NATIONAL SECURITY ASSESSMENT OF THE U.S. AERIAL DELIVERY EQUIPMENT INDUSTRY

A JOINT ASSESSMENT WITH

U.S. ARMY SOLDIER BIOLOGICAL AND CHEMICAL COMMAND

PREPARED BY

U.S. DEPARTMENT OF COMMERCE
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Table of Contents

Charts ..... *iii*

Foreword ..... *v*

Executive Summary ..... *vii*

1. Introduction *1*

Assessment Background 1
Assessment Coverage 2
Methodology 2

2. Defining the Aerial Delivery Industry *5*

Design Technology 6
Customer Base 6
The Big Five 7
Classification of the Aerial Delivery Industry 8

3. The Parachute Industry *9*

Cargo Parachutes 9
Personnel Parachutes 11
Industry Performance 12
Civilian Parachute Industry 14
Net Income 14
Employment 15

4. Market Environment *19*

Procurement and Inventory Control 19
Data Barriers & Bottlenecks 19
DOD Procurement Practices 20
Supplier Issues 21
DOD Sourcing 23

5. Manufacturing Technology, Capital Investment, R&D *27*

Manufacturing Technology 27
Capital Investment 29
Future Investment 31
Research and Development 32
New Tactical Needs Drive R&D 34

6. Managing the Parachute Supplier Environment *37*

Supply Chain Issues 37
Management of Standards and Designs 39
Innovation, Manufacturing & Regulation 40
Industry's Role in Parachute Specifications 42
Defense Missions, Supply Surety and Competition 43

7. Findings and Recommendations.....45
Findings.....45
Recommendations.....47
Appendix A: Survey.....49
Appendix B: Publications List.....71

Guide to Tables & Charts

Tables

Table 1: Customers for Aerial Delivery Products 7
Table 2: Total Defense Parachute Industry Sales 12
Table 3: U.S. Defense Aerial Delivery Supply Chain Sales 13
Table 4: Civilian Parachute Sales 14
Table 5: Supply Chain Commercial Sales 14
Table 6: Combined Civilian & Defense Parachute Sales 14
Table 7: Net Income for Parachute Manufacturers 15
Table 8: Employment for All Parachute Firms Surveyed 15
Table 9: Employment for the Big Five Parachute Firms 16
Table 10: Reasons for Labor Shortages 17
Table 11: Parachute Manufacturers' Capital Investment 29
Table 12: Parachute Manufacturers' Capital Investment -- Big Five Firms 30
Table 13: Reasons for Deferred Capital Investment 32
Table 14: Parachute R&D Spending 33
Table 15: Industry Ratings of PIA in Managing Ex-DOD Specifications 42

Charts

Chart 1: Capital Investment per Employee 31
Chart 2: Total RDT&E Spending by the U.S. Army Natick Soldier Center 34

Foreword

The U.S. Army Soldier Biological and Chemical Command (SBCCOM) requested this national security assessment of the U.S. Aerial Delivery Industry. SBCCOM was concerned about the ability of its suppliers to produce aerial delivery products in the future.

Since BIS undertook this study and collected data from domestic suppliers, the U.S. Aerial Delivery Industry has seen demand for its products increase as a result of U.S. operations in Afghanistan and Iraq. The surge in orders and increased revenue flowing to aerial delivery manufacturers is strengthening their economic positions.

This positive news, however, has not eliminated the management and modernization challenges facing the Department of Defense (DOD), and aerial delivery system manufacturers and their suppliers in the United States. This study identifies both short-term and long-term issues and problems that the industry and DOD must address to assure that the nation can effectively execute tomorrow's national security missions.

The U.S. Department of Commerce's Bureau of Industry and Security (BIS) is delegated the authority under Section 705 of the Defense Production Act of 1950, as amended, and Executive Order 12656 to collect basic economic and production information from industry. These provisions enable BIS to gather data essential to assessing the capabilities of the U.S. industrial base. These assessments enable the government to collect information to develop programs and policies that will improve the capabilities and competitiveness of specific industrial sectors and their ability to support U.S. national security.

The Office of Strategic Industries and Economic Security (SIES) is the operating unit within BIS with the responsibility for industry data collection and industrial base analysis. The Strategic Analysis Division of SIES performed this assessment with technical support from the SBCCOM Natick Soldier Center located in Natick, Massachusetts. SIES has worked with the armed services in conducting more than 35 assessments in the past 15 years. These studies have focused on a wide range of industries that are of great importance to the armed services, such as ball and roller bearings, gears, robotics, semiconductors, ejection seats, and shipbuilding and repair.

Executive Summary

Since their first major deployment in 1942,[1] parachutes have been an important tool in the arsenal of the United States' armed forces, enabling the delivery of troops and equipment to inaccessible locations with speed and often with surprise. Following the initial use of parachutes in World War II for large-scale troop deployments, the technology evolved rapidly to support a broad range of "aerial delivery systems" for cargo and other payloads. The technological and manufacturing base of the air delivery systems used by the armed forces is now many decades old and is well established. The U.S. military relies on these systems not only in times of conflict, but also for assisting in humanitarian relief operations around the globe.

In recent years, however, the Department of Defense (DOD) has experienced some problems in timely delivery of parachute orders from industry and has been concerned about the ability of the U.S. Army to procure parachute systems quickly in a time of national need. A detailed assessment of the health and competitiveness of the industry, specifically addressing its ability to meet future DOD needs, was requested by the U.S. Army Soldier Biological and Chemical Command (SBCCOM), a subordinate unit of the U.S. Army Materiel Command (AMC). The U.S. Department of Commerce, Bureau of Industry and Security, was asked to conduct the assessment.

Many factors, both external and internal, affect the economic health, manufacturing readiness, and technical capabilities of the aerial delivery industry. Interviews with parachute manufacturers and supply chain executives, and survey data collected by the Bureau of Industry and Security (BIS), show that the industry experienced market turbulence and uncertainty during the last decade. The boom and bust cycles experienced by the aerial delivery industrial base are perceived by survey respondents as having negative consequences for the industry's economic stability and its ability to respond to surge requirements. The challenge before DOD and manufacturers operating in the United States is to find ways to bring greater stability to the industry to assure the continuation of a robust supply base.

Industry Overview

"Aerial delivery" is a military phrase that refers to products used to airdrop personnel, ammunition, vehicles, or supplies to military forces or humanitarian recipients on the ground. In major engagements and in large relief efforts, DOD can consume hundreds if not thousands of these highly engineered units.

The industry consists largely of parachute manufacturers and suppliers of components used in various air delivery systems. Cargo and personnel parachutes are the main products of the aerial delivery industry, but manufacturers also produce special skids, pallets, and shock absorbing systems for delivering products to the ground intact.

[1] *History of the Parachute. *See:* http://inventors.about.com/library/inventors/blparachute.htm

There is also a commercial side of the market – the civilian sport-parachute market. There are substantial differences between defense – the larger market – and commercial business sectors. Commercial parachute customers demand wide choices of styles and colors. The manufacturers use very small production runs and are adept at making one or very few of a specific item. Military parachute manufacturers, in contrast, typically have larger production runs of several hundred to over a thousand of a particular parachute system.

Although there are at least 16 manufacturers of parachutes in the United States, five defense-devoted parachute companies produce the majority of completed aerial delivery goods (as measured by gross sales) for the U.S. military, according to BIS survey data. These manufacturers have dominated the defense cargo and personnel markets for years. These "Big Five" firms are engaged in what has been described by industry officials as "cutthroat" competition.

Industry Performance

For the five-year period – 1996-2000 – that is covered by the BIS survey data, the industry's sales declined, only to rebound slightly in 2000. Over the period, defense parachute manufacturers reported annual sales averaging $60.7 million.

Volatility in demand for defense parachutes occurred in both domestic and foreign markets. After seeing domestic sales jump from $46.5 million in 1996 to $55.5 million in 1997, manufacturers watched domestic purchases of military parachutes fall steadily through 2000. Revenues from military parachutes rose overall in 2000 only because of an increase of purchases from foreign customers. In 2000, foreign demand accounted for $15.1 million (26 percent) of the $58.5 million of military parachute sales.

Although the Big Five manufacturers in the United States dominated domestic sales of defense parachutes in 1996-2000, the group experienced a noticeable decline in revenue. The Big Five saw parachute sales to the U.S. military drop from a peak of $54.3 million in 1997 to $41.7 million in 2000. Total domestic defense sales in 2000 for individual Big Five manufacturers ranged from $1.8 million to $15 million.

Net income similarly fluctuated over the period. Companies reported swings in net income of nearly five to 10 percent to the positive or negative in this timeframe. Big Five companies experienced significant shifts in both sales and net income. Indeed, two Big Five companies had year-to-year net income fluctuations exceeding 1,000 percent. In each year from 1996 through 1998, four of 15 parachute manufacturers that provided data (the companies varied from year to year) reported losses.

Inventory Control and Procurement

DOD's purchases of aerial delivery products are affected by a number of variables, including world events, parachute applications, inventory-tracking systems, procurement strategies, vendor lead-times, and related supply-chain issues. The fundamental problem DOD faces in managing its aerial delivery systems is an inability to fully foresee product needs from year-to-year.

As of Fall 2002, the Army estimated that it had more than 103,000 cargo parachutes in stock at its depots – inventory worth approximately $231.6 million. What is held in storage at Army depots is only a part of the total military parachute inventory, however. Substantial numbers of cargo and personnel parachutes are located in the field at military installations in the United States and at U.S. bases around the world. DOD estimates that this "field inventory" may consist of another 175,000 cargo and personnel (including emergency reserve) parachutes.

At the request of manufacturers, SBCCOM Natick shares its forecasts for parachutes and other air-delivery products with industry. However, because unit missions change frequently and field unit ordering activity varies from unit to unit, the 3- to 5-year forecasts are difficult to prepare and often are substantially in error.

This uncertainty in DOD procurements presents problems for manufacturers in terms of scheduling production, maintaining their workforce, working with supply chains, and planning capital and R&D expenditures. Investment in automated manufacturing equipment, which some suppliers say is needed to offset a shrinking supply of skilled labor with specialized sewing experience, is lagging.

Supplier Issues

Several established military parachute manufacturers see SBCCOM Natick's Indefinite Delivery/ Indefinite Quantity (IDIQ) procurement contracting approach as problematic. Indefinite Delivery contracts may be used to acquire supplies and/or services when the exact times and/or exact quantities of future deliveries are not known at the time of contract award. Manufacturers noted that (1) companies in multi-year solicitations may be forced to absorb inflation in materials, labor, and overhead; and (2) parachute suppliers selected as qualified contractors in first-round bids must effectively compete against themselves in subsequent competitions within the solicitation to obtain actual delivery orders.

SBCCOM Natick asserts that multi-year IDIQ contracts have many advantages, including ongoing informal competition throughout the life of an acquisition program, reduced acquisition lead times, and additional opportunities for firms that otherwise would be frozen out of a particular program for up to five years.

Research and Development

There have been few major changes in parachute system designs over the last few decades. SBCCOM Natick reports that some cargo parachutes that were manufactured in the 1950s and 1960s are still in depots awaiting requisitions. The design parameters for personnel parachutes such as the T-10 have remained consistent since the 1950s with few alterations.

Changes in DOD requirements, however, are forcing the redesign of some parachute systems. As the amount of equipment carried by the U.S. soldier has grown, the increased weight translates into higher descent speeds, which in turn increases the likelihood of landing injuries. To address this problem, the U.S. Army is developing a new personnel parachute called the

Advanced Tactical Parachute System, which is designed to lower the paratrooper's descent speed to lessen the potential for injury.

The level of R&D spending by U.S. manufacturers is modest, although expenditures by 15 companies rose from $641,440 in 1996 to $1,461,330 in 2000 (1.85 percent of gross industry sales of $79 million). In addition, $3.2 million in federal R&D grants were awarded annually to a few manufacturers over the survey's five-year period. DOD also provided funding for research, development, testing, and evaluation (RDT&E) activity for aerial delivery systems including parachutes, increasing from about $3.8 million in 1996 to nearly $13 million in 2000.

Production Capability & Competition

Production surge capability can be constrained by a number of factors – the availability of labor, the supply of materials, and facility capacity limitations. Parachute manufacturing firms do not keep a large inventory of textile raw materials in house – and the lead-time for obtaining raw materials sometimes can span months. Because of these factors, DOD can encounter long delivery times on new parachutes.

In addition, there are concerns regarding the management of technical data packages (TDP) – documents that contain detailed specifications on how a given parachute model is to be fabricated, assembled, and packed. These TDP issues, some of which grew increasingly troublesome over decades, have resulted in production errors, unnecessary costs, and delivery delays. Currently SBCCOM Natick is working to transfer TDP drawings from paper and/or microfiche formats into a computer-aided system. This effort will put drawings in a more flexible format that will make changes easier to execute.

Although some DOD staff assert a need for additional competition, there are now at least seven manufacturers of military cargo and/or personnel parachutes in the United States, a number sufficient to guarantee lively bidding in DOD solicitations for parachutes. Moreover, as demonstrated in June 2002, new domestic contractors will enter the military parachute market when they perceive there is sufficient opportunity. On site visits to several Big Five facilities, BIS staff noted that some plants had underutilized manufacturing space and equipment, providing extra capacity to comply with surge production demands. BIS has not seen any data that demonstrate the domestic industry lacks the capacity to meet U.S. defense needs or needs added suppliers or competition.

Recommendations

1. Improve Demand Forecasting

BIS recommends that the U.S Army Materiel Command coordinate with the U.S. Army Forces Command to require field units to submit population datasheets to SBCCOM's Integrated Materiel Management Center (IMMC) for acquisition planning purposes. This will permit SBCCOM Natick to maintain air-delivery products in inventory in a way that meets field unit requirements far more precisely.

2. Advance Parachute Materials and Manufacturing Technology

Additional funding for the development of new manufacturing technology for the production of aerial delivery systems is also recommended. It is unlikely that the industry, particularly the parachute sector, will make truly significant manufacturing changes on its own. Support for this manufacturing initiative should be directed to DOD's ManTech Program or to other appropriate federal government institutions that can actively support the initiative.

3. DOD Management of Aerial Delivery Drawing Packages

This analysis further recommends that SBCCOM Natick complete its scanning of legacy aerial-delivery-system drawings into a computer-aided-drawing system within the next 18 months. In addition, DOD should review the adequacy of the records preservation processes and archive facilities for aerial-delivery product records at SBCCOM Natick.

4. Enhance Managerial and Staff Knowledge of the Aerial Delivery Industry

SBCCOM Natick funding and authority for staff to conduct plant tours of firms that comprise the aerial delivery supply chain is recommended. These educational visits would provide acquisition and logistical staff members with a more comprehensive knowledge of all phases of the manufacturing process – from production of raw materials to finished items.

5. Advanced Parachute Design and Manufacturing Technology Forum

BIS recommends that, at least every three years, SBCCOM Natick and the Parachute Industry Association jointly hold a technology forum that includes representatives from appropriate laboratories of the Departments of Commerce, Defense, and Energy. Among other things, these forums should focus on technologies and services resident at the labs that can: (1) enhance the productivity of existing manufacturing processes, (2) improve performance modeling, testing, and quality control, and (3) develop cost-effective advanced materials and manufacturing processes that might be employed in manufacturing aerial delivery systems.

6. Amend Current Procurement Practices to Adjust for Inflation

BIS further suggests that SBCCOM Natick acquisition staff include a provision in future multi-year Indefinite Delivery/Indefinite Quantity aerial delivery contracts to account for inflation and raw material price increases that cross predetermined thresholds. Although inflation rates have been relatively low in recent years, U.S. aerial delivery product manufacturers may face the erosive effects of inflation in the future. Contractors cannot predict the prices of critical raw materials three to five years in the future.

1. Introduction

The United States aerial delivery industry is a group of companies that contribute to, or directly undertake, the manufacture of parachutes, cargo platforms, and related systems used in airborne operations to drop personnel, ammunition, vehicles, or supplies to military forces or recipients of humanitarian aid on the ground.

The companies that make up the aerial delivery industry are predominantly small manufacturing firms that produce well-established products. Most airdrop systems deployed by DOD have been fielded for many years. Some products in use today have existed since the 1950s.

Today, the aerial delivery industry, particularly its parachute supply chain, is challenged by interconnected issues that affect the ability of companies to provide the U.S. military with essential products in a timely, cost-effective manner. These issues include:

- Requirement Forecasts
- Defense Department Orders and Acquisition Practices
- Business Conditions, including sales, net income, and skilled labor
- Capital Investment
- Supply Chain Lead Times
- Technical Data Packages (TDPs) – (i.e., Government-specified, build-to-print designs)

Assessment Background

The U.S. Army Soldier Biological and Chemical Command (SBCCOM), a subordinate unit of the U.S. Army Materiel Command (AMC), requested that the Bureau of Industry and Security of the U.S. Department of Commerce (BIS) undertake this national security assessment of the aerial delivery sector. SBCCOM had become concerned about the health and competitiveness of the U.S. aerial delivery industrial base due to wide swings in demand for air delivery components throughout the 1990s.

Specifically, some of the SBCCOM locations had experienced problems in timely delivery of parachute orders from industry and were concerned about the ability of the U.S. Army to procure parachute systems quickly in a time of national need. SBCCOM's center in Natick, Massachusetts saw the need for a more detailed assessment of the aerial delivery industrial base that went beyond what was covered in earlier reviews.[2] After a joint meeting of SBCCOM Natick, BIS, and Parachute Industry Association (PIA) representatives, the following overall assessment objectives were defined:

- Collect basic economic data on the firms in the air delivery industry.
- Identify areas of improvement for communication between the U.S. Army and private industry.

[2] In 1994 and 1999, AMC performed multiple studies of the industries that produce and support its combat systems. Many of these studies did not go into extensive detail on individual firms that comprise a sector. Based on these assessments, supporting industries were assigned a "level of health."

- Identify the root cause(s) of shipment delays for air delivery systems.
- Propose recommendations to the U.S. Army and private industry for improving communication and reducing shipment delays.

BIS is delegated the authority under Section 705 of the Defense Production Act of 1950, as amended, and Executive Order 12656, to collect basic economic and production information from industry. These provisions enable BIS to obtain data essential to assessing the health and capabilities of the U.S. industrial base. With this information, the U.S. Government can develop recommendations to improve the capabilities and competitiveness of specific industrial sectors that support the national defense.

The Strategic Analysis Division of the Office of Strategic Industries and Economic Security (SIES) is the operating unit within BIS with the responsibility for conducting industry data collection and preparing analysis. SIES performed this assessment with technical support from the Integrated Materiel Management Center (IMMC) in Natick, Massachusetts,[3] SBCCOM Natick's Military Parachuting & Airdrop Systems Research & Engineering Group, and SBCCOM Natick's Robert Morris Acquisition Center.

SIES has worked with DOD and individual branches of the armed forces in conducting more than 35 assessments in the past 15 years. These studies have focused on a wide range of industries that are of importance to DOD missions, including ball and roller bearings, shipbuilding and repair, robotics, semiconductors, and aircraft ejection seats.

Assessment Coverage

This national security assessment focuses on the U.S. parachute industrial base. Most of the manufacturers surveyed produce parachutes, or components and materials used in the fabrication of aerial delivery systems. BIS' survey mailing list consists of firms identified by SBCCOM Natick, the Parachute Industry Association (PIA), and independent BIS research.

Methodology

BIS, with assistance from SBCCOM Natick, created a survey for aerial delivery firms to complete (*see Appendix A*). The survey contained a range of data elements to obtain information on the industry, including:

- Product identification
- Critical manufacturing equipment identification
- Capital investment
- Supplier identification
- Sales
- Net income

[3] On June 1, 2003, operational control of the IMMC's Aerial Delivery Sustainment Team, originally part of SBCCOM, shifted to the U.S. Army Tank-automotive and Armaments Command (TACOM). The formal date of transfer is October 1, 2003.

