36 to 48 months in advance of production. Market planning requires similar time frames. The production life of the assets can be 15 to 20 years. Without the prospect of growth and proprietary product margins, it is difficult for publicly owned companies producing nonwovens to commit shareholder money to markets.

Nonwovens are attractive for military needs for the following reasons:

- Rate of production is very high compared to weaving or knitting
- Generally a lower cost-per-square-yard equivalent

- Response time allows a reduction of finished goods stock in anticipation of mobilization needs (reduced budget requirements and less product obsolescence)

- Light weight.

However, nonwovens rarely appear as one of the textile components in the list of items considered by this study. Fusible nonwovens are a standard component in tailored clothing, not utilized before to any great extent in the military dress uniforms we analyzed. It appeared in men's and women's all weather dress coats for the Marine Corps. Nonwovens (fusibles) also were included in neck tabs, hot weather sun hats, poly cotton shirts, and an enlisted man's raincoat. With the world-wide consumer acceptance of nonwovens in apparel and tailored clothing, one wonders why its use is so limited in U.S. military clothing.

While the military finds nonwovens attractive, there are several fundamental dissymmetries that must be addressed.

a. Military Requirements for Reliability and Performance

Military clothing and equipment are designed to support the mission of the soldier, etc. For combat-essential items the performance parameters are very strict. The three categories—critical, essential, and desirable—are especially applicable for product characteristics. Nonwovens, by their nature, are random fiber constructions designed to achieve performance within a range. This range is of such width to make nonwovens unacceptable for most uses in the aerospace industry. For combat missions, the reliability of nonwovens again makes them less attractive. An area where nonwovens are under strong consideration is in tentage fabrics. The needs met by tents and tarps are readily defined and well known. Nonwovens offer fast response time in event of mobilization needs for tentage and tarps. Presently, large stockpiles of tents and duck fabrics are required based upon the experience from World War II and other more recent conflicts. Demands for tents increase rapidly at the beginning of a mobilization (for training and initial field operations). Demand declines to a replacement level long before the end of the conflict. With nonwovens, stockage levels would be

reduced; the actual tents and tarps would be significantly lighter in weight; the MMF would obviate mildew and flame-retardant treatments and would "breathe," allowing moisture exchange with the environment.

Another area where performance characteristics are broad enough to consider nonwovens is in parachutes used for air delivery of cargo (nonhuman). Presently, the military is conducting a study of its requirements for air delivery. The Southeast Asian conflict revealed the problems of airborne replenishment of troops in the field where field recovery of the parachute was not possible. The air-delivery parachutes are designed for multiple use. The nonwovens being tested have the advantage of limited use (disposable in essence), low cost, and light weight (more cargo per plane load).

Unfortunately, the military has not analyzed item specifications for critical, essential, and desirable characteristics as they apply to the component parameters. Were this available, industry could efficiently discern multiple uses of nonwovens meeting certain ranges of performance.

b. Specifications are Developed to Define Woven/Knit Fabric Constructions

With this barrier, it is extremely difficult for a nonwoven producer to anticipate opportunities for product substitution, let alone product enhancement. The nature of the nonwoven technology described earlier requires performance descriptions as attributes, not woven fabric performance descriptions. Military procurement is not designed to encourage product evolution. Once a specification is in place, getting changes approved is a lengthy process. The Value Engineering Programs, administered by the DCAS, allows current contractors for a specific product to offer suggestions for improvements in an item specification (material and construction). A company not involved in an item or with the procurement system is virtually precluded from influencing a specification change. The Natick R&D Laboratories do offer an entry point for new products. However, limitations of budget, mission, and existing priorities can reduce the attention NLABS is able to give companies with new ideas.

NLABS could be instrumental in redefining performance in specifications in two critical ways:

(1) NLABS could assign discrete aspects of product specification to achievement of the items' mission.

(2) NLABS could define performance by attribute rather than construction description. This would open up consideration of alternatives which meet the performance criteria. Nonwovens are a different construction with different tests valid for proving performance.

c. Inconsistent Procurement Process for Predicting Volume and Longevity of Contracts

DPSC is restricted in most cases to contracts of less than one year. Volumes are not projected beyond four quarters. A potential contractor of a nonwoven fabric would be unable to ascertain from DPSC what the historical consumption of certain textile components had been. In fact, one company interested in supplying a new fabric for tentage was unable to find out from DPSC how much tentage material was being procured. This reflects the continuing problem mentioned many times in this report. Planning appears somewhat outdated, reflecting needs and missions from the past. The level of detail goes to the end-use-item level; whereas consideration of the process chain is only done when components are GFM. This situation makes it almost prohibitive for a potential nonwoven contractor from considering offering a substitute for a woven/knit product. His suggestion will be judged by woven/knit specifications. He will not be able to find out what his potential volume might be. He will not receive any special consideration for his product development efforts—all contracts are competitively bid. He may be precluded from offering his product through response to a bid because he may be too large a company. These issues do consider the basic understanding of NLABS R&D responsibility and DPSC acquisition.

Certainly, a producer with the prediction potential inherent in the nonwoven process would need to plan his production in advance. This is effectively blocked by the short-term focus of DPSC procurement cycle. Frequently, contracts for GFM vary radically from one year to the next. Historical analysis would provide a reliable estimate of the basic GFM fabrics purchased, on average, year to year. This lack of continuity is one of the most serious

drawbacks mentioned by the limited number of textile mills even considering doing work for the Government. Continuous process technologies provide benefits from continuous operation. The disjointed procurement process actively works against reaping the benefits of nonwovens.

d. Specification Limitations

Government Procurement Regulations prohibit the inclusion of a brand name product in a specification (all descriptions must be generic). This is of particular importance for understanding the limited role nonwovens are playing currently in military products and why they may be restricted in the future. The R&D expenditures of nonwoven producers are focused on evolutionary changes of existing products—product application. Dollars usually flow from annual budget cycles. Corporate consideration of investments in a market possibly over a multiple-year period require believable estimates of potential volume, substantial margins to cover real-time development costs, and longevity of product appeal. These three criteria are not met by military product needs.

Support of substantial margins comes from some form of exclusivity such as proprietary design, but the specification process seeks to deny a contractor these substantial margins. Thus, a contractor becomes involved in consideration of supply of a military need from the point of view of "least disruption—minimal product alterations" as the military needs would be a distant second to the commerical product opportunity which sparked the initial R&D efforts.

Taking the case of developing a nonwoven product as a protective garment to be used in chemical warfare, one readily perceives the problems in industry taking a lead. The mission would take serious evaluation by each combat branch of their services. Then these missions would be translated into a format of evaluation for materials, utilizing past experience. Amounts to be required would not be known. A nonwoven producer may become very frustrated with the slowness inherent in the Government's decision-making process. As a contractor's planning process follows the dictates of the commercial market, he cannot prudently delay asset discussions because the Government can't reach a conclusion.

Shifts to a nonwoven could remove the need for contractors of the material being replaced. These contractors, by virtue of the political system's interaction in the procurement process, could delay the decision or seriously alter the specification to include provisions for "either-or".

Uncertain returns, limited volumes compared to the commerical market, lack of continuity in procurement, and viability to protect proprietary positions indicate nonwovens will have minimal impact on military requirements.

The problems lie with the Government system itself. Until these problems are solved or substantially reduced, product substitution from existing lines will be the dominant role for nonwovens. The growth of nonwoven applications will soon illustrate their flexibility and cost effectiveness for military consideration, but the industry will not be eager to become involved with military specifications without substantial prccedural changes.

2. Improved Fiber Usage

The next 10 years will bring developments in specialty high performance fibers, many of which will have military applications at some stage of development. NLABS will continue to search for improved fiber constructions for chemical protective clothing and possible laser protective garments. NLABS should not expect any new manmade fibers, as textile companies do not spend R&D for pure research as much as for applications research. NLABS is in a position, however, to take advantage of R&D conducted by other government agencies, such as NASA, in conjunction with fiber companies, remembering to establish specification demands that will derive the maximum capacity from industry.

In this regard, NLABS' role should change from an agency that reacts to external requests for new or improved products to an organization that works constantly with industry to increase the capabilities of fibers and fabrics available for military use. NLABS has no counterpart organization and also has no charter to necessarily be reactive. NLABS has demonstrated some efforts in this area through issuance of improvements required for products or textiles.

3. Apparel Mass Production

The next decade will see some attention to the alternative construction techniques described earlier. If

the initiative is not taken by the U.S. apparel industry, robotics and stitchless seaming will have an impact on the industry through imports from foreign countries which have made a commitment to mass production of apparel items. Many countries do not enjoy the same labor and industrial "givens" on which our industries are based, and the countries' incentive to increase market share may lead them to utilization of these alternative methods.

It may be that none of these techniques will ever attract the apparel community because of perceived loss of fashion flexibility generated by today's fabrications. However, the case can be made that NLABS is not in the business of following fashion and can, therefore, take that initiative and pull the industry into acceptance of some or all of the improved mass production alternatives. To do this, NLABS budget for IPL R&D requires considerable upward adjustment.

VIII: CONCLUSIONS AND RECOMMENDATIONS

In the process of research for this study, KSA has become aware of numerous activities having an impact on the entire management of textiles, clothing, and equipment by the military. Before study conclusions and recommendations are presented, these activities will be listed, partially to illustrate the complexity of dealing with total mobilization considerations for textiles and clothing. KSA is convinced after this total review of the current system, that steps are being taken by the Army to improve the overall commodity control of textiles and apparel, and most importantly that NLABS occupies a unique position both with respect to time and organization to have a significant impact on the preparation of the textile and apparel industrial base for the next mobilization.

A. Actions Prior to Study

1. Kennedy Report Versus Industry Involvement

As part of the comprehensive approach taken by this study, we investigated past projects, studies, and other analytical efforts done in this and related areas. There are obvious benefits to be garnered from not duplicating valid research in investigating issues relating to industry capability to meet national defense needs.

A pioneering effort in addressing the issues relating to textile and apparel industry capability was done by Dr. Stephen Kennedy at the conclusion of a long career with the CIE area of the Natick R&D laboratories, spanning three major conflicts in his service to the military procurement system.[7]

Dr. Kennedy used historical data to project what might be industry problems in the future should another mobilization be required. Having lived and worked through the three conflicts used as the database for his analysis, Dr. Kennedy could bring his personal insights to his recommendations. However, given the limited time available to Dr. Kennedy in completing this "first of its kind" analysis, the textile and apparel industries were not able to provide the breadth of assistance to Dr. Kennedy they would have liked.

Consequently, the industries addressed in the report were surprised by some of the conclusions and recommendations of Dr. Kennedy's report. This study generated significant interest on the part of Congress, DoD, and the textile/apparel industries. The present study is a direct result of the effort begun by Dr. Kennedy.

This study was more comprehensive in scope than Dr. Kennedy's, as it utilized extensive industry participation. With the adequate time frame, substantial resources in both Government and industry were tapped. However, the sheer magnitude of textile related CIE items necessitated using a sample generated by NLABS to analyze against industry capability. The conclusions and recommendations to follow are a consensus, and should be updated through timely monitoring of the industries involved. The capability of an industry to respond to national defense needs is dynamic and it should be factored accordingly into mobilization base management.

As changes take place in technology, fibers, processes, and industry structure, the conclusions to follow will change, just as changes took place in the nine years since the completion of Dr. Kennedy's study. Having the extensive industry cooperation, we believe our recommendations assess needs for the next 10 years in the ability to meet national defense needs.

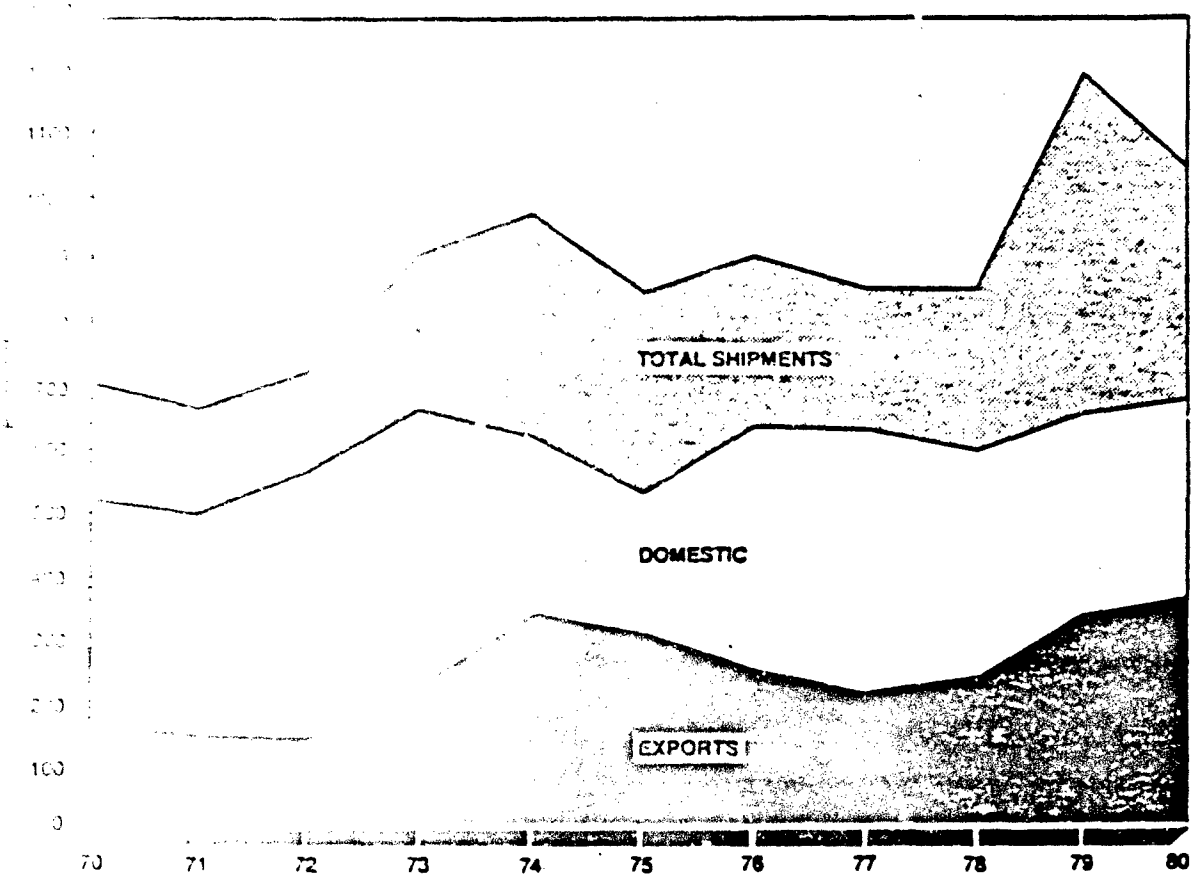
2. DOC Study on U.S. Textile Machinery Industry

The Department of Commerce commissioned a study of the U.S. textile machinery industry to improve this industry's domestic and international competitive position within a five-year period and to increase the industry's viability (as a provider of employment and technology). This analysis was completed in 1980.

Briefly, the study concluded that the U.S. textile machinery industry had declined precipitously in the last 20 years, abdicating its former position of technical leadership and trade reputation. Loss of domestic markets has occurred to the extent that no single domestic mill uses 100 percent U.S.-made equipment. (See Figure 24.)

Causes cited for this decline include lack of product development and technological innovation; absence of dynamic managerial and engineering talent; foreign aggressiveness (with government support/subsidies) in key machine sectors both technically and in export markets; and U.S. government policies and regulations that have contributed to the noncompetitiveness of the U.S. industry.