- Research and development expenditures
- Employment
- Factors contributing to extended manufacturing lead times
- Willingness of purely commercial firms to supply the U.S. military

The Vice President of the PIA and the Chairman of the PIA Government Systems Committee helped field test a draft survey with a representative sample of PIA members. Several modifications were made based on their comments and suggestions. The survey was then cleared by the Office of Management and Budget.

In November 2000, the survey was sent to 63 firms. Eighteen firms within the aerial delivery supply chain (not end-item manufacturers) also were surveyed in order to ascertain issues of importance to them. These companies provide components, or in some cases raw materials, to the end-item manufacturers. Supply chain health, performance, and related issues have been a long-standing concern within the aerial delivery community and are discussed in detail later in this assessment.

Thirty-four of the surveyed firms responded, with a majority filled out entirely. Of the respondents, 16 were parachute end-item manufacturers,[4] and 13 were parachute component manufacturers (supplying items such as hardware, platforms, or parachute accessories). Five firms were manufacturers within the parachute textile supply chain.

Several respondents, for a variety of reasons, could not provide all the requested data. For example, one firm sold the majority of its products to distributors and could not break down the percentage of commercial versus defense sales. The firm knew that some of its products were purchased by military users, but could not provide an accurate estimate.

The majority of respondents (27) reported some portion of their sales come directly from DOD. Five of these companies reported that they were responsible for the bulk of defense parachute end-products purchased by the U.S. military.

Twenty-nine firms were exempt from the survey. Examples of firms that claimed exemptions were either foreign commercial operations that sold in the United States or retailers of parachuting products that did not manufacture their products.

SBCCOM Natick staff provided technical support for this assessment and made comprehensive comments on the draft report. The organization also supplemented BIS survey data with information on its research, development, testing, and evaluation (RDT&E) activities and spending, aerial delivery budget data, and background knowledge about its operations.

Aerial delivery industry members contributed significant information in support of this assessment. BIS staff conducted site visits at parachute manufacturing suppliers to assess their operations and to discuss industry views and concerns on a number of issues. Industry representatives also participated in numerous phone interviews as follow-up to answer questions based on their submitted survey answers.

[4] End-item manufacturers are companies that produce complete parachutes, platforms, and other aerial delivery systems as opposed to components used within a given system.

The PIA played a critical role in raising industry awareness of the assessment. The PIA hosts several meetings per year, bringing together industry and government to discuss issues of mutual importance. The PIA permitted BIS representatives to attend and participate in several of these meetings during the assessment.

2. Defining the Aerial Delivery Industry

"Aerial delivery" is a military phrase that refers to products used to airdrop personnel, ammunition, vehicles, or supplies to military forces or recipients of humanitarian aid on the ground. In major engagements and in large relief efforts, the Department of Defense can consume hundreds if not thousands of these specially engineered units.

The industry consists largely of parachute manufacturers and suppliers of components used in various air delivery systems. Cargo and personnel parachutes are the main products of the aerial delivery industry, but manufacturers also produce special skids, pallets, and shock absorbing systems for delivering products to the ground intact.

Production of military cargo and personnel parachutes account for most of the air delivery industry. There is, however, a commercial component – the civilian sport-parachute market. Although both groups produce parachutes, there are substantial differences between the two business sectors. Commercial parachute customers demand wide choices of styles and color arrangements. Commercial manufacturers are accustomed to very small production runs and are adept at making one or very few of a specific item.

Military parachute manufacturers, in contrast, typically have larger production runs of several hundred to over a thousand of a particular parachute system. The parafoil, or "square" parachute, is popular in sport parachuting but only sees limited use in the military. The majority of military parachutes are round in shape and have limited or no steering capability, which is important to large scale paratrooper operations. It is undesirable to have several hundred paratroopers independently steering their parachutes because of the risk of collision.[5]

There are also common elements in the military and commercial parachute industries. The two sectors, for instance, use common raw materials such as the type of nylon (Type 6,6) parachute fabric. Commercial specifications for parachute raw materials were based originally on military specifications. In addition, the general layout and basic components of military and civilian parachutes are similar. Both commercial and military systems combine a canopy, cords, tapes and webbings, and metal parts to form a complete parachute.

Commercial air-delivery system manufacturers cannot easily become suppliers to the military market. Specifications for military production are very strict, and manufacturers must adhere to specific government-owned drawings rather than meet the performance requirements of their commercial customers. Beyond demonstrating a capability to meet DOD specifications, commercial manufacturers that want to enter the defense aerial delivery market also must learn and abide by government solicitation, procurement, inspection, and payment procedures.

Commercial parachute companies are a resource to which DOD can look in a time of national need. Many suppliers are willing to manufacture aerial delivery components or systems for DOD applications. BIS received eight responses from surveyed firms that currently do not supply products to the U.S. military; five stated they would supply the military in a time of

[5] The exceptions to this are military demonstration teams such as the U.S. Army Golden Knights and the Special Forces community, which use parafoil parachutes for their ability to maneuver and to travel greater horizontal distances compared to round parachutes.

conflict or if there were compelling economic incentives. Three companies stated that under existing market conditions they were interested in becoming DOD suppliers.

Given the opportunity to sell much higher volumes, why don't more commercial manufacturers try to enter the military market for parachutes? New entrants, formerly commercial market-focused, may be required to invest in new manufacturing capability and/or capacity to produce military products without any assurance of obtaining a contract given the strong competition in the military market.

Design Technology

The design technology for defense parachutes has advanced slowly from the 1940s through the mid-1990s. Designs for many currently-deployed systems are mature and have not changed because of their history of success.

Cargo parachutes are a prime example of this. Their mission requirement is to deliver a variety of objects within certain performance parameters, e.g., load specification and rate of descent. With few exceptions, cargo parachutes function as designed. Thus, there has been little need to change their designs radically. SBCCOM Natick reports that some cargo parachutes that were manufactured in the 1950s and 1960s are still in depots awaiting requisitions. The same stability in design parameters is true for personnel parachutes such as the T-10, which uses a design that has been in service with few alternations since the 1950s.

Changes in requirements, however, are forcing the redesign of some parachute systems. Since the deployment of the T-10, the weight of the U.S. soldier has increased as the amount of equipment carried has grown. This increased weight translates into higher descent speeds, which in turn increases the likelihood of landing injuries. To address this problem, the U.S. Army is developing a new personnel parachute called the Advanced Tactical Parachute System which will lower the paratrooper's descent speed and lessen injury rates.

Several cargo parachute development programs also are underway that could change how cargo parachutes are produced and used. The aim of one program is to design a lower-cost, one-time-use cargo parachute and container system that utilizes different materials and construction techniques. Another research and development program is designing precision-guided parachutes that can deliver cargo to a specific location.

Customer Base

The manufacturers operating in the United States that produce military aerial delivery systems sell to a variety of domestic and international customers. Most production is for use by U.S. DOD agencies.

Thirty-four respondents reported selling complete units or components used in purchased air delivery products to at least eight U.S. government agencies. The U.S. Army is the most frequently-referenced customer with 24 mentions. The Air Force and Navy were identified as ultimate customers of their products by 22 manufacturers (see *Table 1*).

Table 1: **Customers for Aerial Delivery Products**	
Customer	***Number of Firms Responding***
U.S. Army	24
U.S. Air Force	22
U.S. Navy	22
U.S. Marine Corps	10
Forestry Service	10
NASA	9
Defense Logistics Agency (DLA)	8
Others (e.g., Coast Guard, National Guard, etc.)	5
Foreign Military	15
Source: U.S. Department of Commerce, BIS Survey	

Seventeen respondents reported foreign defense sales, and 15 of these specified 40 international customers. The most referenced international defense customers were the United Kingdom and Australia. In aggregate, foreign defense sales comprised 17 percent of these reporting companies' total sales. According to SBCCOM officials, U.S.-made parachutes are often preferred by many defense customers around the world.

The Big Five

As stated earlier, five defense-devoted parachute companies produce the majority of completed aerial delivery goods for the U.S. military as measured by gross sales, according to public business sales data and corroborated by BIS survey data.[6] These manufacturers have dominated the defense-cargo and personnel markets for years. Of late, however, they have been challenged by other manufacturers.

The "Big Five" are listed below in alphabetical order:

- FXC Corporation/Guardian Parachute – Santa Ana, CA
- Irvin Aerospace – Hope Mills,[7] NC and Santa Ana, CA
- Mills Manufacturing Corporation – Asheville, NC
- Para-Flite,[8] Inc. – Pennsauken, NJ
- Pioneer Aerospace Corporation – South Windsor, CT and Columbia, MS

Three of these firms (Irvin, Para-Flite, and Pioneer) operate manufacturing facilities in the United States, but are owned by foreign companies. Wardle Storeys Ltd. of the United Kingdom owns Irvin and Para-Flite,[9] and the Zodiac Group of France owns Pioneer Aerospace.

[6] Highest sales based on analyst's comparison of Dun and Bradstreet 2002 sales information from surveyed companies. Compiled from Hoover's Online, March 2004.

[7] Irvin closed its Hope Mills, NC, manufacturing plant in October 2002 and consolidated its operations in its Santa Ana, CA, plant due to reduced business levels. See www.airbornesystems-na.com/main.html.

[8] In 2001, Wardle Storeys Ltd. of the United Kingdom, which owns Para-Flite, Inc., purchased Irvin Aerospace. For the purposes of this assessment however, Irvin and Para-Flight are considered two separate firms.

[9] See www.airbornesystems-na.com/main.html for more merger information.

The Big Five[10] firms are engaged in what has been described by industry officials as "cutthroat competition." These manufacturers compete consistently for the same orders and know each other well. The five firms often file Freedom of Information Act (FOIA) requests after a competitor wins an award to obtain detailed financial data on the winning bid.

The defense parachute industry always struggles for profitability, particularly in times when parachute usage is at low ebb. In order to compete for contracts, the industry uses a lowest-bid process (as compared to Best Value) that further strains profits, observes Bill Kernodle, Site Director of Clemson Apparel Research (CAR)[11] at Clemson University and the former commander of the U.S. Army Natick RD&E Center in Natick, Massachusetts. In fact, BIS survey financial data indicate that at any given point in time over the past decade, at least one of the Big Five suppliers was not financially healthy.

Classification of the Aerial Delivery Industry

Detailed, reliable statistical data on the aerial delivery industry are not readily available from standard statistical sources. DOD does not maintain consolidated records on parachute consumption and purchases by type or by service agencies.

Likewise, it is complicated to acquire specific parachute industry information from Bureau of the Census data. Parachute and parachute component manufacturing (the highest profile aerial delivery activity discussed in this assessment) are subsumed in larger categories of the U.S. Census Bureau's old Standard Industrial Classification (SIC) system and its current North American Industrial Classification System (NAICS), which was adopted in 1997.

Parachute manufacturing falls under SIC 2399 (*Fabricated Textile Products Not Elsewhere Classified*), parachute hardware under SIC 3429 (*Hardware Not Elsewhere Classified*), and parachute fabric under SIC 2221 (*Broadwoven Fabric Mills, Manmade Fiber and Silk*). Under the newer NAICS system, there is no category for parachute hardware, and parachute fabric data are included in the *All Other Textile Product Mills* category under NAICS 314999.

To illustrate the shortcomings of the available statistics, the BIS industry survey respondents indicated approximately $80 million in average annual sales from 1996 to 2000, while in 2000, the Census Bureau reported total shipments of approximately $6.5 billion for NAICS 314999. Because the NAICS classification involves a much broader set of manufacturing firms than strictly parachute manufacturing, these NAICS data are not a precise characterization of the industry.

[10] Within the parachute industry the largest three parachute firms (Irvin, Mills, and Pioneer) are known as the "Big Three." BIS added FXC/Guardian and Para-Flite so that company responses can be discussed without revealing proprietary data.

[11] Since 1988, CAR [http://car.clemson.edu/] has operated a model apparel plant and conducted research and development on apparel-related problems as part of the U.S. Defense Logistics Agency apparel technology program. In December 1992, CAR joined the NIST Manufacturing Extension Partnership as part of SMTC (which is now known as SCMEP - South Carolina Manufacturing Extension Partnership). This established CAR as the national resource center for sewn-products manufacturing and extended its developments to all types of manufacturers.

3. The Parachute Industry

Many factors, both external and internal, can affect the economic health, manufacturing readiness, and technical capabilities of the aerial delivery industry. The challenge before DOD and manufacturers operating in the United States is to find ways to bring greater stability to the industry to assure the continuation of a robust supply base.

Survey data suggest that the industry may be subjected to market turbulence and uncertainty. Sudden, unforeseen events can account for a large portion of the major spikes in military needs for aerial delivery products. The variability[12] that parachute manufacturers experienced in the 1996-2000 period, however, also may be viewed as normal cyclical shifts in demand not unlike those seen in other industries. In any case, the boom and bust cycles experienced by the aerial delivery industrial base are perceived as having negative consequences, including:

- Unstable financial performance
- Reduced ability of firms to deliver products and to meet quality standards in a timely fashion
- Inhibited capital investment and diminished interest in improving manufacturing technology that would reduce the dependency on skilled labor
- Potentially higher finished product prices for the U.S. Government

As of the Fall of 2002, the Army estimated that it had more than 103,000 cargo parachutes in stock at its depots – inventory worth approximately $231.6 million. The average cost of these parachutes is $2,246. Inventory levels for main personnel parachutes were at or near zero. Approximately 20,750 emergency reserve parachute units were held in depots. These parachutes were valued at $17.6 million and have an average cost of $848 a unit.

What is held in storage at Army depots is only a part of the total military parachute inventory, however. Substantial numbers of additional cargo and personnel parachutes are located in the field at military installations in the United States and at U.S. bases around the world. DOD estimates that this "field inventory" may consist of another 175,000[13] cargo and personnel (includes emergency reserve units) parachutes.

Cargo Parachutes[14]

Different factors – mission requirements, safety standards, durability, and environmental factors – influence the draw-down of standing inventory and need for cargo versus personnel parachutes. Cargo parachutes play critical roles in many military and humanitarian missions. They are used to airdrop food, ammunition, heavy equipment, and other supplies into remote regions where no significant logistical network exists to support military missions or relief efforts.

[12] For the purposes of this study, variability is defined as dramatic shifts in orders, sales, employment, and net income from year-to-year at the firm level.
[13] Field inventory estimate provided to BIS by SBCCOM Natick.
[14] SBCCOM Natick officials provided information on procurement processes, mission requirements, storing procedures, other uses, and specific orders.

World events such as the conflicts in Bosnia, Kosovo, or Afghanistan can place the U.S. military in a situation where local infrastructure has been destroyed or is nonexistent, so support for ground forces must be dropped from aircraft. By the nature of the reusable design and intermittent use of cargo parachutes, consumption of such parachutes is relatively low during peacetime, when they principally are used in training exercises. Cargo parachute use can soar, however, in times of conflict or when they are needed to support materiel deliveries for humanitarian assistance.

Predicting DOD needs for new cargo parachute inventory is difficult. The devices have an indefinite shelf life, and once used, may be retrieved and repaired where necessary until the cost of repair is more than the replacement cost.[15] There are cargo parachutes in depots today that were manufactured in the 1950s and 1960s. Parachutes of this vintage and younger are returned to depots when military units no longer require them or when units are disbanded. Depots manage their parachutes based on a first-in-first-out (FIFO) inventory policy.

The standing inventory of cargo parachutes is by no means static given the turn-in practices employed by DOD. Not only does "wear and tear" ultimately require purchases of new cargo parachutes, but military and humanitarian campaigns also deplete inventory levels. U.S. military units do not retrieve parachutes that are used in hostile territory and thus these parachutes are lost. In the case of humanitarian operations, food or supplies are dropped in areas that may not be controlled by U.S. forces and therefore are considered hostile. In such instances, there can be high losses of cargo parachutes – more so than for any other type of supply mission.

Because of the nature of their use, orders for cargo parachutes can be infrequent. When orders are made, they can be for numbers that are high compared to industry's ability to manufacture new items quickly. Industry production lines may be cold or operating at a greatly reduced rate compared to the newly-defined need. Orders can become more erratic if the U.S. military uses reusable cargo parachutes as one-time-use items. Not only is this expensive for the U.S. military, but the resulting demand for replacements after a conflict is difficult for the industrial base to satisfy quickly. At present, SBCCOM Natick is investigating one-time-use parachutes for future actions.

Sudden spikes in DOD requirements for parachutes present manufacturers with numerous management challenges and risks. A military operation can end as quickly as it begins, greatly reducing product demand and causing field units to return excess and recovered parachutes to the depots. In this kind of scenario, contractors have to try to anticipate demand.

Production surge capability can be constrained by a number of factors – the availability of labor, the supply of materials, and facility capacity limitations. For reasons that will be detailed later in the assessment, parachute manufacturing firms do not keep a large inventory of textile raw materials in house – and the lead-time for obtaining raw materials sometimes can span months. Because of these factors, DOD can encounter long delivery times on new parachutes.

Not only do parachute manufacturers have to consider production decisions carefully; so must their suppliers. Suppliers to parachute manufacturers also recognize that demand for production

[15] A standard commonly known as Beyond Economical Repair (BER).

can change rapidly. For companies to avoid incurring excess expenses and remain financially viable, they have to reduce employment levels rapidly and closely monitor material inventories.

In the case of Operation Enduring Freedom in Afghanistan, initial usage rates for G-12 cargo parachutes were very high, which caused a concern that the current inventory and production could not keep up with demand. Cloth suppliers to the parachute industry responded by producing long lead-time textile materials without a contract in order to have the material available quickly.

The intensity of the operation waned faster than many predicted, as did the usage rates for G-12 cargo parachutes. For a period, cargo parachute orders were not guaranteed, even though suppliers had adjusted production systems to accommodate order surges. However, a solicitation for the G-12 parachute worth $19.2 million was released in March 2002 and was awarded in June 2002. The $19.2 million order was large by industry standards – requiring the manufacture of 5,566 cargo parachutes. The average cost of the parachutes was almost $3,500 per unit.[16]

Personnel Parachutes[17]

The parameters governing the manufacture and operational use of personnel parachutes differ from those of cargo parachutes in many ways. Personnel parachutes carry soldiers to the ground and are considered life-support devices, while cargo parachutes do not have the same status. Because of this, requirements for the construction and use of personnel parachutes are different than those for cargo parachutes – and in most cases personnel parachute specifications are more stringent.

Unlike some inventoried cargo parachutes manufactured as early as the 1950s and 1960s, personnel parachutes can have a significantly shorter lifetime. Personnel parachutes have a determined service life (a maximum shelf life) without use of 16.5 years, and every personnel parachute is stamped with a manufacturing date that starts its life-cycle clock. A personnel parachute is also stamped with the date that it is first placed in service (PIS). From that point on, a parachute's service life cannot exceed 12 years. The longer the unit sits on the shelf the less service life it has once placed in service. Every personnel parachute is monitored by field units to track age and level of use. DOD keeps a depot inventory of approximately 20,000 personnel parachutes of various types.

If a parachute is damaged during use, its repair or replacement depends on a combination of repair cost and age factors. A sliding scale (driven by age) determines if it makes financial sense to fix a parachute or to retire the unit and replace it. For example, if a personnel parachute has 10 years remaining on its service life, the cost to repair it cannot exceed 80 percent of the cost to replace it. Generally, the repair cost allowance falls eight percent with every year of service life that is lost.