The overall assessment was not optimistic. Without immediate direction and help, the study felt that the survival of the U.S. textile machinery industry was questionable. In reaction to the projections of the



Source: U.S. Department of Commerce

	TOTAL SHIPMENTS	DOMESTIC	EXPORTS
1970	$ 712,000,000	$524,000,000	$188,000,000
1971	672,000,000	506,000,000	166,000,000
1972	738,000,000	573,000,000	165,000,000
1973	917,000,000	678,000,000	239,000,000
1974	987,000,000	630,000,000	357,000,000
1975	861,000,000	544,000,000	317,000,000
1976	918,000,000	649,000,000	269,000,000
1977	867,000,000	639,000,000	228,000,000
1978	870,000,000	606,000,000	264,000,000
1979	1,222,000,000	670,000,000	354,000,000
1980	1,060,000,000	690,000,000	370,000,000

FIGURE 24. U.S. TEXTILE INDUSTRY CONSUMPTION OF TEXTILE MACHINERY

study, the American Textile Machinery Association (ATMA) has sought to adapt to the foreign penetration of the U.S. domestic markets. A significant proportion of the new textile machinery being installed today in the United States is of foreign origin. Since it will take three to five years for current conceptual developments to reach commercial fruition, the U.S. industry is being encouraged to focus its efforts on those areas where it maintains a viable position, i.e., dyeing and finishing. The scarce resources should not be squandered in attempts to continue competition in areas dominated by foreign manufacturers—primarily shuttleless weaving and spinning. (See Appendix DD.)

For assessment of the textile machinery industry's capability to respond in a mobilization, the ATMA includes all domestic plants owned by foreign textile machinery manufacturers. In essence, ATMA has accepted into its association these companies as their domestic production does provide jobs and continued viability of the industry (although not U.S.-owned).

Our study found the DOC analysis educational and did not find evidence in the last year to alter materially its conclusions and recommendations. Survivability remains the focus for domestic machinery manufacturers. Though the primary DOC recommendation was for the U.S. machinery industry to develop and expand markets in developing nations, the magnitude of this objective involves a coordinated effort by the entire industry. ATMA is not in a position for many reasons to spearhead such a comprehensive marketing operation, though they are prepared to commit resources toward that end.

3. Other actions that occurred prior to this study and have also been mentioned in the body of the study are as follows:

   - CACI Study which highlighted the shortcomings of the present commodity management control system for textiles and was instrumental in the establishment of the CMO-CIE at DARCOM.

   - ARF work in stitchless seaming techniques, which brought to light significant technology associated with these methods and generated initial interest within the apparel industry.

B. Actions Taking Place

1. DARCOM Clothing office has established the CMO-CIE, started in early 1982, which will have a significant

impact on how the entire system, of which NLABS is an integral part, will function in the near future.

2. TSARCOM Mobilization Study for Aerial Delivery Equipment was requested by DA in an attempt to establish for the first time since late 1960's some reasonable expectations of aerial delivery equipment demands for mobilization. This study has obvious significant impact on the overall commodity management of parachute textile components, a direct function of DARCOM and DPSC. The present system of logistical planning for aerial delivery equipment is inadequate and not based on current contingency planning. (See Table 60 and 61 stockage and demand numbers, plus estimated parachute cloth production.)

3. House Appropriations Committee (HAC) Study on Clothing and Textile Procurement Policies was generated by a Congressman who received a document submitted to the commander of DPSC by one of the AAMA subcommittees. The document contained information from the apparel industry relative to the management of the current procurement system for clothing and equipment.

4. DA Study on Training Base Capability is directed by TRADOC and intended to determine the actual capability of TRADOC installations to train Army personnel in a mobilization situation. The results of this study may be very revealing when compared to DA training requirements established for TRADOC.

5. DoD has interest in reducing depot stockage levels. This interest is at the highest level in reducing dependency on war reserve stockage of all commodities due to costs, item deterioration, obsolescence and logistical constraints. This gain represents a critical element in NLABS planning for R&D in the next 5 to 10 year time frame, where there will be opportunities to consider alternative apparel constructions.

6. ASTM has made efforts to incorporate test methods and product standards to military procurement items. An ongoing effort by ASTM will publish support from DoD to encourage this trend and reduce proliferous military specifications. Again strong implications exist for both Natick and the new CMO-CIE office at DARCOM, both of whom should take the initiative to cooperate with industry.

TABLE 60. AERIAL DELIVERY EQUIPMENT AS OF AUGUST 1982
STOCKS AND DEMAND

Model	Description	Unit Level	Depot Level	Peacetime Stockage Total	Average Monthly Demand (AMD)	Peacetime Annual Demand (PAD)
T-10B	PER, TRP, Back Personnel, Troop, Back	7,117	3,876	10,893	192.21	2,306
MC1-1B	PER, TRP, Back	31,526	3,784	35,310	224.77	2,697
T-10R	PER, TRP, Reserve	38,553	7,000		388.78	4,665
G-11B	Cargo	1,202	461	1,663	15.22	183
G-12D	Cargo	4,880	1,367	6,247	105.37	1,264
G-14	Cargo	19,675	6,517	26,192	99.31	1,192
15FT	Cargo, Extraction	1,240	1,706	2,946	43.35	520
22FT	Cargo, Extraction	1,255	299	1,554	6.66	80
28FT	Cargo, Extraction	647	358	1,005	17.43	209
A-22	Bag	8,000	980	8,980	62.87	754
A-23	Bag	0*	280	280	2.39	29
A-7A	Sling	3,300	17,600	20,900	88.66	1,064

* No longer used at unit level.

TABLE 61. ESTIMATED PARACHUTE CLOTH PRODUCTION

Approximate Total Fly Shuttle Looms In U.S.A.	27.3% of Total Broadcloth Looms With Appropriate Widths	Expected Loom Efficiency	Maximum Filling Ends/Inch	Loom Speed	Linear Yards/ Loom/ 24 Hours	Linear Yards/ Loom/ 7 Days	Square Yards/Looms 7 Days @ 40" Width	(X 1,000) Annual Square Yards For Total Looms
45,500 or or 27.3% of Broadcloth Looms	31,941	88%	120	180	52.8	369.6	410.7	655,908

7. DoD interest in logistical determination—reference to the Army Logistics Agency (ALA) at the Pentagon, which has established a sophisticated (and classified) computer model for war-gaming the next conflict completely in terms of logistical planning and support. Clothing and Individual Equipment (CIE) represent one of the 28 logistical "war stoppers" employed at 10-day increments to determine sustainability and criticality levels. Both that agency and this study have implications on NLABS' ability to interface with defense planning and logistical considerations for CIE.

C. Conclusions

1. Comprehensive, Coordinated Planning of Military Clothing and Equipment Requirements (in Peacetime or Mobilization) does not Exist Within or Among the Five Services.

- Services show lack of consideration of requirements of industrial chain to produce combat-essential finished goods.
- There is an absence of "Bill of Materials" for consolidation of component materials needs.
- Minimal coordination among services causes duplication of R&D facilities.
- Planning horizon for CIE is one fiscal year focusing on aggregate dollar amounts, not unit volume.
- No data are readily available for tracking historical demand of all defense-related clothing and equipment requirements to forecast need.

2. Military Clothing and Equipment Requirements do not Reflect a Significant Demand on the Textile or Apparel Industrial Base.

- Military is less than five percent of current U.S. fabric/apparel production; negligible proportion of the textile and apparel industrial bases.
- In spite of the above fact, significant shortfalls occur in procuring military items.
- Use of peacetime procurement to facilitate social goals restricts contractor base of military production experience.

3. Certain Textile Products or Processes Involved in Military Demand May Present Problems for The Textile Industry Under Full Mobilization Conditions.

Potential problems:

- Sole source proprietary fibers;
- Very heavy ducks used in tents, tarpaulins, and vehicle upholstery;
- Finishing processes and chemicals (FWWMR, IR specifications, colorfastness for dress uniforms);
- Fiber producers of proprietary fibers are developing contingency plans to handle a rapid escalation of production;
- Substitution of nonwovens for heavy ducks and non-personnel related parachutes;
- Off-shore sourcing of several raw materials is used in specific military finishes for
  - —colorfastness
  - —fire, water, weather and mildew resistant
  - —FR
- Specification adjustment is expected response by producers to a rapid increase in demand.

4. Clothing and Textiles Require More Centralized Commodity Control to Improve the Industrial Base Response and Expand Interest in Military Production.

- A centralized control would improve:
  - —industry awareness
  - —need identification (from services)
  - —product design
  - —performance monitoring (individual service)
  - —long-range planning
  - —environment of trust and cooperation
- Textiles and apparel are strategic commodities.

5. The Development Process of Clothing and Equipment Specifications and Procurement Inhibits Efficient Product Improvement.

- Primary agency does not initiate activities.
- Budget limitations restrict response to requests.
- Administrative intricacies frustrate industry participation.
- Lack of incentive to initiate product improvements causes next war to be fought with clothing and equipment designed for the last conflict.
- Coordination is hindered by systemic dysfunctions.

6. Production Specifications are too Restrictive, Lacking Identifiable Relationships Between Product Component Requirements and the Item's Critical, Essential and Desirable Characteristics.

7. Textile and Apparel Industry R&D is not Related to Responding to Military Requirements. Specific Projects will be Undertaken Under Paid Contract through Government Initiation.

8. Natick Labs Should Become the Central Coordinating Agency of all Department of Defense Clothing and Equipment R&D with Control of Allocations to Provide Maximum Resource Utilization Benefits.

D. Recommendations to DoD

1. Consider Procurement Process Changes to Expand Military Production Experience in U.S. Apparel Industry.

Alter the procurement eligibility requirements to expand peacetime military production experience to include companies that can bring substantial capacity to bear in response to a military need. The present system involves several contradictions to the goal of developing significant industry capability to respond quickly.

The system is to reflect these sugggested goals:

- build a broad experience base representing sufficient capacity to meet projected mobilization needs;

- o maximize short-term production potential through current contract familiarity with military clothing and equipment items;

- o reduce present risk of apparel industry's lack of familiarity with military specifications;

- o emphasize involving apparel companies that represent capacity to produce specialty clothing and equipment products that have a large mobilization requirement.

It is critical for DoD to achieve access to a larger portion of apparel industry capacity. In textiles, present fabric contractors represent some of the largest textile companies in the U.S. Thus, the capacity and production experience problems are of less concern. This is not the case in apparel. The restrictions of the size of the company allowed to bid, short-term contracts, and lack of procurement continuity have kept present contractor experience in the apparel industry to 150 to 200 firms, the majority of which focus almost entirely on military production.

2. Increase Utilization of ASTM Standards in Military Clothing and Equipment Specifications.

This includes test methods and products. Industry benefits by having a recognized standard applicable not only in commercial markets, but also in military production. This standardization will provide a common entry during the rapid production assimilation required in a mobilization. It will also make it easier for new contractors to participate in the military procurement system, reducing the barrier to entry present in a separate set of Federal standards.

The implementation of this recommendation begins with NLABS' development of an item specification. ASTM standards should be used. To assist with the transition from separate Federal standards to ASTM, both applicable sets would be allowed, phasing out the Federal set over time. Currently, ASTM test method standards could not be substituted completely for Federal Test Method Standards in the GSA document No. 191A.[23]

However, expanding ASTM standards by incorporation into product specifications would lend credibility. Another industry benefit of such a program would be in product quality and performance differentiation against a recognized level of achievement. Additionally, domestic apparel industrial products with recognized ASTM quality standards may have more market appeal than imports not bearing equivalent production standards.

3. Expand and Accelerate the Commercial Item Description (CID) Program.

A quick response to military Clothing and Individual Equipment (CIE) needs in a mobilization is required. The situation of having military specifications and commercial products with nearly identical performance characteristics is illogical. The CID program needs to be brought forward to the inception of a CID item specification. This is a role for NLABS to perform in maintaining close relationships with industry, testing available items for applicability and reviewing current specifications for revision to rationalize them for CID opportunities.

This program has begun with several items under consideration, but the speed of this effort is not a function of industry response since the products are already commercially produced.

4. Improve and Expand Industry Participation in Development of Military CIE Items.

Through early inputs from industry, NLABS and other specification writing agencies can tap the broad experience base of the textile and apparel industries. Future procurement and mobilization planning problems would be reduced significantly as a result. Sole-source suppliers for components can be avoided by better understanding evolutionary changes in requirements that do not impair combat performance but open up large capacities to respond. This must happen at the early stages of CIE item development. Rather than industry providing suggestions after the fact, call upon them at the beginning. The limited size of the military market does not encourage industry activity independent of government initiation. This is particularly true with respect to the apparel industry, where such a small segment is involved with military contracting.

5. Expand Nonwoven Consideration to Include Equipage Items.

Equipage items involve assembly/fabrication processes requiring special needles, sewing machines, and attachments. The available capacity in place is limited in its ability to rapidly expand production in a short-term mobilization demand sequence. Shifting a strong product applications program using nonwoven replacements for textile components would provide alternatives in item fabrication. These results may indicate opportunities for item formation through molding.

Nonwovens used in a molding process for non-life-and-limb equipage items would have the benefits of a rapid response in large item volumes; attractive weights-to-strength ratios; and resistance to mildew, flames, and moisture. This program would be administered by NLABS looking for any application in equipage for nonwovens. The first step is analysis of all specifications for non-life-and-limb items for substitution opportunities. The nonwoven industry has technology that is applicable. The burden of responsibility lies with NLABS to work with industry in developing these synergistic opportunities.

It is understood that nonwoven activities generated by NLABS are in process for some aerial delivery and tentage considerations. These products are obvious for consideration as their requirement for significant textile usage impacts on industry response time. The same response time is the key factor for expanding consideration to small and noncritical articles of individual equipment. All items should be included in initial consideration, with appropriate industry participation.

6. Provide Government Sponsorship of Joint Research on Stitchless Joining and Molding.

The technology for stitchless joining and molding has been available in prototype form for several years. It has aroused limited interest in the apparel industry, as this approach represents a revolutionary shift from current practice. Government sponsorship for a product (military CIE items) that is seen as low risk by manufacturers would be instrumental in developing awareness of the process and its potential.

The military would be able to field-test items in a manner industry cannot readily duplicate. A large, brand-name producer would hesitate risking consumer dissatisfaction with a revolutionary concept. The military market would insulate manufacturers from this risk. As the technology was proven to be effective, it could be included in specifications. The broadened experience base would foster gradual acceptance in the apparel industry. This would provide a substantial boost in response turnaround time for this labor-intensive, fragmented industry.

Though the technology is available, not a significant portion of the apparel industry is oriented toward mass production through loss of fashion flexibility. The benefits for mobilization planning far outweigh the losses to the industry.

7. Reorient GFM Procurement to Focus on Those Textile and Related Materials Critical for National Defense.

Peacetime procurement eligibility restrictions should not be the de facto guideline for the GFM program. Short-term contracts, lack of procurement continuity in quantities, and noninclusion of critical items have all contributed to the problems with GFM. Matching mobilization needs with appropriate units of industry capacity (both textile and apparel) would alleviate many bottlenecks. Ultimately, the adjustments must be reflected in the material and CIE item specifications themselves through critical reevaluation by Natick Labs and other authorities.

Matching long-term contracts for GFM with industry contractors having sufficient capacity to respond would reduce the costs associated with storage of materials, deterioration of inventory, and product obsolescence. As much consideration given to dress uniform fabrics as GFM should be extended to those fabrics involved with critical items of CIE. Those fabrications which represent no problem from either a production or capacity standpoint should not be made GFM, but planned producer procedures should continue.

One questions the inclusion of fabric for dress uniforms in the GFM program. Dress uniforms, by definition, are not combat-essential items. In a mobilization, industry resources would not be focused on providing these desirable aesthetic items. In peacetime, however, these fabric specifications require special dyeing properties that involve commitments by some finishers to consider only military contracts.