[16] All qualified companies were invited to bid and there was significant industry competition. In the end, the largest order went to a hot air balloon manufacturer. Three Big Five companies also won production contracts, as did a firm that primarily manufactures sport parachutes.

[17] SBCCOM Natick officials provided information on procurement processes, mission requirements, storing procedures, other uses, and specific orders.

New orders of personnel parachutes are driven by safety standards limiting the kind of repairs that may be made and by mandatory retirement of aged parachutes. The largest user of personnel parachutes is the U.S. Army, followed by the Marines, Air Force, and Navy. DOD purchases new parachutes every year, but not all personnel parachutes that are retired are necessarily replaced in the same year. For a variety of reasons, replacement purchases may be deferred.

Industry Performance

The U.S. parachute manufacturing industry is focused on two markets – military needs, which account for most of the volume and sales; and civilian sport parachutes. The industry is also divided in another way: 1) manufacturers of parachutes; and 2) suppliers of parachute materials and components.

For the five-year period examined in the survey, the industry was essentially stagnant with defense parachute manufacturers reporting annual sales averaging $60.7 million. Real income from the sale of parachutes shrank overall after accounting for inflation over the course of the reporting period (see *Table 2*).

The defense parachute market is dominated by five manufacturers which, during each of the five years in the reporting period captured at least 95 percent of all defense parachute sales. At the company level, however, not all of these "Big Five" companies performed equally – and some manufacturers saw market share mildly eroded by smaller competitors.

The years 1996 through 2000 were marked by significant swings in demand. Combined domestic and foreign sales jumped about 8 percent in 1997 and 1998 relative to 1996, but then fell nearly 16 percent the following year.

Table 2: **Total Defense Parachute Industry Sales*** *(Millions of Dollars)*

YEAR	***1996***	***1997***	***1998***	***1999***	***2000***
Domestic Defense	$46.5	$55.5	$48.0	$45.8	$43.4
Foreign Defense	$14.4	$10.1	$16.3	$8.6	$15.1
Total Defense	**$60.9**	**$65.6**	**$64.3**	**$54.4**	**$58.5**

**Includes cargo and personnel parachutes.*
Source: U.S. Department of Commerce, BIS Survey

Volatility in demand for defense parachutes occurred in both domestic and foreign markets. After seeing sales jump from $46.5 million in 1996 to $55.5 million in 1997, manufacturers watched domestic purchases of military parachutes fall steadily through 2000. Despite lower 2000 domestic sales, revenues from foreign sales of military parachutes caused overall sales to increase in 2000. That year, foreign demand accounted for $15.1 million (26 percent) of the $58.5 million of military parachutes sold, an increase over 1999 when foreign defense sales totaled only 16 percent of the value of the military parachutes sold.

Although the Big Five manufacturers in the United States dominated domestic sales of defense parachutes from 1996 to 2000, their sales declined over the period. The Big Five saw parachute sales to the U.S. military drop from a peak of $54.3 million in 1997 to $41.7 million in 2000.

Total domestic defense sales in 2000 for individual Big Five manufacturers ranged from $1.8 million to $15 million.

Foreign orders for defense parachutes captured by Big Five companies over the period had a fluctuating pattern, starting at $13.6 million in 1996 and then falling to $9.4 million the next year. By the close of 1998, foreign purchases from the Big Five had soared to $15.6 million, only to plunge in 1999 more than 50 percent to $7.5 million. Sales rebounded again in 2000 to $14 million.

In contrast, a group of some 10 smaller manufacturers of parachutes appears to have had a smoother market experience. These firms recorded small, steady gains in sales even as overall DOD orders declined. In 1996, small manufacturers of military parachutes participating in BIS's survey posted sales to the U.S. government of about $1 million – a figure that hit $1.6 million in 2000. Total sales of defense aerial delivery products in 2000 by smaller U.S. manufacturers to both U.S. and foreign military customers reached $2.76 million.

An important segment of the parachute industry is its supply chain, which provides textile items, manufactured material components of parachutes, and assorted fittings and hardware. There are five textile suppliers[18] and thirteen hardware and component manufacturers that supply both military and civilian parachute makers.

The value of the component products made by the surveyed suppliers in any given year ranges from about 25 percent to nearly 50 percent of the total revenue generated by manufacturers of military parachutes (see *Table 3*). The average annual defense sales of parachute material and component suppliers as a group for the 1996-2000 period totaled $19.2 million.

Table 3: **U.S. Defense Aerial Delivery Supply Chain Sales**
(Millions of Dollars)

YEAR	***1996***	***1997***	***1998***	***1999***	***2000***
Domestic Defense	$17.8	$16.3	$12.9	$13.0	$24.9
Foreign Defense	$1.1	$2.0	$1.3	$4.8	$2.1
Total Defense	**$18.9**	**$18.3**	**$14.2**	**$17.8**	**$27.0**

* Based on data provided by companies and on estimated sales figures.
Source: U.S. Department of Commerce, BIS Survey

The downturn experienced by manufacturers of defense parachutes for the U.S. defense market in the 1996-2000 timeframe was also experienced to a large extent by the parachute supply chain. Sales of material and components for defense products as a group declined from $17.8 million in 1996 to $13 million in 1999. In 2000, however, supply chain manufacturers' sales of materials for domestic military parachute production increased sharply to $24.9 million. Supply chain sales, in fact, equaled 57 percent of sales of the $43.4 million in domestic military parachute sales in 2000. The large increase in business suggests that parachute manufacturers anticipated a major rise in orders in 2000 or 2001.

Supply chain manufacturers also experienced inconsistent annual orders for materials and components from defense parachute manufacturers in support of sales to foreign customers in the 1996-2000 timeframe (see *Table 3*). Overall, demand for materials and components to meet

[18] Textile suppliers for the purpose of this report are defined as parachute textile weavers, canopy material finishers, and tape and webbing manufacturers.

foreign orders for parachutes showed an upward trend. Supply chain sales stood at $1.1 million in 1996 and rose to $4.8 million in 1999, before declining again to $2.1 million in 2000.

Civilian Parachute Industry

Table 4: **Civilian Parachute Sales** (Millions of Dollars)					
Year	***1996***	***1997***	***1998***	***1999***	***2000***
Domestic	$13.6	$19.8	$18.3	$16.0	$18.7
Foreign	$2.9	$3.4	$3.5	$3.1	$2.8
Total	**$16.5**	**$23.2**	**$21.8**	**$19.1**	**$21.5**
Source: U.S. Department of Commerce, BIS Survey					

While production and sales of personnel and cargo parachutes represent the major portion of the U.S. parachute industry, the manufacture of parachutes for the civilian market is also relevant to the industry's health. BIS surveyed 13 parachute manufacturers in the United States that produce civilian products. Three of the Big Five military manufacturers are among these suppliers. As a group, companies surveyed by BIS that serve this market exhibited growth over the 1996-2000 period.

Consumer demand for sport parachutes and other civilian parachutes grew from $16.5 million in 1996 to $21.5 million in 2000. Sales of these parachutes to domestic and foreign customers peaked during the five-year period at $23.2 million in 1997 – and averaged $20.4 million annually. As a whole, the civilian sales reported by respondents are about one-third the size of the military parachute market, where combined domestic and foreign sales in 2000 reached $58.5 million.

Table 5: **Supply Chain Commercial Sales** (Millions of Dollars)					
Year	***1996***	***1997***	***1998***	***1999***	***2000***
Domestic	$5.60	$5.50	$5.00	$5.20	$5.70
Foreign	$0.25	$0.33	$0.33	$0.29	$0.34
Total	**$5.85**	**$5.83**	**$5.33**	**$5.49**	**$6.04**
Source: U.S. Department of Commerce, BIS Survey					

Demand in the domestic market accounts for the majority of civilian parachutes manufactured in the United States. Domestic sales hit $18.7 million in 2000 while sales of civilian parachutes to foreign customers totaled $2.8 million. Domestic parachute sales showed significant growth over the five-year period. Foreign sales increased and then in 2000 fell slightly below 1996's $2.9 million sales level.

The civilian parachute market's consistency may help supply chain manufacturers to some extent with the fluctuations in demand from the military parachute market. Frequently, these companies serve both civilian and military markets. Sales of materials and parachute components to manufacturers of civilian parachutes averaged $5.4 million annually (see *Table 5*) from 1996 through 2000. As with the sales pattern of civilian parachutes, the manufacture of materials and components for domestic parachute producers accounts for the majority of the civilian supply-chain business.

Table 6: **Combined Civilian and Defense Parachute Sales** (Millions of Dollars)					
Year	***1996***	***1997***	***1998***	***1999***	***2000***
Commercial	$16.5	$23.2	$21.8	$19.1	$21.5
Defense	$60.9	$65.6	$64.3	$54.4	$58.5
Total	**$77.4**	**$88.8**	**$86.1**	**$73.5**	**$80.0**
Source: U.S. Department of Commerce, BIS Survey					

Net Income

For the 1996-2000 period, respondent parachute manufacturers operating in the United States had combined sales of military and civilian parachutes that averaged $81 million a year (see *Table 6*). As mentioned previously, sales in both the defense and civilian parachute sectors were up and down over this period.

Most surveyed parachute manufacturers reported positive net income in each of the five years covered by the survey. However, companies reported major fluctuations in net income in this timeframe (see *Table 7*). A 50 to 200 percent shift in net income year-to-year among these companies was not uncommon.

Big Five companies experienced significant shifts in both sales and net income. Indeed, two Big Five companies had year-to-year net income fluctuations exceeding 1000 percent. In addition, it was not uncommon for many manufacturers to have variations in net income from one year to the next of several hundred percent. In each year from 1996 through 1998, four of 15 parachute manufacturers that provided data (the companies varied from year to year) reported losses.

Table 7: **Net Income* for Parachute Manufacturers**
(Millions of Dollars)

Net Income	1996	1997	1998	1999	2000	5-Year Total
Big Five	$-3.1	$0.9	$1.8	$1.0	$2.7	$3.3
All Parachute Mfrs	$-2.8	$1.3	$2.2	$1.4	$3.3	$5.1

*Data cover net income on all company operations, including military and civilian parachute manufacturing activities.
Source: U.S. Department of Commerce, BIS Survey

Given the fluctuation of end-user manufacturer net income, many of the 18 supply-chain manufacturers of textiles and parachute components likely experienced similar volatility in net income for the 1996-2000 period for their parachute-related business. It is not possible to confirm this, however, because the net income information provided to BIS covers the entire corporate activity of those companies, most of which have multiple product lines and operating divisions.

Employment

After sales, the next most apparent area where variability in demand affects the aerial delivery industry is employment. In line with sales figures, the aerial delivery industry's total employment levels also experienced fluctuation. As in many industries, employers at times have difficulty retaining skilled workers and often find it hard to attract and keep qualified replacement personnel. Respondent parachute manufacturers note that they must compete with other industries where there is a shrinking pool of skilled workers.

Table 8: **Employment for All Parachute Firms Surveyed***

Year	Non-Production	Manufacturing, Assembly	Engineering/ R&D	Other Employees	Total Employees
1996	210	1,041	53	27	1,330
1997	220	1,110	54	27	1,411
1998	210	1,037	55	26	1,327
1999	203	952	61	30	1,245
2000	218	958	66	32	1,274

*Total employment represents data collected by BIS for all parachute manufacturers surveyed, including the Big Five; and data for the supply chain firms surveyed. Figures for supply chain firms are estimated based on survey data.
Source: U.S. Department of Commerce, BIS Survey

Swings in sales revenue and in net income in the parachute industry produced highs and lows in employment ranks. Parachute manufacturing companies that participated in BIS's survey employed more than 1,300 people in 1996, a figure that declined modestly in subsequent years (see *Table 8*) before improving again to around 1,270 in 2000. The Big Five parachute companies appear to be responsible for a significant portion of total employment reported by survey participants. Employment at these companies in 1999[19] constituted 69 percent of total parachute manufacturers' employment (see *Table 9*). Consequently, significant changes in business at Big Five companies had a considerable impact on the entire aerial delivery sector in terms of employment.

Table 9: **Employment for the Big Five Parachute Firms**

Year	*Non-Production*	*Manufacturing, Assembly*	*Engineering/ R&D*	*Other Employees*	*Total Employees*
1996	142	845	37	13	1,037
1997	128	872	40	13	1,053
1998	115	694	38	12	859
1999	93	711	43	11	858
2000	110	734	47	11	902

Source: U.S. Department of Commerce, BIS Survey

As with net income, from year to year over the survey period there were extreme swings in employment within specific companies. From 1996 to 2000, the greatest shifts in employment numbers occurred in manufacturing and assembly, including shifts in three well-established defense manufacturers, all of which either increased or decreased their manufacturing workforces by more than 40 percent within two years.

Aerial delivery supply chain firms showed similar characteristics in terms of employment. In 2000 both supply chain firms and end-user manufacturers reported slight increases in employment in the "Engineering/R&D" category, and supply chain companies also reported a small rise in the "Other Employees" category.

Parachute manufacturing operations derive a large percentage of their value added from labor. Sewing operations, in particular, require skills that must be gained through experience. A few experienced and talented sewing personnel can do the work of several less capable individuals, according to an industry representative. Companies in parachute manufacturing can and do use layoffs or allow the work force to reduce significantly through attrition. However, these methods are problematic, according to several of the five largest parachute manufacturers, because employees that leave the industry often do not return.

Hiring new, inexperienced staff has significant costs and drawbacks. Firms and veteran employees must endure learning curves and lower productivity while new manufacturing employees are trained. This slows industry's response to demand surges. In addition, when economic times are good, companies report that competition from other non-aerial delivery-related fields can make attracting and retaining new employees substantially more difficult. Indeed, a number of companies identified reasons why they found it harder to recruit and retain

[19] The year 1999 was selected for measuring the percentage of parachute manufacturing that was attributable to Big Five companies because the data were thought to be more accurate than 2000 numbers, which were based on estimates in some instances.

workers (see *Table 10*). Nineteen respondents reported some type of labor shortage in the 1996 to 2000 period. The top reasons were a lack of skilled workers and a limited applicant pool.

Table 10: **Reasons for Labor Shortages**

	Respondents
Lack of Skilled Workers	17
Limited Applicant Pool	14
Healthy Economy	7
High Cost Labor Zone	4
Facility Location	2
Lack of Government Contracts	2

Source: U.S. Department of Commerce, BIS Survey

Firms also were asked to identify skills they have had difficulty replacing within three areas: manufacturing and assembly, non-production, and engineering/research & development. Manufacturing skills were cited by survey participants with 22 mentions. Sewing was the most referenced problem skill, mentioned 16 times. Throughout the survey, site visits, and phone interviews, respondents stated that people with parachute sewing skills are becoming harder to find. Companies are dealing with this problem in different ways. Some are utilizing recent immigrants with basic sewing skills. Others have the benefit of hiring employees who are laid off from other types of textile operations to take the place of departing employees.

Seven firms stated that workers with non-production skills also are difficult to find. Examples included parachute riggers, equipment maintenance specialists, and administrative workers with knowledge of the parachute industry. In addition, four firms indicated they have difficulty finding industrial and design engineers.

The problem of finding new employees could be a particularly serious issue if manufacturers have to rapidly increase production. When the BIS survey asked respondents how they would ramp up for full production[20] and national emergency production[21] levels, a majority of companies stated they would increase their output through the addition of labor. For example, firms may have to increase the number of shifts from an average of one to three shifts per day for national emergency production. Not surprisingly, finding labor was referenced by nine firms as a limitation to reaching full production and by 13 firms to reaching national emergency production.

[20] Full production capability is defined as the maximum level of production that a manufacturing establishment could reasonably expect to attain under normal and realistic operating conditions. See *Appendix A, p. 52,* for the detailed guidance provided to survey participants.

[21] National emergency production is defined as the maximum level of production that a given manufacturing facility can attain and sustain for one year or more under national emergency conditions. National emergency conditions are situations such as a military mobilization or national disaster which are likely to create widespread excess demand requiring additional work shifts. See *Appendix A, p. 52,* for the detailed guidance provided to survey participants.

4. Market Environment

Procurement and Inventory Control

DOD reports that its purchases of aerial delivery products are affected by a number of variables, including world events, changing parachute applications, inventory-tracking systems, procurement strategies, vendor lead-times, and related supply-chain issues. U.S. Government demand for air delivery parachute systems historically has been inconsistent because requirements for military and humanitarian missions often cannot be predicted.

At the request of manufacturers, SBCCOM Natick shares its forecasts for parachutes and other air-delivery products with industry. But because unit missions change frequently, the 3- to 5-year forecasts often do not reflect actual future orders. The manufacturers, in turn, cannot plan production runs and operate their businesses in an efficient manner.

The weakness in forecasting demand for cargo and personnel parachutes is partly attributed to the uncertain buying habits of military field units. According to SBCCOM Natick, there can be as many as 150,000 personnel and reserve parachutes held in field unit inventories at any one time. Cargo parachute inventories in the field cover more than eight models and are estimated to total around 25,000 parachutes. It is not unusual for field units to order the entire inventory of an aerial delivery product shown to be in warehouse inventory and to backorder additional parachutes as well, according to one SBCCOM Natick representative.

Conversely, field units at times restrict their purchases to only items that are in stock – and defer orders of additional parachutes without necessarily notifying SBCCOM Natick that there is an outstanding need. Consequently, the military warehouse rebuilds inventory to normal levels, not recognizing that there is a remaining unmet need that will draw down replenished inventory levels at a faster than normal rate.

In addition, the relationship between parachute inventories at DOD depots and DOD need for the parachutes can be skewed further when a field unit reduces its demand for an item while a procurement is in process. This action can create an unplanned "surplus" of that type of parachute, which must be placed in depot inventory. In such cases, DOD winds up with more parachute inventory than required and must bear additional costs associated with storage and management of the inventory.

Warehouse managers and their suppliers encounter additional supply chain fluctuations near the end of fiscal years, when field units may face a "use it or lose it" situation with their budgets. Unanticipated purchases of aerial delivery products introduce further peaks and valleys in demand, thus affecting manufacturers' planning for production runs and warehousing requirements.

Data Barriers and Bottlenecks[22]

DOD employs several mechanisms to manage inventories of items such as parachutes. Making use of them, however, is not always possible or easy, nor does it produce inventory and usage

[22] SBCCOM Natick provided information regarding DOD data processes.

information that is consistently reliable. The reason: modern, standardized data reporting processes for inventory levels, inventory condition, current consumption, and projected needs are not uniformly employed within all DOD field units. Indeed, some DOD organizations use paper-based inventory systems that do not convert readily to newer systems being employed in other DOD units. Field units keep their data in a variety of formats.

SBCCOM Natick has sought to overcome this problem by establishing a standardized reporting system, the Population Data Sheet (PDS) form, as a DOD-wide inventory information standard. However, organizational barriers and "corporate cultures" within field units inhibit the use of common information standards, according to DOD officials. Were field units to adopt PDS as a standard, SBCCOM officials say they could forecast the future need for some parachutes classes, specifically personnel parachutes, with far greater accuracy than is now possible.

Moreover, field units historically have not shared their inventory information with SBCCOM Natick in *any* format despite frequent requests to do so. In August 2003, SBCCOM Natick reported that it had received inventory information from the U.S. Army Special Operations Command, which is responsible for 12 of what SBCCOM Natick estimates to be 60 active duty field units. However, without broader participation, especially from large organizations like the 82nd Airborne Division, accurate field inventory information remains elusive.