8. Adjust Procurement Process to Include Long-Term Contracts for Appropriate Apparel Items.

The first step in implementing this recommendation is to develop an historical database relative to demand for military clothing and individual equipment items. Obvious items would appear suitable for long-term procurement planning. A long-term contract would encourage industry interest in matching production to military requirements.

The present eligibility requirements for bidding contradicts the potential advantages of this recommendation. The set-aside programs ignore mobilization planning, focusing instead on short-term peacetime benefits. The concept of using small apparel companies does not

contribute to increases in industry capability to respond to military needs. To participate in the program, a company must be a going concern, producing an item similar to the one in the contract up for bid. This restriction does not increase domestic employment. At best, it shifts employment from one producer to another. Only 150 to 200 firms out of nearly 15,000 supply the bulk of military CIE. The restrictions on size work against efficiency.

To achieve the benefits of long-term procurement contracts in apparel, a reevaluation of the set-aside program must be undertaken. It is our opinion that few of the major concerns currently expressed by the apparel industry segment involved with government contracting would materialize. The flexibility and improved response to mobilization needs heavily favor such a restructuring of the set-aside program.

9. Increase Industry Contributions in Specification Development to Avoid Dependency on Sole Sources for Fibers.

Sole-source dependencies presently exist in some critical CIE items, which seem to indicate development of a specification in the absence of broad industry participation. This appears to be a problem at the NLABS level, where mobilization concerns must demand as much attention as meeting peacetime procurements.

More thorough fiber industry participation combined with determination of relationships between CIE item specifications and their critical, essential, and desirable characteristics should open up opportunities for broader supply capacity of selected fibers.

Using a sole source fiber supplier without full awareness of the projected mobilization needs or the capacity available to meet these needs is inadequate planning. NLABS and other specification-creating agencies should:

- Request a projected mobilization unit volume from appropriate DoD Operations Planning (OPLAN) offices for items under consideration.
- Canvass the fiber industry for probable solutions to the performance characteristics needed.
- Select a range of standards to ensure capacity in a mobilization.

- Use the IPPS of DPSC to develop planned producer agreements with several suppliers.

The present exposure to a possible lack of capacity for sole-source fibers is one developed by the specification creating agencies themselves. This is a planning problem which can be corrected at the R & D level of the procurement chain.

10. Expand Military Participation in Research Activities Sponsored or Conducted by Academic Laboratories.

These laboratories conduct not only industry-funded research in state-of-the-art process and product applications, but also do pure research in fibers, fabric formation, and garment construction. They bring the stimulation of new concepts, ideas, and approaches generated by a constant stream of graduate students.

The military would benefit from the obvious synergies of such a relationship. It would be the responsiblity of NLABS to assess present military CIE items for opportunities to incorporate state-of-the-art developments.

Academic laboratories, having strong ties to industry, would be catalysts for blending industry interest and capability with military needs. An atmosphere of mutual trust must exist to facilitate the flow of ideas. The academic setting is suited for this purpose, and NLABS would not be required to indicate any preference toward specific industry ideas by dealing through academic institutions.

11. Develop a Comprehensive Understanding of all Military Products Dependent Upon the Textile/Apparel and Related Industries.

In the course of this study, we were unable to obtain from the multitude of procurement authorities a comprehensive listing of products including textiles. Consequently, the study used a representative sample of combat essential and dress CIE developed by the Natick Labs. The sample considered only a few vehicle-related and air-delivery items. It is unclear if DoD presently could respond to the question, "How many parachutes, of what configuration, are presently procured and would be required in a mobilization?"

This indicates the need for a DoD-wide centralized commodity control for textiles. Using fragmented end-use items totally ignores the need for long-range

strategic planning for the components needed to produce the items. This is a serious flaw in mobilization planning relative to industry capabilities. This requirement is recommended to involve the entire Defense system to avoid duplications of product specifications and to provide a simple source for mobilization planning relative to textiles and apparel. The Army has made a very positive step in that direction with the establishment of the CMO-CIE at DARCOM.

12. Develop a Central Data Base for Unit Allowances on all Military CIE Items, Including Aerial Delivery, Tank, and Automotive Command Items.

This task begins with inclusion of all components presently classified as CFM on the IPPL for combat essential items. Having a central data base on unit allowances gives the centralized commodity control function the necessary information to develop mobilization needs. The IPPS of DPSC would take these projections of all materials and match them with industry capacity through planned producer agreements. At the present, lack of capacity to meet CFM needs in a mobilization would be unknown.

The unit allowances would be for planning purposes. They would not be used to circumvent the benefits of the competitive bidding process for awarding contracts. Awareness of possible capacity problems combined with constant re-evaluation of CIE item specifications will provide an efficient utilization of procurement resources as well as offer the most suitable products of combat use.

Again, this effort should be directed to the entire DoD textile commodity system, incorporating all items to assist in projecting mobilization requirements.

13. Expand the IPPL of IPPS to Include all CFM for Mobilization CIE.

This adds a critical dimension lacking in the present system, one which deals only with end-use items or GFM. The fabrics listed on the IPPL should be those identified as required for combat-essential missions. Inclusion of dress uniform fabrics, items to be dropped in a mobilization emergency, is not part of the mission to prepare industry for responding to military procurement needs.

Use of a Bill of Materials concept, coupled with unit allowances, would facilitate compilation of aggregate demand from all combat-essential CIE items for textiles. These amounts projected for mobilization scenarios, over time, can be matched to industry capability.

14. Reduce Duplicate Specifications Between DPSC and GSA for Identical Items.

Where GSA has a CID specification for an item identical to a military specification, combining the two, with the preference given to adopting the CID, would allow larger orders to be placed, generating increased industry interest. An evaluation of GSA CIDs should be done to find items applicable to military use. Where appropriate, these CIDs should be adopted by DLA's procurement agencies.

The inefficiencies of multiple small contracts can be removed by elimination of duplicate procurement authorities for identical items. There is overlap of contractors for GSA and DPSC procurements. GSA has the authority for production of Federal specifications for clothing and textiles, and NLABS is involved with many of the provisions in those specifications already.

GSA has been more involved with CID activities than specifications in recent years, and integration of GSA and NLABS for specification purposes would give more emphasis to the CID program.

15. Update and Establish Complete Replacement Factor Documentation for all Combat Essential Items (All Services).

In this study, many of the combat-essential items of CIE used in the sample did not have replacement factors. Those having replacement factors involved judgments based on experience in World War II and Korea. As specifications are developed with new materials, these replacement factors must be updated to keep mobilization planning current.

Lacking replacement factors ensures inefficient utilization of procurement dollars in inventory, inappropriate levels of stock, and errors in planning for deployment. CIE is one of 28 critical logistical components for mobilization planning. It must include accurate rates for replacement to have sufficient quantities available to support the combat/training missions of the services.

In mobilization emergencies, scarce production resources need to be focused on those CIE items most in need. Dissipation of those resources producing unneeded quantities of CIE items due to a lack of replacement factor information need not occur if effective planning is done now. The replacement factor exercise should be coordinated as part of a centralized commodity control operation.

16. Consolidate all DOD CIE R&D Activities at NLABS, Combining all Military Services Laboratories Under a Central DOD Authority. Such an Operation Would Coordinate R&D Activities with Industry.

This revised and expanded mission for the Natick Research and Development Laboratories places mobilization planning and military CIE item development above parochial service interests. NLABS currently has the largest facility, budget, and experience base to conduct research and development activities for CIE. Its recognized ability in this area is utilized by many non-military related government agencies.

For DoD to implement effectively its expanded mission would require a commitment by DoD to consolidate its multitude of research and development efforts in the CIE area. The extent of research and development duplication is unknown as all requests to document funding of CIE research and development in the other areas of DoD were unsuccessful. A critical aspect of this consolidation is NLABS' taking a very active role in cooperation with industry in the CIE item development chain, getting inputs and suggestions prior to the creation of a specification.