Without the benefit of the PDS, SBCCOM Natick is mandated by the Army Materiel Command to use Supply Control Studies (SCS) that capture the history of recurring and non-recurring demands from units to forecast what parachutes it will need to procure in the future. These reports are generated by a computer system recalling the last two years of the procurement history for a given item and providing a monthly forecast to the Integrated Materiel Management Center (IMMC).[23] However, the results of supply-control studies are highly dependent on the demand inputs provided by units, and as such, accurate demand forecasts may not be realized with the SCS data. Although the system is useful for items purchased frequently, several years often elapse between procurements of some aerial delivery items, and demand forecasts may not be accurate.

If SBCCOM Natick required universal field units to use a better tool (such as the PDS) to gauge requirements, it could more effectively match its acquisitions with the near future needs in the field. DOD also could avoid unnecessary costs associated with procuring and managing excess inventory.

DOD Procurement Practices[24]

As a result of (1) inventory management practices and (2) uncertain demand patterns for aerial delivery systems, it is difficult for the parachute industry to predict DOD procurements of aerial delivery products. This uncertainty presents problems for manufacturers in terms of scheduling

[23] SBCCOM's Integrated Materiel Management Center (IMMC) provides centralized management of SBCCOM's sustainment and readiness efforts. It manages and oversees cost schedule and performance parameters of SBCCOM's major and secondary items, as well as maintenance, logistics operations, security assistance, supply acquisition, sustainment, and disposal system activities. The IMMC funds most acquisitions through the Army Working Capital Fund, a revolving fund that supports all Major Subordinate Commands including SBCCOM Natick.

[24] SBCCOM Natick officials provided information on DOD procurement procedures.

production, maintaining their workforce, working with supply chains, and planning capital and R&D expenditures.

To some extent, the variability in defense parachute procurements forces parachute suppliers to incur higher variable costs (labor) relative to fixed costs (capital equipment) than is seen in similar industries. These companies have to retain excess skilled labor in order to respond to unforeseen demands for production. These labor costs negatively affect the companies' economic situations, in many cases reducing capital investment.

According to three large suppliers that participated in the survey, uncertain demand also can inhibit companies from making significant investment in new automated manufacturing equipment, which would improve product quality and increase manufacturing efficiency. Increased automation in the industry is needed, they warn, because maintaining skilled labor with specialized sewing experience is becoming more difficult (*See Pages 15-17).*

Respondents to BIS's survey cited demand uncertainty as the most challenging aspect of government contracting. Lack of balanced overall delivery schedules, the requirement that personnel parachutes be certified and included in a Qualified Product List,[25] and rules affecting contract deviations and waivers (*See Page 41*) are also problems for manufacturers. According to survey participants, these matters and other issues contribute to extended manufacturing lead times, thus delaying delivery of shipments. They noted that product delivery schedules can be adversely affected by slow responses by DOD to questions, very small orders, frequent changes in contracting personnel, and long wait-times for the award of contracts after the issuance of a Request For Proposals.

Supplier Issues

Several of the largest military parachute suppliers are troubled by a contracting vehicle used by SBCCOM Natick known as Indefinite-Delivery/Indefinite-Quantity (IDIQ). Indefinite-Delivery contracts may be used to acquire supplies and/or services when the exact times and/or exact quantities of future deliveries are not known at the time of contract award.[26] SBCCOM Natick contends that it uses the IDIQ contract to help ensure that government gets the best price possible as well as to achieve efficiencies and other benefits.[27]

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[25] A Qualified Product List (QPL) is a registry of companies whose products meet the performance, quality, and reliability levels of a DOD product qualification program (See *http://www.dscc.dla.mil/offices/sourcing_and_qualification/default.asp*).

[26] FAR 16.501-2 General. (a) There are three types of indefinite-delivery contracts: definite-quantity contracts, requirements contracts, and indefinite-quantity contracts. The appropriate type of indefinite-delivery contract may be used to acquire supplies and/or services when the exact times and/or exact quantities of future deliveries are not known at the time of contract award. Pursuant to 10 U.S.C. 2304d and section 303K of the Federal Property and Administrative Services Act of 1949, requirements contracts and indefinite-quantity contracts are also known as delivery order contracts or task order contracts.

[27] FAR 16.501-2 General. (b) The various types of indefinite-delivery contracts offer the following advantages:
(1) All three permit-
(i) Government stocks to be maintained at minimum levels; and
(ii) Direct shipment to users.
(2) Indefinite-quantity contracts and requirements contracts also permit-
(i) Flexibility in both quantities and delivery scheduling; and
(ii) Ordering of supplies or services after requirements materialize.
(3) Indefinite-quantity contracts limit the Government's obligation to the minimum quantity specified in the contract.
(4) Requirements contracts may permit faster deliveries when production lead time is involved, because contractors are usually willing to maintain limited stocks when the Government will obtain all of its actual purchase requirements from the contractor.

Some parachute manufacturers contend that very large ranges between the minimum and the maximum acquisition estimates included in IDIQ solicitations make judging the military's true need nearly impossible. An example of this type of solicitation is DAAD15-02-R-0004 issued February 14, 2002, for the MC1-1C/MC1-1D personnel parachutes and harnesses. The minimum contract value is $400,000 and the maximum is $28 million, although the Federal Acquisition Regulations (FAR)[28] specify that "the contracting officer shall state a realistic estimated total quantity in the solicitation and resulting contract."[29]

In such a business environment, one industry representative observed, manufacturers are forced to wait until the delivery orders are awarded before they can commence production. Because there is a limited shelf life for parachute nylon, firms cannot afford to hold a vast inventory of raw material that may or may not be used in the future. In turn, suppliers of this material also must balance the size of their workforces.

IDIQ solicitation rules permit DOD to split delivery orders among the winning contractors. In the case of DAAD15-02-R-0004, SBCCOM Natick stated that its solicitation likely would be split – the aim being to maintain manufacturing capability at multiple contractors. If each of the Big Five parachute suppliers, for example, were to win this solicitation and the minimum ($400,000) was split evenly among them, it would equate to $80,000 of business for each company, an inefficiently small production run.

In addition to having concerns about the size difference between the minimum and maximum contract values, industry companies contend there are other solicitation elements that put them at a disadvantage. One of the determining factors that industry uses to formulate its price is the cost of raw materials. In the example of solicitation DAAD15-02-R-0004, firms are required to give unit prices for each ordering period of the five-year contract based on the following potential production runs:[30]

- 1 to 500 units
- 501 to 1000 units
- 1001 to 1500 units
- 1501 to 2000 units
- 2001 to 2500 units

The solicitation allows no provisions for price adjustment based on escalations in costs. One company noted that proposed unit prices must be computed up to five years in advance without knowing what raw material prices will be at that time. Parachute manufacturers are faced with the choice of: 1) taking the risk that raw material prices during the contract will not climb significantly, or 2) building in a cushion to protect themselves – at the risk of not being competitive against other bidders.

[28] FAR 1.102 Statement of guiding principles for the Federal Acquisition System. (a) The vision for the Federal Acquisition System is to deliver on a timely basis the best value product or service to the customer, while maintaining the public's trust and fulfilling public policy objectives. Participants in the acquisition process should work together as a team and should be empowered to make decisions within their area of responsibility.

[29] FAR 16.503 Requirements contracts

[30] An ordering period is equivalent to one calendar year.

Another contracting provision that complicates procurement is a requirement that imposes economic quantity pricing rules on contracts awarded within 45 days of a given contract. Suppliers must combine total-unit orders for each contract and then recalculate the unit price to the government based on the higher unit volume.

While DOD aims to benefit from lower prices in such situations resulting from improved economies of scale, the affected vendor may not be able to obtain similar economic quantity pricing from his supply chain given what can be up to a 44-day spread in placing material orders.

As mentioned above, parachute manufacturers typically keep little parachute fabric and related materials in inventory because of limited shelf life and cash management considerations. Consequently, companies receiving multiple orders from DOD within a short period may see profits significantly reduced, depending on contract provisions.[31]

Discontinuity: The Move from St. Louis to Natick

In 1997, the U.S. Army shifted aerial delivery logistical and procurement responsibilities (SBCCOM) from St. Louis, Missouri, to Natick, Massachusetts. However, a majority of the experienced staff from the U.S. Army's Aviation Troop Support Command in St. Louis did not move with their organization.

While the Natick Soldier Center facility did have expertise in aerial delivery items, it was in the area of research & development and engineering support. Personnel at Natick had little knowledge of the logistical or procurement functions – the business end of obtaining parachutes and maintaining inventories.

A significant number of manufacturers participating in BIS's survey are fairly critical of the way the transfer of the parachute requisition branch was handled. Nine companies accounting for a majority of the defense sales addressed in this report stated that they were negatively affected moderately to severely by the move.

Four of the nine firms stated that SBCCOM lost institutional knowledge in the areas of program history, technical expertise, and procurement history, which led in some cases to a substantial slowdown in operations. One firm stated that this situation has improved over the last several years as SBCCOM Natick staff has become more familiar with their new responsibilities.

In a similar move, the U.S. Navy and Air Force relocated their respective aerial delivery procurement functions to the Defense Logistics Agency in the late 1990s. The results of this move were less disruptive, according to BIS survey respondents. One firm stated that it had a severe effect, while seven firms said the impact was moderate. Many of the comments made regarding the Air Force and Navy relocation were similar to those made about the Army's move from St. Louis to Natick.

DOD Sourcing

Moreover, receiving a contract to supply DOD is not necessarily a straight forward process based on the simple submission of sealed bids and the selection of a low bidder. As a general rule, DOD prefers to have multiple sources of supply for many kinds of goods and services, and it tries to hold down costs. These goals are no different when it comes to buying parachutes.

SBCCOM Natick frequently issues solicitations for supplying parachutes over a period of time, often years. Firms are selected as qualified contractors after being evaluated on such considerations as past performance in meeting delivery schedules, product quality requirements, and price. Even if a company is selected as a qualified contractor, however, actual sales to DOD may prove elusive. In many parachute solicitations carried out in the last five years, SBCCOM

[31] In the case of the referenced solicitation of MC1 personnel parachutes, the solicitation states (Section H-3) that:
"Should the Government issue delivery orders within 45 days of each other and final delivery has not occurred, the delivery order will be issued reflecting the economic quantity pricing the total quantity of all relevant delivery orders. All affected delivery orders will be subsequently modified to reflect the lower economic quantity pricing."

Natick has required firms to go through a second round of bidding for follow-on delivery orders under a given solicitation. The prime aim is to reduce costs further.

Industry executives note that competitive tension is heightened by the fact that detailed information on supply bids submitted by those companies selected in the first round of the solicitation can be divulged to competitors – essentially made public – through Freedom of Information Act (FOIA) requests.[32]

SBCCOM Natick does not release unit price data on delivery orders awarded to parachute manufacturers in response to Freedom of Information Act (FOIA) requests if legitimate reasons are provided to justify blocking release. Manufacturers are notified by certified mail and given at least 30 days to respond before SBCCOM Natick will releases contract award and unit price data. Release of unit price or unit quantity data does not occur when a company can demonstrate that competitive harm will result. The schedule of a near-term solicitation for bids for parachute production can be a legitimate reason to deny the release of unit pricing and unit data associated with recent delivery contract awards, according the FOIA Officer at SBCCOM Natick. In such instances, SBCCOM Natick may choose to release total contract values without unit quantity data. FOIA requests received by SBCCOM Natick are handled on a case-by-case basis. Until sometime in 2002, SBCCOM Natick's acquisition office routinely posted contract award data on its website, but that practice was halted. Contract award information now is released only in response to FOIA filings that have been reviewed and after affected companies have had an opportunity to respond to the disclosure request.

The environment of uncertainty generated by DOD's bidding process is amplified by the suppliers' inability to know what size order the department will actually place, how many certified contractors will share that order, and how that order will be apportioned.

SBCCOM Natick IDIQ parachute solicitations typically identify supply requirements in terms of minimum and maximum needs over a period of time, usually three to five years. SBCCOM Natick may elect to buy only the minimum figure cited in the solicitation, and it can spread the acquisition over several years in a series of supply competitions based on price and ability to meet delivery schedules. These awards do not permit explicit escalators for inflation. Moreover, SBCCOM Natick reserves the right to award the entire supply contract to a single vendor or to distribute supply orders across some or all of the previously qualified contractors.

In addition, in no case over a solicitation's time span may DOD pay a given contractor more[33] for a parachute than the price the company bid in the initial bid package on the basis of which the company was determined to be an eligible contractor. This requirement is different from some DOD procurement policies in other sectors, where new technology development costs, for example, may rise unexpectedly and require excess payments above the original bid price.

[32] A review of recent case law on the release of unit price data under FOIA requests can be found at: http://www.usdoj.gov/oip/foiapost/2002foiapost13.htm.

[33] Section H of solicitation DAAD15-02-R-0004 states, "Offerors are encouraged and expected to further compete price and delivery orders for additional quantities on further orders. In no case will a delivery order be awarded at a higher price or longer delivery schedule than imposed by the basic contract."

Several industry suppliers contend that IDIQ actually violates the spirit of FAR performance standards of "fairness."[34] Competing for an initial award is certainly fair, but several parachute manufacturers contend that requiring a company to compete against itself after winning the initial contract in an open competition[35] violates the aforementioned concept of fairness.

Although the FAR does not state a second competition is prohibited, it also does not state that one should be performed. In one instance, the FAR states that the contracting officer should solicit prices on a delivery order "…if the contract did not establish the price for the supply or service...."[36]

Several established military parachute manufacturers see the IDIQ approach as problematic because (1) companies in multi-year solicitations may be forced to absorb inflation in materials, labor, and overhead; and (2) parachute suppliers that are selected as qualified contractors in first-round bids must effectively compete against themselves in subsequent competitions within the solicitation to obtain revenue-producing delivery orders.[37] When SBCCOM Natick requests bids on delivery orders, parachute suppliers know that competitors have knowledge (through FOIA, as previously discussed) of their initial baseline prices for a given parachute. Hence, manufacturers are likely to have to submit bids that are below the original prices they offered in the qualifying round.

This process can create concerns about contractor profitability and the ability to sustain the current number of suppliers. Industry executives assert the parachute manufacturing base supporting SBCCOM Natick is strained by the IDIQ contract process. There also are concerns that manufacturers' future investments in plant modernization to improve quality and efficiency – actions that would benefit DOD – may suffer as a result. Capital investment by the five largest parachute manufacturers is already lagging, having declined 41 percent from 1996 to 2000.

From SBCCOM Natick's vantage point, multi-year IDIQ contracts have many advantages. SBCCOM states that "This type of contract allows for ongoing informal competition throughout the life of an acquisition program, streamlines and reduces acquisition lead times, and provides

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[34] FAR 1.102-2(c)(1) Conduct business with integrity, fairness, and openness.
(1) An essential consideration in every aspect of the System is maintaining the public's trust. Not only must the System have integrity, the actions of each member of the Team must reflect integrity, fairness, and openness. The foundation of integrity within the System is a competent, experienced, and well-trained, professional workforce. Accordingly, each member of the Team is responsible and accountable for the wise use of public resources as well as acting in a manner which maintains the public's trust. Fairness and openness require open communication among team members, internal and external customers, and the public.

(2) To achieve efficient operations, the System must shift its focus from "risk avoidance" to one of "risk management." The cost to the taxpayer of attempting to eliminate all risk is prohibitive. The Executive Branch will accept and manage the risk associated with empowering local procurement officials to take independent action based on their professional judgment.

(3) The Government shall exercise discretion, use sound business judgment, and comply with applicable laws and regulations in dealing with contractors and prospective contractors. All contractors and prospective contractors shall be treated fairly and impartially but need not be treated the same.

[35] FAR 2-201.1(b) Definitions. "Full and open competition," when used with respect to a contract action, means that all responsible sources are permitted to compete.

[36] FAR 16.505 (b) (3 – Pricing Orders)

[37] FAR 16.501-1 Definitions. As used in this subpart - "Delivery order contract" means a contract for supplies that does not procure or specify a firm quantity of supplies (other than a minimum or maximum quantity) and that provides for the issuance of orders for the delivery of supplies during the period of the contract.

additional opportunities to firms that would otherwise be frozen out of a particular program for periods of up to five years."

As for the aspect of the IDIQ process that requires qualified contractors to compete against their own bids, Natick Acquisition Center (NAC) officials acknowledged that from a contractor's standpoint, this "is a drawback." The agency, however, asserts that the parachute industry "…overstates the impact of this feature on the process." NAC states that "Were contracts awarded on a single-year basis, competitors would gain the benefit of knowing the successful offer's price in any case – and price is not the sole evaluation factor used …."

It should be noted that SBCCOM Natick's decision to change its contracting process from the previous "winner-take-all" to an IDIQ acquisition strategy was partly driven by industry dissatisfaction with earlier solicitation practices. Under past awards, unsuccessful offerors could go more than a year without new production contracts from SBCCOM for a given product. Large parachute manufacturers sought an alternative to awards to a single firm.

5. Manufacturing Technology, Capital Investment, and R&D

The methods and processes employed on the production floor, the attitude of management toward employing new technology and investing in new tooling and facilities, and the financial commitments that organizations make to research and development are the basis for success in any industry.

These measures are applicable to U.S. parachute manufacturers, but their industry works in a unique environment. Most of its income is obtained from U.S. federal government orders rather than small foreign government purchases, and civilian parachute manufacturers capture a much smaller share of the market than defense parachute manufacturers. As described earlier in this report (*see Chapter 3),* the core defense parachute industry during the 1996-2000 period experienced a general decline in orders and sales. The economic stress caused by this decline is reflected in the limited resources companies allocated to capital investment in new plant and equipment and to R&D.

Manufacturing Technology

For years, officials at SBCCOM Natick have been concerned about the state of the manufacturing equipment used by the aerial delivery industry. This is also an issue that the Parachute Industry Association (PIA) is watching. At a February 2002 PIA meeting, the organization's vice president noted that aging production equipment was not being replaced or updated in a timely fashion.

Industry officials acknowledge that, with few exceptions, the manufacturing technology in use today in most plants lags the state-of-the art. Information provided by industry participants in BIS's survey confirms that a number of manufacturers operate with production equipment that is many decades old. In addition to data gathered from survey questions, BIS examined equipment age and technology issues during site visits and through additional interviews.

The data reveal that there is a wide age-range of manufacturing equipment in use in U.S. parachute plants – dating from 1919 to the present. The most numerous manufacturing tool in use was the manual sewing machine. There were a variety of sewing machine types used by various companies which were made by many different manufacturers. Single-, double-, and four-needle machines were the production tools most often mentioned by survey respondents.

Parachute manufacturers frequently referenced textile-cutting equipment as well. Some firms use manual methods for cutting, while others use automated cutting equipment. Manufacturers of textile items for use in aerial delivery end-products reported traditional textile manufacturing equipment such as looms, finishing, and drying equipment. Firms that manufacture metal parts for aerial delivery products listed traditional metal working equipment such as machining centers and milling machines. In total, BIS obtained data on approximately 305 production machines, of which 15 units were described as irreplaceable equipment.[38]

[38] Because respondents described their manufacturing equipment in various levels of detail, it was difficult to catalog and identify precisely the number of different production machines currently in use across the industry. Therefore, the 305 machines noted here is an approximation, and does not necessarily represent unique machine types.

During site visits, parachute firm representatives commented that they are not particularly concerned about using manual sewing machines. These industry representatives indicated that they use several mitigating strategies to reduce the risks of using older manufacturing equipment including these machines. Some firms, for example, manufacture spare parts on site, while others purchase surplus equipment from closed textile operations. Companies also stated that the cost of newer computer-controlled sewing equipment is much higher than the cost of manual equipment: Under current business conditions, it is less expensive for companies to repair and maintain their current equipment than to purchase new equipment.