A consolidation would reduce the duplication of both testing facilities and personnel. The dress uniform items would be better managed as well, even with service differences. Such a consolidation is also a reasonable extension of the recent interest in CIE as evidenced by the changes to the Clothing and Evaluation Board and the establishment of CIE commodity control at DARCOM for the Army.

17. Evaluate the Contributions of the DCAS and the AAFES Organizations in Developing an Industrial Capability to Meet National Defense Requirements.

The roles of the AAFES and the DCAS in managing the textile/apparel industrial mobilization bases are unclear. In its regional format, DCAS seems a duplicative administrative level for determining contractor compliance and performance for CIE items. The final

decisions are made by agencies at DPSC, NLABS, etc. The existence of the SBA Certificate of Competence program renders the pre-award survey almost superfluous. The apparel industry questions the ability of DCAS regional auditors' ability to evaluate a contractor's capability in a brief plant visit.

Consolidation of evaluation is the logical choice, including the VEC program. Having a separate procurement process for optional uniform and equipment items of slight difference from military specifications for AAFES does not contribute directly to improving apparel industry capacity committed to military production for mobilization products. None of the AAFES procured clothing items would be required in a mobilization except for new items entering the system and not yet involved in a full production program.

This document reports research undertaken in cooperation with the US Army Natick Research and Development Command under Contract No. DAAK60-81-C-0153 and has been assigned No. NATICK/TR-84/003 in the series of reports approved for publication.

LIST OF REFERENCES

1 Organization and Functions of U.S. Army Research & Development Laboratories, NLABS Regulations No. 10-2, 1 January 1981.

2 "How Sharing the Shortages is Paying Off," Government Executive, March-April, 1982, page 16.

3 Erna Risch, U.S. Army in World War II, the Quartermaster Corps. Organization, Supply and Services, 1953, page ix.

4 Government-Furnished Materiel (GFM) Mechanized Requirements Computation Program, Directorate of Clothing and Textiles, Defense Personnel Support Center Staff Memorandum number 4140.28, DPSC-TMMR, 6 August 1975.

5 Military Specification MIL-C-44031A, Cloth A; Cloth, Camouflage Pattern: Woodland, Cotton and Nylon.

6 Military Specification MIL-T-43548; Thread, Polyester, Cotton Covered, and Rayon Covered.

7 S. J. Kennedy, The Changing Capability of the Textile Industry to Support National Defense. Technical Report 73-50-CE, December 1975 (AD 777 791).

8 Ibid.

9 Supply Bulletin 10-496, Supply Control Wartime Replacement Factors and Consumption rates for DLA/GSA Assigned Items, Department of the Army, January, 1982.

10 Government Executive, p. 16.

11 Emergency Wartime Capacity of the Training Base, TRADOC study, 1982, ongoing.

12 War Reserve Stockage List Army (WARSL), D.A. Supply Bulletin 700-40, November, 1979.

13 Frost & Sullivan, Durable Nonwovens Market in the U.S., August, 1982.

14 Military Specification MIL-T-43548B, thread, polyester, cotton-covered and rayon covered, 30 September, 1981.

15 U.S. Department of Commerce, Bureau of the Census, Current Industrial Reports, Broadwoven Fabrics (Gray), MQ-22T, Fourth Quarter, 1982.

16 Textile World's Shuttleless Weaving Chart for 1982, Textile World, October, 1982, page 40.

17 Davison's Textile Blue Book, Davison Publishing Company, 116th Edition, 1982.

18 Conversation, November, 1982. Office of U.S. Senator Sam Nunn.

19 Emergency Preparedness for Interruption of Petroleum Imports into the United States, a report of the National Petroleum Council, April, 1981. (Advisory Committee to the Secretary of Energy).

20 American Textile Machinery Association, Opportunities and Strategies for U.S. Textile Machinery Manufacturers to Improve their Competitive Positions in Domestic and Foreign Markets - 1980-1985, September, 1980.

21 Third Textile Equipment Expenditure Outlook Survey, Roberts, Curry & Company, January, 1982.

22 U.S. Army Natick Research and Development Laboratories, Posture Report, FY81. DRCDL-101-10., 1981.

23 Federal Test Method Standards, General Services Administration (GSA) Document 191A.

BIBLIOGRAPHY

The Future of the U.S. Hosiery Industry, National Association of Hosiery Manufacturers Delphi Survey of U.S. Hosiery Through the Year 2000, December 1978.

The Carpet Industry of the Future, Report on the Findings of a Modified Delphi Survey of the U.S. Broadloom Carpet Industry, Kurt Salmon Associates, 1978.

The Future of the U.S. Sales Yarn Industry, Report to the American Yarn Spinners Association, 14 September 1978.

Delphi Survey of the U.S. Apparel Industry Through the Year 2000, Kurt Salmon Associates, December 1978.

Army National Guard and Army Reserve, Order to Active Duty as Individuals During Peacetime, National Emergency, or Time of War, Army Regulation Number 135-210, Headquarters Department of the Army, 28 March 1977.

Department of Defense, Selected Manpower Statistics, Fiscal Year 1981, Directorate for Information, Operations and Reports (DIOR), the Pentagon, 1982.

Alternative Fabrics for Distinctive Air Force Uniforms, ASD-TR-79-5009, Department of the Air Force, Headquarters Aeronautical Systems Division (AFSC), June 1979.

Clothing and Individual Equipment, Common Table of Allowances (CTA) Number 50-900, Headquarters, Department of the Army, October 1978.

Table of Authorized Material, NAVMC 1017 Revision No. 6, United States Marine Corps, 25 November 1980.

Marine Corps Uniform Regulations, MCO P1020.34C, United States Marine Corps, 17 November 1978.

The Budget of the United States Government, Department of Defense Extract for Fiscal Year 1983, 8 February 1982.

Defense 82, American Forces Information Service, February 1982.

Defense 81, Special Almanac Issue, American Forces Information Service, September 1981.

Summary - Response to Vice President Bush's Request for Regulatory Information of American Textile Manufacturer's Institute, May 1981.

Defense Budget Increases, How Well are They Planned and Spent?, Comptroller General Report to the Congress of the United States, 13 April 1982.

U.S. Army Research Office Program Guide, September 1981.

The Posture of the Army and the Department of the Army Budget Estimates for Fiscal Year 1983, Statement by Secretary of the Army, The Honorable John O. Marsh, Jr. before United States Senate and House of Representatives, Second Session, 97th Congress.

Thread Consumption, Union Special Corporation, October 1974.

Army Uniforms of the 80's, U.S. Army Natick Research and Development Command, Natick, Massachusetts, December 1976.

Selected Bivariate Frequency Tables: U.S. Army Men and Women, Technical Report NATICK/TR-81/012, Clothing Equipment and Materials Engineering Laboratory, CEMEL 226, January 1981.

Forecast of New Releases for Clothing, Shelters, Organizational and Airdrop Equipment, Technical Data Packages, United States Army Natick Research and Development Laboratories, December 1981.

Army Management of Clothing and Equipment Study, Conract Number MDA 903-81-C-0585, Directorate for Transportation, Energy and Troop Support, Department of the Army, March 1982.

Expendable/Durable Items (Except: Medical, Class V, Repair Parts and Heraldic Items), Common Table of Allowances (CTA) Number 50-970, Headquarters Department of the Army, January 1982.

War Reserve Stockage List Army (WARSL), Department of the Army Supply Bulletin (SB) Number 700-40, Headquarters, Department of the Army, November 1979.

Stitches, Seams and Stitchings, Federal Standard Number 751a, 25 January 1965.

Sampling Procedures and Tables for Inspection by Attributes, Military Standard Number 105-D, 29 April 1963.

Department of Defense Appropriations for Fiscal Year 1982, Senate Hearings before the Committee on Appropriations, Part 2 - Manpower, U.S. Government Printing Office, 1981.

Department of Defense Appropriations for Fiscal Year 1982, Senate Hearings before the Committee on Appropriations, Part 3 - Operation and Maintenance, U.S. Government Printing Office, 1981.

Department of Defense Appropriations for 1982, Hearings before a Subcommittee of the Committee on Appropriations, House of Representatives Ninety-Seventh Congress, U.S. Government Printing Office, 1981.

FY 1983 Budget, FY 1984 Authorization Request, and FY 1983-1987 Defense Programs, Annual Report to the Congress, Caspar W. Weinberger, Secretary of Defense, U.S. Government Priting Office, 8 February 1982.

Budget of the United States Government, Fiscal Year 1983, Executive Office of the President, Office of Management and Budget, U.S. Government Printing Office, 1982.

Man-Made Fibers Fact Book Update: Statistics, Man-Made Fiber Producers Association, Inc., 1981.

Commerce Business Daily, U.S. Government Printing Office, Issue No. PSA-8074.

Standard Industrial Classification Manual, Statistical Policy Division, Office of Management and Budget, 1972.

U.S. Industrial Outlook 1982, Bureau of Industrial Economics, U.S. Department of Commerce, 1982.

Rubber Footwear, A Study of Domestic and Import Competition, International Trade Administration, U.S. Department of Commerce, June 1981.

Clothing and Textile Study Group review, Director, Defense Supply Agency, June 1968.

All-Purpose Lightweight Individual Carrying Equipment (ALICE), booklet, U.S. Army Troop Support Command, Clothing and Personal Life Support Equipment Laboratory, November 1973.

Cotton Quality Evaluation: Testing Methods and Use Report Summary, Economic Research Service, United States Department of Agriculture, November 1981.

Cotton Versus Polyester, reprinted from American Scientist, Vol. 66, No. 3, May-June 1978.

Focus on Man-Made Fibers, Man-Made Fiber Producers Association, No.8, September 1981.

The Future of Synthetic Materials: The Petroleum Connection, Worldwatch Paper 36, Worldwatch Institute, 1980.

Protective Clothing and Equipment, Army Regulation No. 385-32, 1 January 1981.

Survey of U.S. Textile Machinery Industry: Knitting, International Research Associates and Modern Textiles Magazine, September 1980.

Man-Made Fibers Fact Book, Education Department, Man-Made Fiber Producers Association, 1978.

The Outlook for the Textiles Industry in the 80's, Presentation to the New York Board of Trade, Frank H. Dayton, Monsanto Textiles Company, 18 February 1982.

Focus on Man-Made Fibers, Man-Made Fiber Producers Association, No. 5, 1978.

Guide to Textile Chemicals, Supplement to JTN, March 1982.

This is DARCOM, Pamphlet 360-1, U.S. Army Material Development & Readiness Command, October 1980.

Committee for the Implementation of Textile Agreements, Federal Register, Vol. 47, No. 249, Tuesday, 18 December 1982, Page 57749.

Weaving Machines: Activity Heightens as Shuttleless Boom Accelerates, P. Abbenheim, International Textile Machinery, 1981.

Economic Developments of Significance for Textiles, ATMI Finishers Committee, Economic Information Division, American Textile Manufacturers Institute, 17 March 1982.

High Speed Drafting Developments for Long Staple Fibers, Richard A. Doyne, The Warner & Swasey Company, Seminar Presentation for U.S. Light Industry Exhibition, February 1982.

Industrial Uses for Textile Fibers, Richard G. Mansfield, 1980.

World Cotton Spindles, Looms and Fiber Consumption, International Textile Manufacturers Association, 1979.

Wartime Apparel Price Control, Wilfred Carsel, Office of Temporary Controls, Office of Price Administration, U.S. Government Printing Office, 1947.

Textile Materials Systems and the Soldier, Quartermaster Research and Engineering Command, September 1960.

Dyeing and Finishing Machinery Update, Textile Month, May 1982, Page 29.

Market Gains Based on a Global Spread, Textile Month, June 1982, Page 27.

Analysis and Perspective, Government Contracts, Legal Times of Washington, 17 August 1981; 31 August 1981; 14 September 1981; 19 October 1981; 11 January 1982; 22 February 1982; 12 April 1982; 5 July 1982.

Government Contracts, The National Law Journal, 15 January 1979; 13 April 1981; 14 September 1981; 11 January 1982; 26 April 1982.

Only One Science, Twelfth Annual Report of the National Science Board, National Science Foundation, 28 September 1981.

ATMA Executive Report, Vol. 8, No. 6, September 1982.

Technology Update in Long Staple Spinning, H.M. Behery and E.A. Vaughn, School of Textiles, Clemson University, 1980.

The Changing Capabilities of the Textile Industry to Support National Defense, S.J. Kennedy, Technical Report 73-50-CE, U.S. Army Natick Laboratories, April 1973.

The Economics of Ring Spinning in Worsted Spinning Mills, H. Moder, Rieter Machine Works Ltd., Textile World, August 1976.

Standardization Procedure for Two Instruments for Color Measurement, Technical Report NATICK/TR-82/024, Individual Protection Laboratory, United States Army Natick Research & Development Laboratories, September 1981.

Posture Report FY 81, DRCDL-101, U.S. Army Natick Research and Development Laboratories, 1981.

Government Executive, Volume 14, March/April 1982, Executive Publications, Inc., 1982.

Supply Control Wartime Replacement Factors and Consumption Rates for DLA/GSA Assigned Items, Department of the Army Supply Bulletin 10-496, Headquarters, Department of the Army, January 1982.

Annual Historical Review, 1 October 1980 - 30 September 1981, RCS CSHIS-6 (R3), U.S. Army Natick Research & Development Laboratories, 1981.

Emergency Preparedness for Interruption of Petroleum Imports into the United States, A Report of the National Petroleum Council, Committee on Emergency Preparedness, 1981.

Review and Analysis, 4th Quarter FY 1981, U.S. Army Support Activity, December 1981.

Selling to the Military, Defense Purchasing Information Pamphlet, U.S. Government Printing Office.

Modern Textile Business, Volume 63, No. 3, Vista Publications, March 1982.

Modern Textile Business, Volume 63, No. 8, August 1982.

Memorandum: Prospective Clothing, Textile, Equipment and Footwear Bidders, Forecasted OPSC Procurement, Defense Logistics Agency, 1 October 1981.

Acceptable Suppliers List (ASL), Defense Personnel Support Center, 7 January 1982.

Duck and Webbing Under the Single Manager for Clothing and Textile, Quartermaster General, 1956-1960.

Military Readiness, Mobilization Planning, and Civil Preparedness: Issues for Planning, U.S. General Accounting Office, 25 February 1981.

Procurement List 1982, Committee for Purchase from the Blind and Other Severely Handicapped, January 1982.

Fibers/Textiles/Apparel: A Unified Industry Dealing with the Import Problem, Report prepared by Economic Consulting Services, Inc., 8 January 1981.

Department of Defense Catalog of FY 1981 - FY 1982 DIOR Reports, Directorate for Information Operations and Reports, Washington, Headquarters Services, March 1982.

Life Cycle Management of Clothing and Individual Equipment, Draft Army Regulation No. 700-86, Headquarters, Department of the Army, 1982.

Items of Clothing and Equipment, United States Army, NATO Combat Clothing and Personal Equipment Working Party Meeting, November 1976.

Review and Analysis, 1st Quarter FY 1982, U.S. Army Support Activity, March 1982.

Market Analysis, Market Research & Economics Department, The Wool Bureau, Inc., 20 July 1982, and 17 November 1982.

Industrial Preparedness Planning List (IPPL) FY 83, Contracting and Production Division, Division of Clothing and Textiles, Defense Personnel Support Center, 23 December 1981.

An Analysis of the Domestic Rubber Footwear Industry, Rubber Manufacturers Association, 28 September 1981.