For the moment, firms do not anticipate any kind of production crisis will be caused by equipment problems. BIS asked firms to rate the frequency of causes of longer-than-expected lead times – and equipment problems were not cited as a frequent cause. Companies participating in the survey largely categorized manufacturing equipment function as an "occasional" problem. The specific problems referenced were machinery breaking down and old equipment where tooling and parts were difficult to obtain.

Is there an equipment crisis that could significantly disrupt delivery of parachutes from U.S. vendors? According to the industry respondents, the answer is "No." However, although the systems function adequately at present, there is a general recognition across major manufacturers that in the future, as spares and replacements for old machines disappear, old machines will require replacement with new ones.

In interviews, the majority of the Big Five expressed interest in exploring new manufacturing technology. The level of interest depended on each company's needs. Three companies were interested in new processes and another firm was moderately interested, but one manufacturer was not. The moderately and non-interested firms were not convinced that newer automated equipment is robust enough for the parachute industry. To be attractive to the companies, the acquisition and use of modern equipment must show net economic benefits compared to maintenance and use of existing equipment, including consideration of relative labor costs.

Firms that were more optimistic voiced similar concerns, but expressed a belief that utilizing modern automated equipment would make their operations more flexible and reduce their dependence on labor. One manufacturer observed that for some production tasks, capital equipment could be reconfigured faster than people could be reoriented to new production work.

Even if new equipment is shown to be flexible enough to support several product lines, firms say that at this time the cost of automated equipment is too high and not justifiable under current business conditions. Modernization may have to take place over time unless there is a sustained pickup in parachute orders and revenues.

The use of modern production equipment has been finding its way into parachute production processes for some time. Some automated sewing machines can perform specific stitch patterns based on a mechanically automated, cam-driven system. A few firms have invested in computer-controlled equipment. In addition, some firms have attempted to automate existing manual equipment, with mixed results. These modernization efforts, however, have been very limited compared to the total inventory of manual equipment on production floors. Indeed, one industry

representative wondered why companies should invest in expensive manufacturing equipment for production runs of only 100 of a given item.

Capital Investment

Historically, the manufacture of parachutes has been a labor-intensive business. It remains so today at most parachute manufacturers in the United States.

Economics plays a large role in the decision of parachute manufacturers to upgrade production plants, or buy machinery and equipment that would enable them to produce more efficiently and to improve quality control. The relatively low-volume nature of the business and uncertainty of order frequency and size are key reasons why many U.S. manufacturers have been slow to adopt modern, automated processes.

To survive in uncertain business conditions, companies have focused on variable costs (labor) rather than fixed costs (capital equipment). This is reflected in the fact that capital expenditures for the aerial delivery industry are low compared to many other industries, especially capital expenditures per employee (*See Pages 30-31*).

Since 1997, overall capital investment in plant and equipment by the 16 firms surveyed has declined steadily. Total investment peaked in 1997 at $1.6 million – a figure that declined to $626,000 in 2000. Average annual spending on plant and equipment across the 16 companies was $1.1 million for the five-year period (see *Table 11*).

Table 11: **Parachute Manufacturers' Capital Investment***
(Actual Dollars)

Type of Investment	***1996***	***1997***	***1998***	***1999***	***2000***	***Annual Average***
Plant	$419,807	$1,098,868	$632,704	$727,538	$212,113	$618,206
Equipment Machinery (New, Used, Rebuilt)	$577,365	$518,789	$589,420	$435,540	$413,831	$506,989
Total	$997,172	$1,617,657	$1,222,124	$1,163,078	$625,944	$1,125,195

Source: U.S. Department of Commerce, BIS Survey
** Responses from 16 surveyed firms*

In three of the five years covered by the survey, most of the capital investment went into production plant facilities as opposed to the acquisition of equipment and related production machinery. Average annual capital investment in plants and facilities by the 16 companies was $618,000 compared to $507,000 for equipment and machinery.

Much of the decline in annual capital investment came from the Big Five parachute manufacturers. Overall expenditures on plant and equipment declined steadily from $572,000 in 1996 to $335,000 in 2000. The average annual expenditure for the five companies was $470,000 during the five-year period (see Table *12*).

Big Five expenditures on plant and facilities averaged $200,000 a year, dropping from $279,000 in 1996 to $145,000 in 2000. A single company accounted for most of the capital spending by

the Big Five over five years. Another manufacturer had no capital outlays for new plants or improvements during the survey period. In addition, spending on equipment and machinery by the Big Five averaged $270,000 a year. These outlays peaked in 1998 at $323,000 and fell to $190,000 in 2000. Two companies' outlays on equipment and machinery represented more than half of all Big Five spending in each year of the survey period.

Table 12: **Parachute Manufacturers' Capital Investment -- Big Five Firms**
(Actual Dollars)

Type of Investment	***1996***	***1997***	***1998***	***1999***	***2000***	***Annual Average***
Plant	$279,000	$216,000	$226,000	$135,000	$145,000	$200,200
Equipment Machinery (New, Used, Rebuilt)	$293,000	$293,000	$323,000	$251,000	$190,000	$270,000
Total	$572,000	$509,000	$549,000	$386,000	$335,000	$470,200

Source: U.S. Department of Commerce, BIS Survey

In total, the Big Five's major competitors, all smaller firms, logged nearly as much capital investment, or in some years more, than the Big Five firms. Larger firms, such as the Big Five, often require less capital expenditure than newer, smaller competitors. However, some of the competitors also spent little on capital improvements during the period.

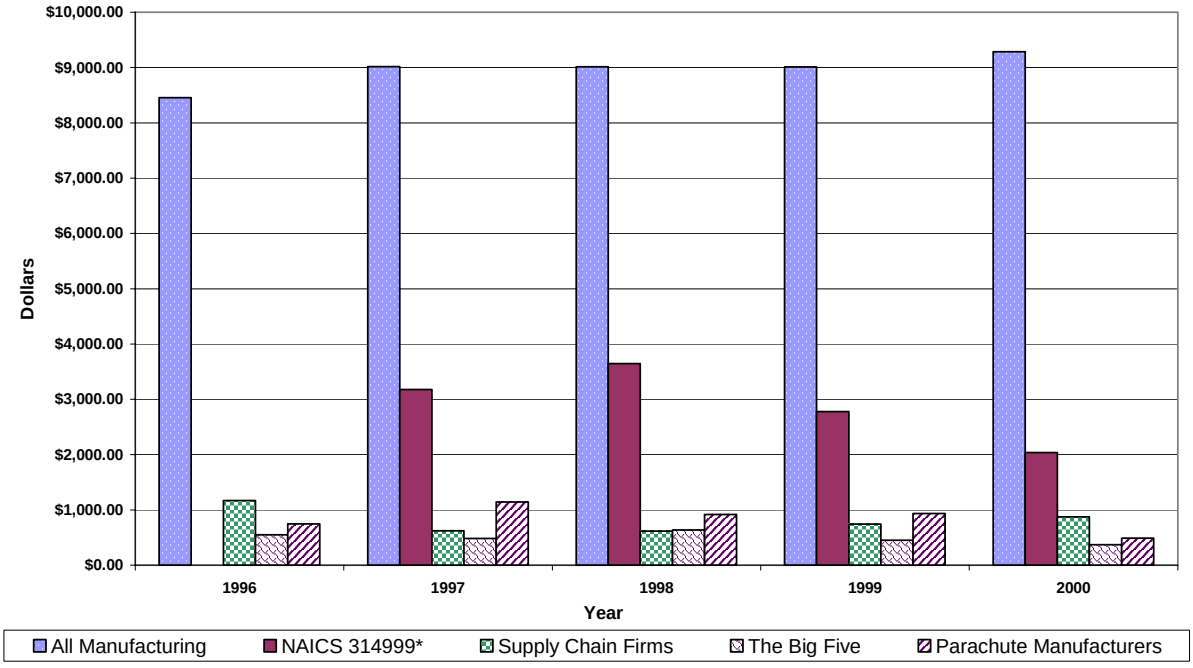
Of the 11 smaller competitors to the Big Five, six spent no funds at all during 1996-2000 on new plant or plant improvements. Similarly, three of the 11 smaller parachute manufacturers made no investment in equipment and machinery during the five-year period. A single company's purchases of equipment and machinery accounted for most of the capital outlays by the smaller manufacturers in this category. In most years, the majority of the 11 companies had capital outlays below $50,000.

Capital Investment per Employee

In the parachute manufacturing industry, the importance of labor costs vs. capital investment is particularly acute given the concerns about skilled labor in the sector and the relatively old production equipment. As such, compared to other industries, parachute manufacturers often exhibit low levels of capital investment per employee.

During the final years of the five-year period from 1996 to 2000, parachute manufacturers spent less per employee on capital expenditures than during the years at the beginning of the period. Capital expenditures per employee fell from a high point of approximately $1,100 per employee in 1997 to approximately $500 by the year 2000 (see *Chart 1)*.

Chart 1: **Capital Investment per Employee**



* NAICS 314999 did not exist in its current form until 1997.

Source: U.S. Department of Commerce, BIS Survey

The Big Five spent less on investment per employee than did all parachute manufacturers. Their capital investment fell approximately 42 percent from 1998 to 2000, ending the period with average expenditures of less than $400 per employee. In terms of capital investment per employee, aerial delivery supply chain companies outspent the "Big Five" each year with the exception of 1998 and outspent all parachute manufacturers in 1996 and 2000.

BIS also compared survey participant results against the U.S. Census Bureau's code for All Other Textile Product Mills (NAICS 314999[39]) and the entire manufacturing sector (NAICS 31). NAICS 314999 capital expenditures per employee also fell from 1996 to 2000 – from approximately $3,200 to $2,000. In contrast, capital investment per employee increased for the entire manufacturing sector from approximately $8,500 to $9,200 per employee from 1996 to 2000.

Future Investment

When BIS survey respondents were asked if they plan in the next five years to replace or upgrade the manufacturing equipment they described as critical in the BIS survey, just over half of the parachute firms, including the Big Five, responded "yes."

[39] NAICS 314999 did not exist until 1997.

Of the 16 parachute manufacturers surveyed, nine (or 56 percent) planned to upgrade or replace their manufacturing equipment. Of the remaining firms, five did not expect to invest in upgraded or new equipment while two companies were unsure. Of the 18 aerial delivery supply-chain firms surveyed, 10 (or 56 percent) planned to upgrade or replace their equipment, five did not plan to invest, and three manufacturers were uncertain.

Table 13: **Reasons for Deferred Capital Investment**

Reason	***Number of citations***
Overcapacity (within firm)	4
Shrinking Market	4
Low Profitability	3
Insufficient Funding	3
Excessive Competition	3
Stagnant Equipment Technology	2
Equipment Replacement not Available	1
Other: (Out of the Market or Exiting the Market)	2

Source: U.S. Department of Commerce, BIS Survey

Three of the Big Five companies expected to invest in new equipment, according to the survey. However, BIS interviews with defense parachute manufacturers revealed that their recent capital expenditures during the survey period did not replace a significant amount of manufacturing equipment compared with their total holdings of production equipment.

Firms that stated they did not plan to upgrade or replace manufacturing equipment gave a variety of reasons. The most referenced causes (four citations each) in the BIS survey were overcapacity within a firm and a shrinking market. The next tier of causes (cited three times by companies) for not making such investments were: low profitability, insufficient funding and excessive competition (see *Table 13*).

Research and Development

Unlike the industry trends found in accounting measures such as sales, employment, and net income, research and development (R&D) expenditures saw relative stability in the aerial delivery industry. Parachute manufacturers as a group increased spending over the five-year period covered in the survey.

Investment in R&D by 15 companies rose from $641,440 in 1996 to $1,461,330 in 2000. The industry's R&D spending climbed steadily in every year of the five-year period (see Table *14*). This level of R&D spending as a percentage of revenues is tiny, less than one percent of the $75.9 million in sales of civilian and military parachutes posted by manufacturers in the United States in 1996. By the year 2000, however, overall R&D spending by the industry rose to 1.85 percent of gross industry sales, which were approximately $79 million.

While the increase in R&D spending by the industry may seem to be an encouraging sign, a closer look at the data shows that most of the investment was made by just a few of the 15 manufacturers. In 1996, 77.5 percent of the $641,000 invested in R&D by the industry could be attributed to three companies – and five companies reported no R&D spending at all that year.

After 1996, R&D expenditures started to increase noticeably across the industry. In 2000, the three companies that dominated R&D spending in 1996 accounted for less than half the industry's R&D expenditures. The number of companies reporting spending nothing on parachute-related R&D dropped from five to three. Even so, R&D investment by the parachute

industry trails that of many manufacturing sectors, in part because DOD – the industry's prime customer – finances some of this activity. In fact, most of the R&D pertaining to parachute technology is financed not by industry but by the government, according to BIS survey data.

Federal spending on parachute R&D for the survey period experienced a bounce in 1997, but was essentially flat for four out of five years. R&D expenditures in 1996 were $3.09 million, and jumped to $4 million the following year before dropping to $3.14 million in 1998. R&D fell further to $2.91 million in 1999 and then climbed slightly to $3.19 million.

In 1996 and 1997, DOD spent all its parachute R&D funds through a contract with a single parachute manufacturer. For 1998 through 2000, R&D spending went to two contractors in any given year – but the vast majority of spending again was concentrated in the single contractor that won all the R&D contract funds in 1996 and 1997. In short, most manufacturers of parachutes that responded to the BIS survey received no federal contracts to perform parachute-related R&D.

In addition to R&D by parachute manufacturers (financed both by the manufacturers and by DOD), R&D also was performed by companies in the supply chain. Most of these supply firms were not able to break out R&D costs associated with the manufacture of parachutes, as many of the suppliers' R&D activities have multiple applications for a range of consumer and military products.

Total federal expenditures on parachute technology were significantly larger than the $3.2 million in 2000 R&D funding reported by BIS survey respondents (see *Table14*). In addition to R&D performed by survey respondents and internally by the U.S. government, there were additional expenditures for testing and evaluation (T&E) of parachute designs and pre-production units.

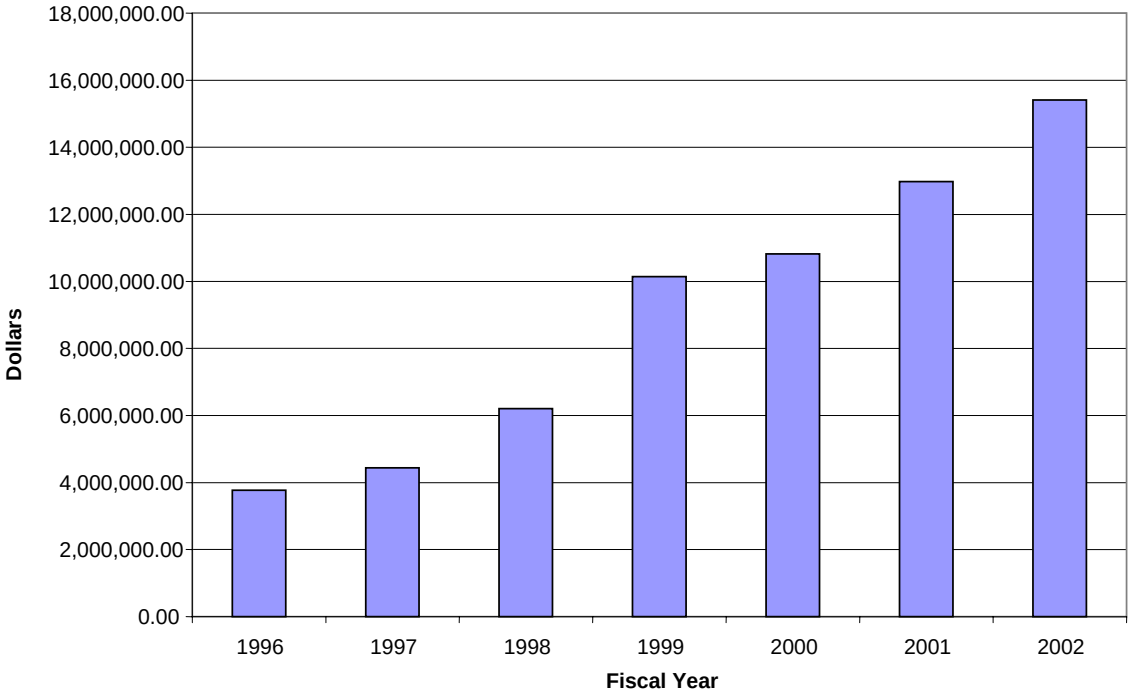
Table14: **Parachute R&D Spending**
(Thousands of Dollars)

Year	***1996***	***1997***	***1998***	***1999***	***2000***	***Total***
Companies	$641	$907	$1,023	$1,145	$1,461	$5,177
Government	$3,089	$4,004	$3,140	$2,913	$3,188	$16,334
Other	$300*					$300
Total	**$4,030**	**$4,911**	**$4,163**	**$4,058**	**$4,649**	**$21,811**

**Represents a one-time expenditure by one company.*
Source: U.S. Department of Commerce, BIS Survey.

Support for most DOD Research, Development, Testing and Evaluation (RDT&E) air delivery activities is centered at the U.S. Army Natick Center, which reported spending nearly $13 million in 2001. Overall RDT&E related to parachutes grew to this amount from about $3.8 million in 1996. As can be seen by comparing Table 14 with Chart 2, most DOD RDT&E parachute expenditures in recent years – as reported by Natick – appear to have been for testing and evaluation activities.

Chart 2: **Total RDT&E Spending for Air Delivery – U.S. Army Natick Soldier Center**



Source: U.S. Army Natick Soldier Center

New Tactical Needs Drive R&D

Changes in technology and new tactical strategies are being adopted by DOD. These events are sparking a phase-change that already is putting new demands on manufacturers to innovate and to produce new products. The evolution that is taking place poses risks for established firms that stand to lose market share if they cannot adapt – and may provide opportunity for new entrants in the industry.

One of the higher profile products that boosted RDT&E is the development of the Advanced Tactical Parachute System (ATPS). This new personnel parachute will replace the ubiquitous T-10, the primary paratrooper parachute since the 1950s. ATPS has advanced through the development and evaluation phases of the RDT&E cycle and is currently scheduled to begin production in fiscal year 2005. As a result, DOD spent increasing amounts of T&E dollars on the project from 1996 through 2002.

Two other primary drivers for this spending are precision airdrop and the Low Cost Aerial Delivery System (LCADS). Precision airdrop consists of a family of airdrop systems that use the Global Positioning System (GPS) or other guidance packages to re-supply ground forces with much higher accuracy than current systems. The guidance package controls the delivery of a cargo load to a specific point using gliding or non-gliding canopies. Several programs are in development for various cargo weights (600 lbs., 700-1,500 lbs., and 10,000-42,000 lbs.).

The impact of precision airdrop on the aerial delivery industrial base could be substantial. These systems integrate guidance and steering equipment into a complete aerial delivery system.

Current parachute manufacturers will be challenged to develop these new guidance and systems capabilities and integrate them in future products. This might be done by working with subcontractors or entering into joint ventures with firms with electronics expertise. Manufacturers that choose not to position themselves to make these new products could cede this portion of the market to current or future competitors.

An additional R&D effort is the LCADS program, DOD's effort to develop and evaluate the feasibility of deploying disposable parachutes in humanitarian operations and other special situations in place of more costly, reusable, conventional parachutes.

Tactical Switch to Boost Parachute Use?

The ability to place cargo in a specific location will become more important in the future due to changes in U.S. Army strategy. The Army aims to configure itself as a more deployable force – in the form of either the Interim Brigade Combat Teams (IBCTs) or the Objective Force that is planned in the longer term.

The IBCT is a medium-weight force that can be deployed anywhere in the world (chiefly by air) within 96 hours.