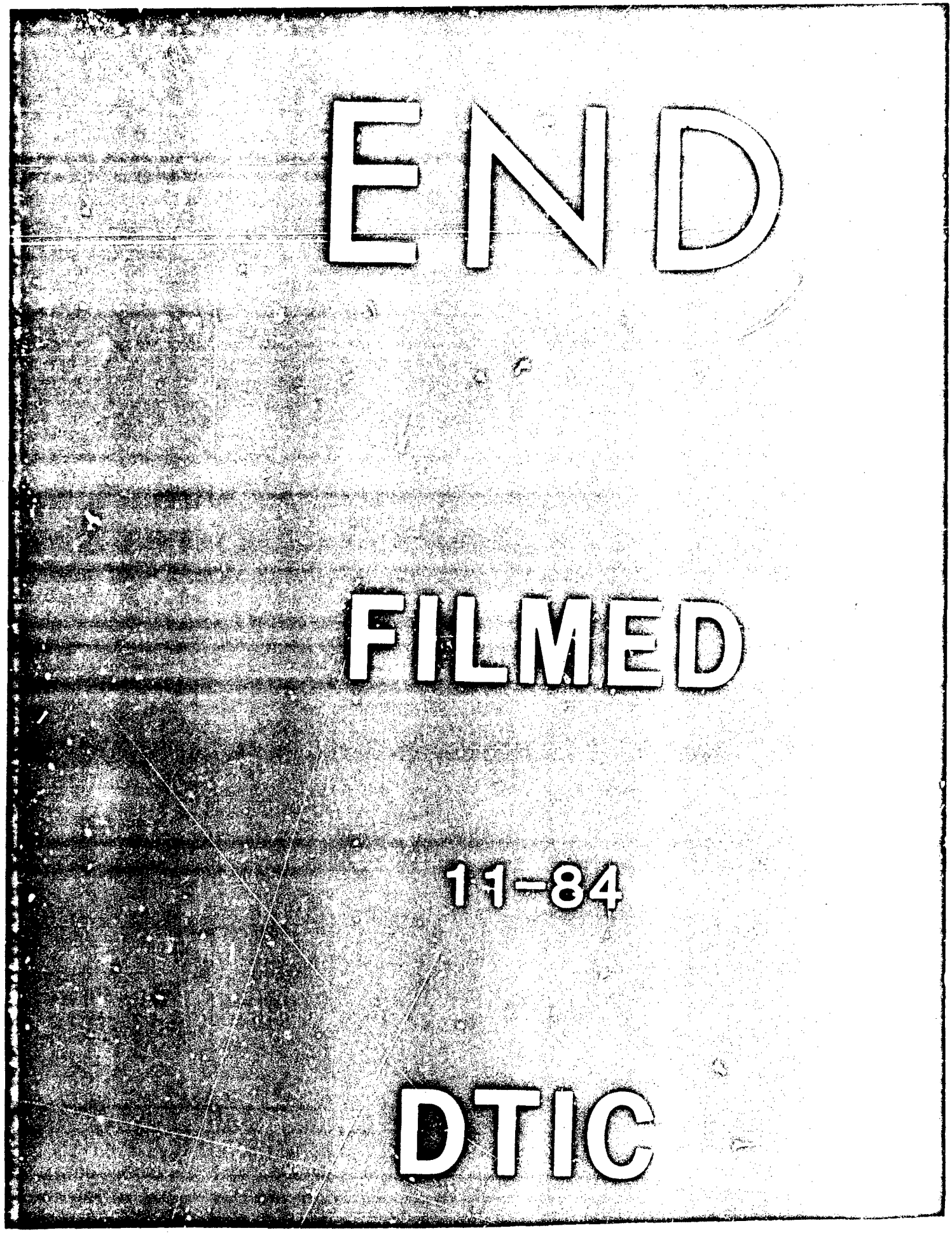
Researches on Sewability of Industrial Sewing Machines and Automatic Sewing System, M. Sekijuchi, Japan Industrial Sewing Machinery Manufacturer's Industry, JTN, March 1982. Pg. 55.

LIST OF ABBREVIATIONS

AAFES	- Army and Air Force Exchange System
AAMA	- American Apparel Manufacturers Association
ACEB	- Army Clothing and Equipment Board
AGR	- Annual Growth Rate
ALA	- Army Logistics Agency
ASA	- U.S. Army Support Activity
ASPR	- Armed Services Procurement Regulation
ASTM	- American Society for Test Methods
ATMA	- American Textile Machinery Association
ATME-I	- American Textile Machinery Exhibition - International
ATMI	- American Textile Manufacturers Institute
AUB	- Army Uniform Board
BDU	- Battle Dress Uniform
CAG	- Clothing Advisory Group
CFM	- Contractor Furnished Material
CID	- Commercial Item Description
CIE	- Clothing and Individual Equipment
CIR	- Current Industrial Reports
CMO-CIE	- Commodity Management Office/Clothing and Individual Equipment
CMT	- Cut, Make, Trim
COC	- Certificate of Compliance
COE	- Cost of Equity
CSA	- Chief of Staff, Army
CTA	- Common Tale of Allowances
DA	- Department of the Army
DAR	- Defense Acquisition Regulation
DARCOM	- U.S. Army Materiel Development and Readiness Command
DCAS	- Defense Contract Administration Services
DCSLOG	- Deputy Chief of Staff for Logistics
DCSPER	- Deputy Chief of Staff for Personnel
DIPP	- Defense Industrial Preparedness Program
DLA	- Defense Logistic Agency
DOC	- Department of Commerce
DOD	- Department of Defense
DOE	- Department of Energy
DPSA	- Defense Personnel Support Activity
DPSC	- Defense Personnel Support Center
EDOS	- Effective Date of Supply
FAR	- Federal Acquisition Regulation
FIT	- Fashion Institute of Technology
FORSCOM	- Forces Command
FPI	- Federal Prison Industries
FPR	- Federal Procurement Regulation
FR	- Fire Resistant
FSC	- Federal Supply Classification
FWWMR	- Fire, Water, Weather and Mildew Resistant
GFM	- Government Furnished Material
GSA	- General Services Administration
HAC	- House Appropriations Committee
IFA	- Industrial Fabrics Association
IPL	- Individual Protection Laboratory
IPPD	- Industrial Preparedness Planning Division

LIST OF ABBREVIATIONS
(Continued)

IPPL - Industrial Preparedness Planning List
IPPS - Industrial Preparedness Planning Section
ITMA - International Textile Machinery Exposition
JCS - Joint Chiefs of Staff
KSA - Kurt Salmon Associates
MACOM - Major Army Commands
MFA - Multifiber Arrangement
MM - Million
MMB/D - Million Barrels per Day
MMF - Manmade Fibers
MMFPA - Manmade Fiber Producers Association
MOB - Mobilization
MOS - Military Occupational Specialty
MSO - Management Supply Office
MTN - Multilateral Tariff Negotiation
NAHM - National Association of Hosiery Manufacturers
NASA - National Aeronautics and Space Administration
NFI - Narrow Fabrics Institute
NIB - National Institute for the Blind
NICP - National Inventory Control Point
NLABS - Natick Laboratories
NPC - Natonal Petroleum Council
NSC - National Security Council
NSN - National Stock Number
NTA - Northern Textile Association
OFPP - Office of Federal Procurement Policy
OMB - Office of Management and Budget
OPLAN - Operations Plan
OSHA - Occupational Safety and Health Administration
OSUT - One Station Unit Training
O&MA - Operations and Maintenance Army
PCO - Primary Contract Officer
PCST - Philadelphia College of Science and Textiles
QA - Quality Assurance
QML - Qualified Manufacturer's List
RDT&E - Research, Development, Testing and Evaluation
ROE - Return on Equity
ROI - Return on Investment
R&D - Research and Development
SB - Supply Bulletin
SBA - Small Business Administration
SIC - Standard Industrial Classification
SICC - Service Item Control Center
SPR - Strategic Petroleum Reserve
SYE - Square Yard Equivalent
TECOM - Army Test and Evaluation Command
TRADOC - U.S. Army Training and Doctrine Command
TSARCOM - U.S. Army Troop Support and Aviation Material Readiness Command
USASPTAP - United States Army Support Activity Philadelphia
VCSA - Vice Chief of Staff, Army
VECP - Value Engineering Change Program
WGMA - Work Glove Manufacturers Association


END
FILMED
11-84
DTIC