The Objective Force will be built around a new generation of combat vehicles that have much of the same capability of current heavy mechanized forces. These combat vehicles, however, will be much lighter (20 tons) than today's vehicles (up to 70 tons. They will be deployable by air, thereby giving DOD a mobile and lethal force that can be more readily inserted into situations that require military intervention.

Expanded use of this aerial delivery capability, according to an SBCCOM Natick representative, would take airdrop beyond "airborne and emergency resupply to more routine use for Army ground units."

In concept, LCADS may be less complicated to manufacture and easier to use than conventional parachutes. The materials involved in the construction of LCADS most likely would not be nylon Type 6,6. Instead, the parachutes would be made of non-woven materials available on the commercial market in such large quantities that any military demand would be a small portion of the total demand for the material. One candidate material that was considered is Dupont's non-woven Tyvek®,[40] an engineered sheet material for vapor control used by the housing industry. There is a possible secondary benefit to DOD of deploying LCADS other than lower manufacturing costs. The use of lower-cost materials that are more readily available could expand the number of manufacturers willing to produce cargo parachute systems for DOD.

The effort through LCADS to find new materials for parachutes also could lead to a larger initiative to move away from woven fabric for other cargo aerial delivery systems. Using non-woven materials would allow for new manufacturing techniques that could reduce or eliminate non-critical sewing operations from the manufacture of aerial delivery products.

The principal method for joining sections of material would most likely be lamination rather than sewing.[41] If the technology is perfected and shown to be cost effective, sewing of seams would be greatly reduced or eliminated. The need for a highly skilled production works also would vanish in certain manufacturing steps.

[40] SBCCOM Natick tested and eliminated Tyvek® as a potential material for parachutes.
[41] Information about the LCADS technology provided by SBCCOM Natick.

Hard Sell: Exploration of Manufacturing Modernization Opportunities

Textile items such as clothing and parachutes may not be viewed as high technology items, or as a high priority compared to aircraft or complex weapons systems, but they are critically important to the U.S. military. The preservation of a U.S. capability for producing quality defense textile items at a low cost is a concern in some quarters of the Department of Defense and within industry, particularly given the erosion of the domestic commercial textile base over the past 20 years.

In 2000, researchers from the Clemson Apparel Research Center at Clemson University in South Carolina and colleagues at North Carolina State University joined with officials of the Research and Engineering group of SBCCOM Natick's Military Parachute and Airdrop Systems Division to conduct a preliminary assessment of whether there are significant opportunities for improving parachute manufacturing processes and technologies.

These research entities were accompanied by manufacturers of tools for fabricating textile-based products such as parachutes and clothing. The team visited multiple parachute manufacturers and confirmed suspicions that parachute manufacturing practices have not kept pace with other forms of textile manufacturing.

In early 2001, the research groups delivered a four-page plan to SBCCOM's management for submitting a formal proposal for a study on opportunities for updating manufacturing practices and equipment used to produce combat clothing and textiles. The proposal for funding was to be submitted to the Defense Department's ManTech Program,* which funds R&D that improves defense technologies and manufacturing.

SBCCOM Natick originally envisioned a parachute-industry-specific proposal. The group was concerned, however, that such a focused proposal would not be broad enough to receive serious consideration. Thus, the project was expanded to support combat clothing and textiles, making the project relevant to more military communities and increasing its chances for funding.

In addition, the proposal would have sought funding to create a demonstration facility to integrate existing mass production techniques in the manufacture of parachutes and other defense textile-based products. The demonstration would extend beyond the production floor to management and supply chain companies. The key goals were to improve quality and efficiency.

The reduction of sewing skill levels is viewed as extremely important because there is a shortage of skilled sewers, according to survey participants; and because it takes a long time to develop these skills. One process highlighted by SBCCOM Natick was a high-strength, double-lapped, double-needle seam, which is a major stumbling block for training machine operators compared with other operations. With changes in technology, new operators could be trained much more quickly using more advanced equipment than is currently used.

Under the proposed initiative, equipment manufacturers would work with parachute firms to modify existing equipment or to develop new equipment to meet parachute industry needs. These needs include working with a wide range of textile materials from lightweight canopy material to extremely thick multi-layer tapes and webbings (with which current apparel manufacturing equipment cannot work efficiently). However, according to an SBCCOM Natick representative, this proposal is still awaiting approval.

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* Established by Congress, the ManTech Program supports the national defense through the development and application of advanced manufacturing technologies and processes that will reduce the acquisition and supportability costs of defense weapon systems and reduce manufacturing and repair cycle times across the life cycles of such systems. Additionally, one of the eight program purposes under the ManTech legislation is improving "the manufacturing quality, productivity, technology, and practices of businesses and workers providing goods and services to the Department of Defense."

6. Managing the Parachute Supplier Environment

The production of aerial delivery products is affected by a variety of factors, including materials availability, government regulations, manufacturing infrastructure, and the availability of skilled personnel. A problem with any of these factors can stretch delivery schedules in times of "normal" production. When manufacturers must respond rapidly to a military campaign or a call for humanitarian assistance, such problems can be major obstacles to delivering what the armed forces need.

Interviews with aerial delivery industry companies indicate that there are opportunities to address a range of problems related to procurement, manufacturing, and delivery practices to enable manufacturers to increase production speed and, ultimately, respond more rapidly to U.S. government needs. The pursuit of these ideas could lower costs, help level out industry production cycles, and enhance the ability of manufacturers to react more nimbly to sudden surges in orders.

For this to happen, however, changes must be implemented in DOD's management of parachute TDPs (these documents contain detailed specifications on how a given parachute model is to be fabricated, assembled, and packed) with respect to document preservation, updating of parachute designs, and procurement processes. The industry's biggest customer – the United States military – is in many ways an unpredictable client. Although DOD holds significant inventories of parachutes, it often cannot anticipate some kinds of events that escalate consumption of parachutes. Even in "normal" times companies cannot be sure of what size orders to expect from DOD from year to year.

Recent history shows that parachute manufacturers at times are unable to perform to DOD's desired delivery timetables. The supply chain, for instance, reacted slowly to sudden rises in demand for parachutes in the mid-1990s when orders were placed in rapid succession. These supply chain lags are a source of concern for DOD personnel involved in parachute development and procurement, and ultimately have an impact on overall defense preparedness.

Supply Chain Issues

Many industries rely on a chain of suppliers to manufacture critical subcomponents, and this is true in the production of parachutes. It is particularly important to understand the lead-times for obtaining materials and supplies. This is a niche industry in which the widespread practice of "just-in-time" delivery methods is not easily applied in many production settings.

One area where there can be considerable turbulence in the parachute supply-chain is the procurement of basic raw materials and components. In many high-volume industries, manufacturers can shift the burden of maintaining inventory to their suppliers. This is not the case in the parachute industry. It is fundamentally a low-volume business in which both parachute components and complete parachutes are typically made in periodic, batch production runs.

Aerial-delivery suppliers usually only manufacture components when they have received an order. As a result, manufacturers that are prepared to respond to government orders often must wait for raw materials and components to be produced. The temporary unavailability of raw materials can delay the delivery of finished parachutes to the U.S. military.

Under normal circumstances, for example, it can take several months to manufacture finished parachute fabric from raw, nylon-yarn material. The chief reason for this is that parachute fabric is not a large portion of business for Dupont[42] as a supplier of nylon; nor is it for cloth weavers or for fabric finishers. As a consequence, according to parachute industry executives, it can be difficult to get small, rush orders for parachutes into manufacturing schedules that are dominated by larger commercial fabric production orders.

Dupont schedules production of parachute-quality nylon periodically over each calendar year using projection methods to gauge material demand into the future. A three-month projection is based on sales and a second six-month projection is based on a computer system that tracks historical demand.

Supplying Parachute Fabric: A Complex Process Requiring Coordination

The delivery of parachute fabric is a complex process, and because of the multiple steps involved, lead times can be long, especially when the demand for parachutes changes rapidly.

Not only do manufacturers not keep stocks of complete parachutes in inventory, they do not stock much in the way of parachute fabric. The reason: the material has a mandated shelf life of three and one half years (from the time of the last fabric manufacturing step to the cut and sew date) after which it can not be used in a parachute.

Nylon 6,6 is produced by Dupont three to four times a year in response to customer demand. The importance of military orders is taken into account when the company develops its production schedule. This schedule can be adjusted, according to Dupont, if demand warrants it.

Parachute fabric is not produced by integrated manufacturers, but by a series of partially integrated fabricators. In some instances, jobbers take responsibility for producing fabric by coordinating all of the manufacturing steps and handing parachute manufacturers finished fabric that is ready to be cut and sewn.

Several issues make working with parachute fabric problematic. In addition to the manufacturing and raw materials issues involved in parachute fabric production, parachute fabric must meet rigorous performance specifications. It is not uncommon in the finishing industry to have to rework fabric that does not meet specifications.[43]

Beyond the procurement and production challenges for obtaining parachute-quality nylon textile, there are other supply issues related to components used in canopies. Commercial and industrial demand for some kinds of textile materials has declined greatly in some instances, making it difficult to obtain these items for use in parachute components. In some cases, the amount of material required by a DOD parachute supplier's production run can be smaller than the material manufacturer's minimum order quantity. Parachute suppliers must either agree to pay for a minimum order of material – or locate and buy spare material (often at premium prices) that other manufacturers hold in inventory.

[42] All discussion of Dupont nylon production schedules, demand, and projections based on extensive discussions with Dupont executives and PIA officials. None of the information is considered confidential.

[43] The load performance and descent rates of parachutes can be controlled by treating parachute nylon to increase or decrease the porosity of the fabric – essentially the rate of air flow through the material.

An example of this increasingly scarce material is cotton duck and its anti-mildew treatment. Cotton duck is used in aerial delivery applications where a significant amount of heat is generated due to friction. According to an industry official, it is difficult to find cotton duck manufactured in the United States in small quantities. Moreover, SBCCOM Natick's preferred mildew-resistant treatment is currently banned by the Environmental Protection Agency.

In many instances, suitable alternative materials are available. DOD parachute suppliers, however, are often not able to use these new materials because of stringent DOD material approval processes. DOD officials cite the costs to change the Technical Data Package (TDP) and to test the new material as barriers to the use of new materials.

Management of Standards and Designs

When parachute manufacturers obtain orders for cargo or personnel parachutes, these items must be fabricated in accordance with the parachute TDPs. With TDPs in hand, all that manufacturers must do is "build-to-print" – follow the lengthy documents that cover every design detail needed to build the entire parachute, including subassemblies. The benefit for manufacturers is that they do not have the performance liability that would be associated with their own proprietary parachute designs; the government bears this responsibility for the cargo and personnel parachutes that it buys.

Despite these benefits, the TDPs do place a strain on manufacturers and procurement processes. In written comments from BIS survey respondents and in interviews, parachute manufacturers repeatedly noted that TDPs often have not been accurate and/or have had missing critical sections. The TDPs for many systems are decades old – and in many instances they have not been updated either at the individual drawing level or at the end of the document through amendments. In other instances, drawings are difficult to read because of their age and routine wear and tear.

The key historical problems associated with TDPs have included: 1) maintaining parachute design documents properly; 2) updating design documents to incorporate approved design changes; and 3) processing waivers and deviations to TDP designs in a timely fashion. These problems, some of which have grown worse over time, have resulted in production errors, unnecessary costs, and delivery delays.

One reason for inaccuracies is the cumbersome file management and document preservation practices at DOD agencies. Not only has the physical condition of TDPs declined, so has the number of skilled personnel capable of producing parachute drawings to update design information. For example, in the past several decades SBCCOM Natick's ability to make drawing changes degraded as staffing was reduced. SBCCOM Natick claimed in interviews that it no longer has sufficient staff to fix all of the drawing packages needing correction.

Just how many parachute design packages are corrupted is unclear. Fixing TDPs, however, can be a daunting task especially if the drawings have been out of date for some time. More than a thousand drawings can be included in a TDP. Historically, it has been easier to add "amendments" – written descriptions of design changes – to a TDP rather than to address the more complicated, costly, and time-consuming task of properly altering the drawings.

In the course of this study, BIS learned of an example in which a high-volume personnel parachute's drawings are outdated and in some places incorrect. SBCCOM Natick hired an outside contractor to review the drawings, and the contractor stated that it was unsure how a parachute manufacturer would be able to produce a parachute that met specification based on the condition of the TDP drawings. When the contractor was asked how much it would cost to completely update the package, SBCCOM Natick was told it would cost hundreds of thousands of dollars. In this instance, the problem of the incomplete TDP was overcome because the manufacturing firm had previously manufactured the parachute. When a firm is not experienced in making the product, however, the issue of whether the drawings are accurate and/or complete becomes critical.

Another dimension of the TDP problem has been that specifications concerning cargo and personnel parachutes have been managed by several DOD agencies. In one instance, the U.S. Air Force owned a critical specification used in the construction of the T-10, as well as other personnel parachutes, but it had not maintained the TDP package. SBCCOM Natick had to initiate a series of discussions in June 2002 with the Air Force to revise the specifications. More recently, in early 2003, SBCCOM Natick was able to gain custody of 49 cargo and personnel parachute drawing packages from the U.S. Air Force. The change in custody allows SBCCOM staff to fix these drawing packages more quickly, according to a SBCCOM representative.

Currently SBCCOM Natick is working to transfer drawing packages from paper and/or microfiche formats into a computer-aided drawing (CAD) system. This effort will put drawings in a more flexible format that will make changes easier to execute. According to SBCCOM Natick officials, having drawings in a CAD system will save time for both the military and private companies. As of the summer of 2003, according to a SBCCOM Natick official, the project to move drawings from paper to computer formats was progressing. Drawing packages are being converted on the basis of need, and approximately 25 percent of the drawings requiring preservation have been converted to a digital format.

Innovation, Manufacturing, and Regulation[44]

Beyond maintenance of critical design documents, another industry issue is the process of approving manufacturing design changes to existing parachute drawings or products that are under contract. Manufacturers cite delay in processing industry requests for waivers in manufacturing specifications as a significant problem – and a major cause for longer-than-anticipated manufacturing lead times.

Formal changes to parachute drawings can be required for several reasons: 1) to correct a design flaw, 2) to improve a parachute product, or 3) to allow use of a substitute component or material because of inadequate availability of supplies or major increases in costs. These types of changes can be made to the drawing before production. Changes also may be needed as an item is produced, or in some cases after production, if an abnormality is discovered during a company or government inspection.

[44] SBCCOM Natick provided information on regulatory details and design innovation processes.

There are three types of changes that can be made to a drawing or a specific product under contract. An Engineering Change Proposal (ECP) is used by a contractor or by the government to propose a permanent change to a drawing.

A Request for Deviation (RFD) is a one-time change to a parachute item that is proposed before it goes into production. An example of this type of change would be if the textile materials received are dyed a shade of green that does not match the specification. A RFD would be utilized only if the difference is not deemed to adversely affect the form, fit, or function of the product. Requests for Waivers (RFW), on the other hand, are one time changes to the product after the item is manufactured. An abnormality may be discovered through company or government inspection after a product has been manufactured. A RFW can be submitted to find out if the government will accept the product. Like the RFD example, the deviation cannot affect the form, fit, or function of the product.

In the case of Requests for Deviation (RFD) and Requests for Waiver (RFW), the parachute production run in question cannot be completed until the situation is resolved. Companies have stated that the changes can take months to resolve. Firms raised this concern in interviews with BIS, at industry/government forums, and in written comments contained in BIS survey responses. The BIS survey identified 14 cases indicating "waivers for specification deviation are slow to process."

Parachute Changes Face Regulatory Hurdles

Companies propose changes in parachute manufacture to the Defense Contract Management Agency (DCMA) through their Quality Assurance Representatives (QARs).*

The QAR acts as a government representative at the manufacturing facility, assuring that products for U.S. and allied militaries are delivered on time, within cost, and with all required specifications. The QAR also works with the contractor through all stages of the acquisition cycle.

The QAR has the latitude to allow Class I** changes or deviations. However, ECP, RFD, and RFW change proposals are most frequently routed from DCMA to the acquisition staff at SBCCOM Natick, according to an SBCCOM Natick official.

An internal body at SBCCOM Natick called the Configuration Control Board meets to consider the proposed change, waiver, or deviation and decides whether to grant it. Once the decision has been made, the answer is routed through the SBCCOM Natick acquisition staff back to the contractor.

The entire cycle historically has taken two to four months before companies have a decision on how to proceed.

* Quality Assurance Representatives are DOD employees who visit plants and interact with suppliers.

** Class I changes are minor changes to manufacturing specifications.

In response to complaints from parachute manufacturers, in February 2002, SBCCOM Natick announced at a Parachute Industry Association meeting that it would modify its process for reviewing ECPs, RFDs, and RFWs to reduce the time it takes to rule on a change or waiver. A firm proposing changes or waivers now will file simultaneously with its Quality Assurance Representative (a U.S. Government representative) and the Configuration Control Board (a SBCCOM-based engineering group) – a step that will cut one month on average off the review process.

Additionally, in the winter of 2003, SBCCOM Natick increased by 50 percent the staff of the Aerial Delivery Engineering Support Team (ADEST), the technical evaluator of the aerial delivery drawings, to enable it to process proposals more rapidly. Part of this increase in staffing

was attributable to the addition of a contractor to work with SBCCOM Natick staff to facilitate ECPs, RFDs, and RFWs. SBCCOM Natick also asked industry to make suggestions on other ways to streamline the waiver deviation process.

Industry's Role in Parachute Specifications

Not all parachute specifications are determined by the United States government. In fact, DOD relinquished a part of its standards-setting responsibility in 1994 when then-Secretary of Defense William Perry directed the elimination of certain defense specifications (so-called "mil-specs") in favor of commercial or performance standards. This substitution of commercial standards for mil-specs occurred in a number of procurement areas, including parachutes.

However, commercial firms feared their specifications would be lost or become outdated without a bona fide organization in place to maintain parachute specifications. PIA became concerned about the government's withdrawal from the standard-setting process and took over the role of setting specifications for parachute components, hardware, and related materials.[45] DOD still retains overall responsibility for and manages the mil-specs for the complete parachute designs to which manufacturers build.

Initially, PIA mainly renamed government parachute specs by replacing the MIL prefix with the PIA initials. Within a short time, however, a standing Specifications Committee was established, and it meets several times a year to discuss and modify specifications. These changes are made to reflect changes in raw materials. A minimum of seven representatives of the U.S. armed services and other U.S. government agencies hold voting positions on the Specifications Committee, along with 39 parachute manufacturers and component suppliers. Government agencies, as well as companies, can submit and vote on the creation or modification of specifications.

The parachute industry's management of part of the parachute specifications process appears to be accepted by parachute manufacturers and their suppliers. BIS survey data show that the parachute industry largely supports PIA's standards-setting activities (see *Table 15*). Less than 10 percent of the survey respondents were critical of the industry association's performance. Fifty-seven percent of survey respondents said they were either "very positive" or "positive" while 35 percent stated they were "neutral" with respect to the management of parachute specifications by PIA.

Table 15: **Industry Ratings of PIA in Managing Ex-DOD Specifications**

Measure	*Very Positive*	*Somewhat Positive*	*Neutral*	*Somewhat Negative*	*Very Negative*
Number of Respondents	15	4	12	1	2
Percent	45%	12%	35%	3%	6%

Source: U.S. Department of Commerce, BIS Survey

[45] The Parachute Industry Association (PIA) started as a sport parachute organization. It has grown into an industry association that serves both the military and civilian portions of the industry. PIA formed its government systems committee in 1996 to focus on the concerns of government contractors.

Defense Missions, Supply Surety, and Competition

Is the U.S. industrial base for the manufacture of parachutes the correct size? Should this highly specialized industry have a larger or smaller population of manufacturers than it does now? These are questions debated within some quarters of DOD and the parachute industry.

One driver behind this discussion is a desire by DOD offices to control government expenditures for parachutes, to slash warehousing requirements, and to reduce delivery times on parachute manufacturing orders. For U.S. parachute manufacturers, the question of industry size is linked to optimal utilization of existing production capacity to meet DOD demand while maximizing return on investment.

Some officials within SBCCOM Natick and the Defense Logistics Agency have expressed an interest in seeing the U.S. government enlarge the number of suppliers of military parachutes. Proponents believe that more competition would result in lower prices. In addition, they argue, in a time of national need there would be more companies to fill a higher level of DOD parachute orders. To help achieve this new competitive climate, some DOD procurement officials also advocate repealing provisions of the Berry Amendment that currently prohibit the use of foreign-made parachutes. They argue that foreign competition would drive down parachute prices, improve product quality, and enhance national security, according to some DOD officials.

Although some DOD staff assert there is a need for additional competition, there are at least seven manufacturers of military cargo and/or personnel parachutes in the United States today – a number sufficient to guarantee lively bidding in DOD solicitations for parachutes. Moreover, as recently demonstrated, new domestic contractors will enter the military parachute market when they perceive there is sufficient opportunity.[46] During this study's analysis period (2001-2003), there was no evidence of price gouging by U.S. suppliers. In fact, BIS staff noted on several Big Five site visits that the domestic industry had underutilized manufacturing space and equipment. Moreover, BIS has not seen any data demonstrating that the domestic industry lacks the capacity to meet U.S. defense needs.

Indeed, senior managers from several Big Five companies confirmed that the industry was coping with excess production capacity in the military parachute market relative to the levels of orders they were receiving.

Policymakers must also determine whether it is appropriate for DOD in periods of sustained conflict to rely on timely delivery of product from overseas manufacturers. The question is whether U.S. national security will be served by relying on foreign suppliers in pursuit of cost savings.

It would appear that U.S. aerial delivery manufacturers stand to be weakened if DOD turns to offshore manufacturers in the face of excess domestic production capacity. Given the

[46] In the June 2002 G-12 cargo parachute award, newcomers to cargo parachute production won a significant portion of the award. One firm is primarily a sport parachute manufacturer while a second is known for its manufacture of hot air balloons.

overcapacity in the industrial base, industry executives contend that dividing orders among a larger circle of suppliers will only create a greater number of unhealthy companies.

The cost benefits of buying air delivery products from foreign vendors may be short-lived if these offshore suppliers are able to drive U.S. aerial delivery companies out of business and then exercise price leverage. Reestablishing dismantled manufacturing capacity in the United States might not be achieved quickly, if at all, given the niche nature of the industry.

It is difficult to determine the "correct" size of the industrial base, given its high dependence on demand over time. Demand for aerial delivery systems can change quickly with humanitarian crises or military operations. U.S. industry must remain prepared to increase production capabilities in response to DOD demand – and then wind down operations to peacetime levels. To assure readiness, DOD must monitor effectively the state of its aerial delivery supply base.

As stated earlier, current SBCCOM Natick forecasts of demand for both personnel and cargo air delivery systems often change and are difficult to use for both U.S. government and industry planning purposes. Were the U.S. Army to identify its requirements more reliably, SBCCOM Natick could provide aerial delivery suppliers with better forecasts.

At the same time, DOD must continue to weigh its future needs in the context of potential technological change. Initiatives such as the proposed parachute supply chain project, the Low Cost Aerial Delivery System, precision airdrop, and other technology development initiatives (new materials and/or manufacturing techniques) have the potential to affect the industrial base. Likewise, new manufacturing techniques and/or the integration of new technology in air delivery systems (e.g., GPS guidance) could significantly change DOD requirements for aerial delivery products and alter the profile of the industrial base.

7. Findings and Recommendations

Findings

From both a production and technological standpoint, the aerial delivery industry in many ways has been a mature industry since World War II. With few exceptions, changes in aerial delivery products have taken the form of incremental improvement as opposed to revolutionary innovation.

- There are an adequate number of parachute manufacturers operating in the United States, but the supply base for core textile fiber has traditionally been one company, and there are only a few weavers and finishers of parachute-quality cloth. There have been instances where a rapid increase in parachute demand has overwhelmed the shrinking supply chain.

- Thirty-four firms provided data on their aerial delivery defense sales – either for components or entire parachute systems. Most production of complete defense parachute systems is concentrated among five companies, although a total of 14 parachute manufacturers provided defense sales data (domestic and foreign) to BIS. These Big Five manufacturers are engaged in what has been described by industry as cutthroat competition where the low bid is the main factor in making contract awards. Nevertheless, recent procurements show that smaller manufacturers and new entrants can compete against larger, established competitors for contracts.

- Manufacturers of military parachutes contend with a great deal of variability in their operations. Military demand for cargo and personnel parachutes, historically, has been erratic. DOD parachute needs can increase rapidly as a result of humanitarian operations and during conflicts (e.g., Operation Enduring Freedom in Afghanistan and Operation Iraqi Freedom), which can be difficult to predict. Large numbers of cargo parachutes, for example, were dropped into hostile territory and not recovered, triggering large DOD orders for replacement inventory.

- The financial health of aerial delivery firms operating in the United States, especially manufacturers of entire parachute systems, can be subject to significant swings, depending on the size of DOD orders, which vary from year to year.

- Weak reporting tools for tracking and managing inventory in the field can adversely affect DOD and its air delivery suppliers. Current management practices at times lead to excessive quantities of certain parachute products being ordered while other product inventories are not maintained at optimal levels. This occurs chiefly because procurement managers are at times unaware of field inventory levels. With limited budget resources, managers often downsize planned orders for some kinds of air delivery platforms because poor information leads them to perceive a greater need for another parachute type.

  There are somewhat better forecasting opportunities for personnel parachutes, which have a predetermined shelf life while cargo parachutes do not. Parachute age and use data are

currently maintained by field units, but they are not frequently shared with the U.S. Army's Soldier Biological and Chemical Command's Natick Soldier Center, even though the data are requested.

- Many parachute manufacturers consider the use of Indefinite-Delivery/Indefinite-Quantity contracts by SBCCOM Natick to be onerous. Companies assert that they must compete against themselves in second-round bidding after having qualified on price and delivery schedules with first-round bids. Company pricing information contained in first-round bids at times is obtainable by competitors prior to second-round bidding. The two-phase process, companies contend, is designed to put extra pressure on parachute suppliers to lower prices further, regardless of the long-term effect on the economic well-being and modernization needs of the industry.

  SBCCOM Natick defends its IDIQ contracting practices, stating that this type of contract allows for ongoing informal competition throughout the life of an acquisition program, streamlines and reduces acquisition lead times, and provides additional opportunities to firms that would otherwise be frozen out of particular programs for periods of up to five years. DOD acknowledges that the second-phase competition mentioned in the report is a drawback for industry. Even so, the acquisition staff at SBCCOM Natick believes that industry overstates the impact.

- Delivery of parachute products, historically, has been delayed and extra costs have been imposed on manufacturers because of problems with Technical Data Packages (TDPs), critical documents that govern the manufacture of aerial delivery systems. In some cases, incorrect and/or incomplete packages have been forwarded to industry, creating delays in delivery of finished products to DOD. An effort is underway at SBCCOM Natick to update drawings and scan them into an electronic format.

- Manufacturing technology in the defense parachute industry is old compared to other textile manufacturing operations. This is a function, in part, of rapidly changing market cycles that discourage capital expenditures on expensive automated manufacturing equipment because revenue predictions are not necessarily reliable. There is little motivation to change the production process. Many firms prefer to maintain older, less-expensive manufacturing equipment as a fixed cost and modify the variable cost of labor.

- There are signs, however, that parachute manufacturers are becoming increasingly interested in modernizing production systems and are increasing R&D spending. One factor behind this is that skilled labor is harder to find as the domestic commercial textile industry shrinks. Second, DOD has new personnel and cargo parachute systems in development, and SBCCOM Natick is investigating new materials and manufacturing techniques that could significantly reduce or eliminate sewn seams in air delivery products. Both BIS survey respondents and the U.S. Army reported increases in research and development spending from 1996 to 2000.

Recommendations

1. Improve Demand Forecasting

The U.S Army Materiel Command should coordinate with the U.S. Army Forces Command to require field units to submit population datasheets to SBCCOM's Integrated Materiel Management Center (IMMC) for acquisition planning purposes. Possession of these data is essential to enabling IMMC to devise more accurate personnel parachute forecasts, which will, in turn, permit SBCCOM Natick far more accurately to maintain air-delivery products in inventory that meet field unit requirements. Better inventory management is also critical to begin leveling government procurements and to foster a more predictable business climate for the parachute industry.

SBCCOM Natick should work with the U.S. Army's Quartermaster Center and School in Fort Lee, Virginia, to teach its students headed for field paratrooper units a formalized and consistent electronic format for collecting population data sheet information.

2. Advance Parachute Materials and Manufacturing Technology

Additional funding for the development of new manufacturing technology for the production of aerial delivery systems should be provided. It is unlikely that the industry, particularly the parachute sector, will make truly significant manufacturing changes on its own. Support for this manufacturing initiative should be directed to DOD's ManTech Program or to other appropriate federal government institutions that can actively support the initiative.

3. DOD Management of Aerial Delivery Drawing Packages

SBCCOM Natick should complete its scanning of legacy aerial-delivery-system drawings into a computer-aided-drawing system within the next 18 months. DOD should request additional funding for this task from Congressional appropriations committees. The aim is: 1) to protect DOD's large investment in aerial delivery technology; and 2) to make it easier for SBCCOM Natick to manage and update drawings, steps that can help speed delivery of product to DOD customers.

In addition, DOD should review the adequacy of the records preservation processes and archive facilities for aerial-delivery product records at SBCCOM Natick. Duplicate digital copies of design records of important aerial delivery systems used by DOD should be archived in a secure DOD location in another part of the United States. The purpose is to provide backup files should SBCCOM's Illinois records storage facility be destroyed by fire or any other kind of disaster. This task should be accomplished within 24 months.

4. Enhance Managerial and Staff Knowledge of the Aerial Delivery Industry

SBCCOM Natick should provide funding and authority for staff to conduct plant tours of firms that comprise the aerial delivery supply chain. These educational visits would provide acquisition and logistical staff members with a more comprehensive knowledge of all phases of the manufacturing process – from production of raw materials to finished items. This action is necessary to ensure that SBCCOM and TACOM Natick staffs have a thorough understanding of the industry.

5. Advanced Parachute Design and Manufacturing Technology Forum

At least every three years, SBCCOM Natick and the Parachute Industry Association should jointly hold a technology forum that includes representatives from appropriate laboratories of the Departments of Commerce, Defense, and Energy. Such interaction with a variety of organizations with deep analytical capabilities in physics, material science, and advanced computer simulation is needed to help the industry think "outside the box" to address short-term needs and to pursue breakthrough innovations.

Among other things, these forums should focus on technologies and services resident at the labs that: (1) can leverage the productivity of existing manufacturing processes, (2) will improve performance modeling, testing, and quality control, and (3) focus on cost-effective advanced materials and manufacturing processes that might be employed in manufacturing aerial delivery systems.

6. Amend Current Procurement Practices to Adjust for Inflation

SBCCOM Natick acquisition staff should include a provision in future multi-year Indefinite-Delivery/Indefinite-Quantity aerial delivery contracts to account for inflation and raw material price increases that cross a predetermined threshold. Although inflation rates have been relatively low in recent years, U.S. aerial delivery product manufacturers may face the erosive effects of inflation in the future. Contractors cannot predict the prices of critical raw materials three to five years in the future.

Appendix A: Survey

"BUSINESS CONFIDENTIAL"

Ref. # P-1

U.S. Department of Commerce
Bureau of Export Administration

OMB Control #0694-0119
expires 10/31/02

NATIONAL SECURITY ASSESSMENT OF THE U.S. AIR DELIVERY INDUSTRY

The U.S. Department of Commerce, Office of Strategic Industries and Economic Security (SIES) is partnering with the Army Materiel Command, Soldier and Biological Chemical Command (SBCCOM), to review the availability of air delivery production capability for defense end markets. In recent years, the increasing demand for defense parachutes has raised concerns about the health and competitiveness of domestic manufacturers of parachutes and related materials. Your timely and complete response will assist the Department of Commerce in its efforts to perform an analysis of this critical sector for senior policy officials.

THIS REPORT IS REQUIRED BY LAW

This report is required by law (50 U.S.C. App. Sec. 2155). Failure to report can result in a maximum fine of $10,000 or imprisonment up to one year, or both. Information furnished herewith is deemed confidential and will not be published or disclosed except in accordance with Section 705 of the Defense Production Act of 1950, as amended (50 U.S.C. App. Sec. 2155).

BURDEN ESTIMATE AND REQUEST FOR COMMENT

Public reporting burden for this collection of information is estimated to average 6 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to BXA Information Collection Officer, Room 6881, Bureau of Export Administration, U.S. Department of Commerce, Washington, DC 20230, and to the Office of Management and Budget, Paperwork Reduction Project (0694-0119), Washington, DC 20503.

Check (ŏ) here if you are interested in receiving a copy of the final report:

Note: Any information submitted in response to this survey will be deemed business confidential and exempt from public disclosure in accordance with Section 705 of the Defense Production Act of 1950, as amended.

"BUSINESS CONFIDENTIAL"

GENERAL INSTRUCTIONS

YOUR RESPONSE IS DUE SIX CALENDAR WEEKS AFTER RECEIPT

DEFINITION: The Air Delivery Industry includes any U.S. company that produces/manufactures parachutes or related components. "Related components" includes (but is not limited to) items such as harnesses, ripcords, rigging equipment, forged hardware, suspension lines, and webbing necessary for the proper functioning and maintenance of parachutes for civil and military applications.

1. **WHO MUST COMPLETE THIS SURVEY:** Please complete this questionnaire if your firm has manufactured parachutes or parachute components in the United States during the past 5 years. The survey has seven sections as follows:

PART I - Firm Identification PART II – Products/Equipment PART III – Sales/Profit/R&D
PART IV – Employment *PART V - Defense Suppliers PART VI – Commercial Suppliers
PART VII – Certification

*If your company produces only commercial parachutes/components, please skip Part V and continue with Part VI.

2. WHO IS EXEMPT: If you received this questionnaire, but do not manufacture the above described parachutes or related components in the United States, please check one of the following and describe your business operations below:

Sales/Distributor
Exited the parachute industry prior to January 1, 1996
Parachute Training Facility
Do not manufacture items for the parachute industry

_____

_____

_____

Then, please provide your address and ownership information on Page 1, sign the certification on Page 17, and return the document in the enclosed envelope.

3. The questions in this survey are designed to minimize the amount of time required referring to computer databases or filed documentation. It is not our desire to impose an unreasonable burden on any respondent. If information is not readily available from your records in the form requested, furnish estimates and designate by the letter "e". If an item does not apply, please mark "n/a".

4. Questions related to this survey should be directed to Christopher Weller at (202) 482-8236, or e-mail, cweller@bxa.doc.gov.

5. If you are interested in downloading additional copies of the survey, please visit our website at: http://www.doc-bxa.bmpcoe.org/dmrr_airdelivery.html.

6. Before returning your completed questionnaire, be sure to sign the certification on the last page and list a point of contact and phone number in case of questions regarding your response. Return the completed questionnaire in the enclosed envelope within six calendar weeks of receipt to:

Mr. Brad Botwin, Division Director
U.S. Department of Commerce
14th & Constitution Ave., NW
Room 3876, P-1
Washington, D.C. 20230

Note: Any information submitted in response to this survey will be deemed business confidential and exempt from public disclosure in accordance with Section 705 of the Defense Production Act of 1950, as amended.

DEFINITIONS

1. MARKET VALUE OF PRODUCTION: The value of production based on estimated sales price(s) of what was produced during the year, not yearly sales. Estimate the sales price(s) of item(s) produced, then multiply the sales price(s) by the total number of items produced during the year.

2. FULL PRODUCTION CAPABILITY: The maximum level of production that this establishment could reasonably expect to attain under normal and realistic operating conditions. In estimating full production capability, assume the following:

- Only the machinery and equipment in place and ready to operate will be utilized. Do not include facilities or equipment that would require extensive reconditioning before they can be made operable.
- Normal downtime, maintenance, repair, and cleanup. If full production requires additional shifts or hours of operation, then appropriate downtime should be considered in the estimate.
- Number of shifts, hours of plant operations, and overtime pay that can be sustained under normal conditions and a realistic work schedule.
- A product mix that was typical or representative of your production during the year. If your plant is subject to short-run variation assume the product mix for the current period.
- Do not assume increased use of productive facilities outside the plant for services (such as contracting out subassembly work) in excess of the proportion that would be normal during the year.

Method of Calculation – For your parachute product with the highest sales value (for a U.S. military customer) in 1999, estimate the number of units that could have been produced if operating at full production, as by the assumptions above. Multiply the number of units produced by their sales price (or market value) and enter the value in the table on page three.

3. NATIONAL EMERGENCY PRODUCTION: The maximum level or production that this plant could expect to attain and sustain for one year or more under national emergency conditions.

National emergency conditions are situations, such as a military mobilization or national disaster, which are likely to create widespread excess demand requiring additional work shifts.

In estimating national emergency production, assume the following:

- Full use of all machinery and equipment in place (including machinery and equipment that would require extensive reconditioning before they could be made operable).
- Minimal downtime and multi-shift operations.
- Plant production as close to 168 hours per week as possible, including extra shifts (e.g., operating 7 days per week, 24 hours per day less minimal downtime).
- You can sell all of your product.
- Your product mix can change
- Increased use of production facilities outside the plant for services (such as contracting out subassembly work) in excess of the proportion that would be normal during the last year.

Method of Calculation – For your parachute product with the highest sales value (for a U.S. military customer) in 1999, estimate the number of units that could have been produced if operating at national emergency production, as by the assumptions above. Multiply the number of units produced by their sales price (or market value) and enter the value in the table on page three.

PART I ~ FIRM IDENTIFICATION

1. **U.S. PARACHUTE AND/OR PARACHUTE COMPONENT COMPANY NAME AND ADDRESS**: Please provide the company name, address, year of firm establishment, and number of years your primary manufacturing facility has existed in its current location.

_____
Company Name

_____
Street Address

_____
City, State, Zip Code

_____ _____
Year Established Number of Years Manufacturing Facility Has Been in Current Location

2. **OWNERSHIP**: If your firm is wholly or partly owned by another firm, indicate the name and address of the parent firm, extent of ownership, and year acquired.

_____
Parent Name

_____
Street Address

_____
City, State, Zip Code (Country)

Ownership:_____% Year Acquired:_____

3. Is your company classified as a "small business" by a U.S. Government agency? Yes No

4. Please provide the *approximate* percentage of sales that are devoted to the following types of products.

_____% Completed parachutes from components and/or raw materials

_____% Parachute components from subcomponents and/or raw materials

5. **TYPE OF ACTIVITIES:** Which of the following "core" parachute and/or parachute component activities (activities not contracted out) does your company participate in? Select all that apply.

Manufacturing	Other, specify: _____
Assembly	_____
Research & Development	
Product Engineering	Other, specify: _____
Warranty/Repair	_____
Maintenance/Overhaul	
Packaging	
Subcontractor/Supplier	

6. If any of the core activities listed above are performed at other locations owned by your company, please provide names and addresses below.

Establishment	Activity	City, State, Country (if not in the US)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

7. Does your establishment perform any activities unrelated to parachute and/or parachute component manufacturing?

Yes No

If yes, what percent of your total revenues are attributed to these activities? _____%

Please describe these activities:_____

_____

_____

8. **ACTUAL / FULL / NATIONAL EMERGENCY PRODUCTION LEVELS:** Please complete this table for your parachute or parachute component product with highest sales value *(for a U.S. military customer)* in 1999. In the first column, please provide the approximate market value of production your firm is capable of producing for the three types of production listed in the table below. In the second column, please indicate the number of shifts per week your production line could accommodate for the three types of production. In the last column, please describe any limitations preventing you from reaching full or national emergency production levels (if any). *If your firm does not produce parachute products for the U.S. military, please write N/A in the table below.*
(Please see Page iii for definitions of the various "*states of production")*

Please identify your parachute product with highest sales value *(for a U.S. military customer)* in 1999.

_____

Types of Production	Market Value of Production in ($000)	Number of Shifts per Week	Limitations on Reaching Full Production or National Emergency Production
Actual Production for 1999			
Full Production Capability			
National Emergency Production			

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PART II ~ PRODUCTS/EQUIPMENT

1. **PRODUCTS MANUFACTURED:** In ***each*** of the separate categories (Parachutes, Components, and "Miscellaneous") below, please rank your products in *approximate* order of greatest sales (dollar value) to least. Begin with the number 1, and restart your numbering in each category. For items that your firm does not manufacture, please leave the spaces blank.

PARACHUTES

___ Personnel – Round
____ Personnel – Parafoil
____ Heavy Cargo
____ Container
____ Recovery
____ Brake
____ High Velocity (load stabilization)
____ Drogue
____ Extraction
____ Munitions
____ Booster Recovery (NASA)
____ Ejection Seats
____ Other, specify: _____

COMPONENTS

____ Harness/Container System
____ Rigging Equipment
____ Altimeters
____ Forged Hardware
____ Webbing
____ Suspension Lines
____ Deployment Bags
____ Automated Actuated Devices (AADs)
____ Static Lines
____ Extraction Lines
____ Ripcords
____ Canopies
____ Cords, other: _____
____ Other, specify: _____
____ Other, specify: _____

"MISCELLANEOUS"

____ Flight Suits
____ Threads & Tape
____ Fabric/Cloth
____ Air Drop Platforms
____ Apparel, specify: _____
____ Other, specify: _____

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2. In the space provided below (and on the next page), please list the ten most critical pieces of equipment related to the manufacturing of the items marked number 1 on the previous page. In the second column, please indicate the approximate year the equipment was purchased. If the equipment has been upgraded/refurbished since its purchase, please provide the approximate year of upgrade/refurbishment in the third column. If a particular piece of manufacturing equipment has no modern replacement, please check the corresponding box in the fourth column.

Parachutes – Manufacturing Equipment	**Purchase (Year)**	**Upgrade/Refurbished (Year)**	**Check (ŏ) if no replacement is available**
1. _____	_____	_____	
2. _____	_____	_____	
3. _____	_____	_____	
4. _____	_____	_____	
5. _____	_____	_____	
6. _____	_____	_____	
7. _____	_____	_____	
8. _____	_____	_____	
9. _____	_____	_____	
10. _____	_____	_____	

Components – Manufacturing Equipment	**Purchase (Year)**	**Upgrade/Refurbished (Year)**	**Check (ŏ) if no replacement is available**
1. _____	_____	_____	
2. _____	_____	_____	
3. _____	_____	_____	
4. _____	_____	_____	

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Components – Manufacturing Equipment (Continued)	Purchase (Year)	Upgrade/Refurbished (Year)	Check (ǒ) if no replacement is available
5.			
6.			
7.			
8.			
9.			
10.			

"Miscellaneous" – Manufacturing Equipment	Purchase (Year)	Upgrade/Refurbished (Year)	Check (ǒ) if no replacement is available
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

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3. REPLACE/UPGRADE EQUIPMENT: Do you intend to replace/upgrade any of the equipment listed in the previous question during the next 5 years? Yes No Not sure

If no, for which of the following reasons? (Select all that apply.)

Low profitability		Insufficient funding
Shrinking market		Stagnant equipment technology
Excessive competition		Manufacturing equipment is less than five years old
Overcapacity (within firm)	*	Spec drawings do not allow for use of modern equipment
Equipment replacement not available		Other, specify:_____

3a. * If your firm checked the response labeled, "Spec drawings do not allow for use of modern equipment", please list the specific Technical Data Package(s) (TDP), the equipment that does not manufacture products to the TDP, and explain why the equipment is incapable of producing items that meet the TDP.

_____

_____

_____

_____

_____

4. **INVESTMENT:** Please enter expenditures ***(in thousands of dollars)*** for investment in plants and new/used or rebuilt machinery and equipment from calendar year 1996 to 1999 (and projected amounts for 2000) in the table below.

CAPITAL INVESTMENT IN PARACHUTE AND/OR PARACHUTE COMPONENT OPERATIONS					
TYPE OF INVESTMENT	**1996 ($000)**	**1997 ($000)**	**1998 ($000)**	**1999 ($000)**	**2000 (est.) ($000)**
Plant					
Machinery & Equipment (New/Used or Rebuilt)					
TOTAL					

5. INDUSTRY SPECS: What is your opinion of the Parachute Industry Association adopting and updating the former Mil Specs for parachutes and components?

Very positive Somewhat positive Neutral Somewhat negative Very negative

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6. **SUB-TIER SUPPLIERS:** Please provide the name, product, address, point of contact, and phone number for your *critical* suppliers. If you need additional room, please copy this sheet and enclose the supplementary pages. Please check the fifth column if this company/product has caused supply problems in the past 5 years and comment about the supply problem in the last column. *If your company has no critical subcontractors, please mark here* .

Name of Company	Product Supplied	Address	Company Contact and Phone #	ð	Comments About Supply Problem

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PART III ~ SALES/PROFIT/R&D

1. **SALES:** Please include the total dollar values ***(in thousands of dollars)*** for all commercial and military manufactured products sold in both the domestic *and* foreign markets during the past 5 years for your parachute and/or parachute component operations.

YEAR	DOMESTIC ($000)		FOREIGN ($000)		TOTAL SALES ($000)
	Commercial	Defense	Commercial	Defense	
1996					
1997					
1998					
1999					
2000 (est.)					

2. **NET INCOME:** Please provide your net income (profit or loss) for each of the following years ***(in thousands of dollars)***.

   1996_____ 1997_____ 1998_____ 1999_____ 2000 (est.) _____

3. **RESEARCH & DEVELOPMENT (R&D) EXPENDITURES:** Please provide R&D expenditures ***(in thousands of dollars)*** according to funding source for your parachutes and/or related components. **Check here if your firm performs no research & development**

YEAR	Self-Funded ($000)	Govt. Funded ($000)	Other Funded ($000)	TOTAL R&D ($000)
1996				
1997				
1998				
1999				
2000 (est.)				

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PART IV ~ EMPLOYMENT

1. For the end of each calendar year listed below, please provide the number of employees in each of the following job categories.

Year	Non-Production (Mgmt./Admin)	Manufacturing & Assembly	Engineering/ R&D	Other Employees	Total Employees
1996					
1997					
1998					
1999					
2000 (est.)					

Please describe any jobs that your firm classifies as "Other Employees."

_____

_____

2. Has your company experienced a labor shortage in the past 5 years? Yes No
If yes, for which of the following reasons? Select all that apply.

Healthy economy
High cost labor zone
Facility location
Limited applicant pool
Lack of skilled workers
Lack of government contracts
Other, specify:_____

If yes, which departments have been impacted by this labor shortage? Select all that apply.
Non-Production Manufacturing & Assembly Engineering/R&D

3. Has your firm had difficulty replacing skilled/highly trained workers? Yes No

If yes, which specific skills are difficult to replace?

Non-Production Skill(s):_____

Comments: _____

_____

Manufacturing & Assembly Skill(s):_____

Comments: _____

_____

Engineering/R&D Skill(s):_____

Comments: _____

_____

4. Please provide the approximate percentage of Manufacturing & Assembly workers in your firm with the following years of experience.

____% 0-5 years ____% 6-10 years ____% 11-15 years ____% 16-20 years ____% 20+ years

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PART V ~ DEFENSE SUPPLIERS

1. Has your firm competed for a contract or supplied parachutes and/or parachute components for ultimate use by the U.S. Government or foreign government at any time since 1/1/1996? (Including any company that has ceased production for the U.S. Government after 1/1/1996)

   Yes — If yes, please answer the following questions, then skip to Page 17.
   No — If no, please skip to Page 15, Part VI ~ Commercial Suppliers.

2. Which Government organization(s) purchase/use your products? Select all that apply.

   Army
   Air Force
   Navy
   Marine Corps
   Forestry Service
   Defense Logistics Agency (DLA)
   NASA
   Others (e.g. Coast Guard, National Guard, etc.)
   Foreign Military (please answer Question 3)

3. Please list your top 10 foreign military customers by country name, in order of greatest sales to least.

   a. _____ f. _____
   b. _____ g. _____
   c. _____ h. _____
   d. _____ i. _____
   e. _____ j. _____

4. Has U.S. military demand for your product(s) increased/decreased/stayed the same during the following years? Please explain the basis for your answer.

Year	Increased	Decreased	Stayed the Same	Comments
1996				
1997				
1998				
1999				
2000				

5. Please list your top five domestic and international competitors (for foreign military sales) in the industry.

DOMESTIC	
Company	**Location (State)**

INTERNATIONAL	
Company	**Location (Country)**

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6. **LEAD TIMES:** Defense orders sometimes take longer than expected. Below is a list of possible causes. Please review the list to determine the frequency (frequent, occasional, or never) that each possibility caused you to miss a scheduled delivery of a defense order. Note that slot numbers 9, 13, and 17 are labeled as "Other". Use this space to identify additional causes.

LOGISTICS MANAGEMENT CAUSES	Frequent	Occasional	Never
1. Defense orders issued erratically, made planning difficult.			
2. Clearance of paperwork associated with defense orders is slow.			
3. Waivers for spec deviation are slow to process.			
4. Product specifications for defense orders made manufacture difficult.			
5. Design prints for defense orders not readily available.			
6. Small unit volume defense orders not produced optimally in my facilities.			
7. Production procedure for defense orders is inflexible and needs updating.			
8. Environmental regulations slowed defense orders.			
9. Other – Specify:			
FACILITIES – INTERNAL CAUSES			
10. Machinery and/or equipment problems:	**Frequent**	**Occasional**	**Never**
a. Machinery and/or equipment broke down.			
b. Machinery and/or equipment is old; tooling and parts are difficult to obtain.			
c. Machinery and/or equipment seldom utilized (learning curve problem).			
11. Shortage or absence of skilled labor delayed production.			
12. High rate of capacity utilization extended lead times.			
13. Other – Specify:			
SUPPLY CHAIN CAUSES			
14. Textile materials* needed for defense orders not available in a timely manner	**Frequent**	**Occasional**	**Never**
a. Order quantity insufficient to buy economic quantities of materials.			
b. Capacity booked-up, resulting in longer than normal queue.			
c. Type is rare and produced only on customized basis.			
*Identify textile materials:_____			
15. Inconsistent nylon supply limits production.			
16. Non-textile subcontracted work took longer than expected.			
17. Other – Specify:			

Note: Any information submitted in response to this survey will be deemed business confidential and exempt from public disclosure in accordance with Section 705 of the Defense Production Act of 1950, as amended.

7. To what extent was your company impacted by the transfer of the U.S. Army's Soldier and Biological Chemical Command (SBCCOM) parachute operations from St. Louis, MO to Natick, MA in 1997?

   No effect Moderate Severe Exited defense business

   Comments:_____
   _____
   _____
   _____
   _____
   _____
   _____

8. To what extent was your company impacted by the transfer of U.S. Air Force and Navy procurement and stock functions to the Defense Logistics Agency?

   No effect Moderate Severe Exited defense business

   Comments:_____
   _____
   _____
   _____
   _____
   _____

9. Should there be a single manager for Air-Delivery products within the U.S. Armed Services?

   Yes No No opinion

   If yes, in which military organization should this proposed single manager reside in? _____

10. Does your company also support a commercial parachute and/or parachute component line? Yes No

    If yes, is your defense production performed on the same equipment as your commercial products? Yes No

11. Which parts of Government contracting are extremely challenging? (Select all that apply.)

    Certifying for the Qualified Product List (QPL)
    Meeting the requirements for a first article test
    Length of term on Government contracts is too long
    Length of term on Government contracts is too short
    Uncertainty of Government demand
    Deviation/waiver process
    Payments/Billing
    Lack of balanced overall delivery schedules

    Other, specify _____

12. Since 1995, has your company exited the defense business? Yes No
If yes, for which of the following reasons? (Select all that apply.)

Inconsistent procurement practices
Decrease in defense demand
Merger/Acquisition
Sold defense portion of business
Department of Defense regulations too cumbersome
Commercial market more profitable

Other, specify: _____

13. OFFSET AGREEMENTS: Offset agreements in international trade are a range of industrial and commercial compensation practices that are mandated by a foreign government as a condition of purchase of U.S. defense-related systems. Activities to implement offset agreements may include co-production, licensed production, subcontractor production, overseas investment, technology transfer, and purchases.

Example: A U.S. prime contractor sells a jet fighter to a foreign government. As a condition of the purchase, the foreign government requires an offset: the prime contractor must use a local manufacturer to produce parts for the airplane equal to a mandated percentage of the value of the entire plane.

a. Has your firm been involved in an offset agreement? Yes No

If yes, has your firm been negatively affected by offset agreement practices? (For example: Have you ever lost a sale because of an offset agreement, or shifted production, transferred technology and know-how, or changed suppliers at the request of your prime contractor due to an offset agreement?) Yes No

If yes, has your firm been positively affected by offset agreements? Yes No

If you answered yes to any of the questions above, please explain your answer.

_____
_____
_____
_____
_____
_____
_____
_____

~~PLEASE SKIP TO PAGE 17~~

PART VI ~ COMMERCIAL SUPPLIERS

Please complete this section if your company ***has not*** competed for or fulfilled any government contracts since 1/1/1996. We would like to ascertain your company's capability and willingness to support defense production if needed.

1. Please check the agree or disagree box for each statement listed below. If there are other inducements that would make the defense business more attractive to your firm, please describe them in the Other category at the bottom of the table.

Inducements for Entering Defense Business	Agree	Disagree
My company is strictly commercial, but would supply in wartime if needed.		
The defense market would have to expand to make it worthwhile.		
The Defense Department would have to change its procurement policies.		
Defense production would have to be compatible with my production lines.		
Other, specify:		

2. On a scale of 0 to 5, how compatible are your current production processes with defense manufacturing requirements? Please check the appropriate response.

0 Require substantial modification

1

2

3

4

5 Require little modification

Not Sure

3. Is your company interested in becoming a Department of Defense (DoD) supplier? Yes No
If your company is not interested in becoming a DoD supplier, please explain the reason for your decision.

_____

_____

_____

_____

_____

_____

4. Is your company listed on U.S. Army's Soldier and Biological Chemical Command's (SBCCOM) Qualified Product List (QPL)?

Yes No

Note: Any information submitted in response to this survey will be deemed business confidential and exempt from public disclosure in accordance with Section 705 of the Defense Production Act of 1950, as amended.

4a. Please list all parachutes and/or parachute components your firm is qualified to produce under the QPL.

_____
_____
_____
_____
_____
_____
_____

5. Please list your top five domestic and international competitors in the industry.

DOMESTIC	
Company	**Location (State)**

INTERNATIONAL	
Company	**Location (Country)**

Note: Any information submitted in response to this survey will be deemed business confidential and exempt from public disclosure in accordance with Section 705 of the Defense Production Act of 1950, as amended.

PART VII ~ CERTIFICATION

The undersigned certifies that the information herein supplied in response to this questionnaire is complete and correct to the best of his/her knowledge. It is a criminal offense to willfully make a false statement or representation to any department or agency of the United States Government as to any matter within its jurisdiction. (18 U.S.C.A. 1001 (1984 & SUPP. 1997))

_____
(Company Name)

_____
(Authorizing Official – Print Name)

_____ _____
(Title) (Phone Number)

_____ _____
(Signature) (Date)

_____
(Point of Contact – Print Name)

_____
(Title)

_____ _____
(Email) (Phone Number)

GENERAL COMMENTS AND/OR INDUSTIAL BASE ISSUES

Is there any other information that we did not request above or that you believe would be important for this national security assessment of the U.S. air delivery industry? Please use the space below to provide any additional comments or information regarding your operations, or related issues impacting your firm.

_____

_____

_____

_____

_____

_____

Note: Any information submitted in response to this survey will be deemed business confidential and exempt from public disclosure in accordance with Section 705 of the Defense Production Act of 1950, as amended.

Appendix B: Publications List

Office of Strategic Industries and Economic Security

STRATEGIC ANALYSIS DIVISION

PUBLICATIONS LIST

May 26, 2004

The U.S. Department of Commerce's Strategic Analysis Division is the focal point within the Department for conducting assessments of defense-related industries and technologies. The studies are based on detailed industry-specific surveys used to collect information from U.S. companies and are conducted on behalf of the U.S. Congress, the military services, industry associations, or other interested parties.

PUBLICATION TITLE	**Italics* indicate forthcoming studies
9th Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 – Fall 2004	
National Security and Foreign Availability Assessment of the Infrared Imaging Systems Industry – Fall 2004	
Dodd Amendment Assessment of the Impact of Offsets on Defense Industrial Base Employment – Summer 2004	
National Security Assessment of the Munitions Power Sources Industry – Spring 2004	
National Security Assessment of the U.S. Shipbuilders' Supplier Base – Winter 2004	
8th Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 – May 2004	
National Security Assessment of the Air Delivery (Parachute) Industry – May 2004	
Industry Attitudes on Collaborating with DoD in R&D – Air Force – January 2004	
Army Theater Support Vessel Procurement: Industrial Base/Economic Impact Assessment – December 2003	
A Survey of the Use of Biotechnology in U.S. Industry – October 2003	
U.S. Textile and Apparel Industries: An Industrial Base Assessment – October 2003	
7th Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 - July 2003	

- Continued on Next Page -

Technology Assessment: U.S. Assistive Technology Industry – February 2003
6th Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 - February 2003
Heavy Manufacturing Industries: Economic Impact and Productivity of Welding – Navy – June 2002
The Effect of Imports of Iron Ore and Semi-Finished Steel on the National Security – October 2001
National Security Assessment of the U.S. High-Performance Explosives & Components Sector –June 2001
National Security Assessment of the U.S. Shipbuilding and Repair Industry - May 2001
Statistical Handbook of the Ball and Roller Bearing Industry (Update) - June 2001
5th Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 - May 2001
National Security Assessment of the Cartridge and Propellant Actuated Device Industry: Update - December 2000
The Effect on the National Security of Imports of Crude Oil and Refined Petroleum Products - November 1999
4th Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 - October 1999
U.S. Commercial Technology Transfers to The People's Republic of China – January 1999
Critical Technology Assessment: Optoelectronics - October 1998
3rd Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 - August 1998
National Security Assessment of the Emergency Aircraft Ejection Seat Sector - November 1997
2nd Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 – August1997
Critical Technology Assessment of the U.S. Semiconductor Materials Industry - April 1997
1st Offsets in Defense Trade - Conducted under §309 of the Defense Production Act of 1950 - May 1996
National Security Assessment of the Cartridge and Propellant Actuated Device Industry - October 1995
A Study of the International Market for Computer Software with Encryption – NSA -1995
The Effect of Imports of Crude Oil and Petroleum Products on the National Security - December 1994
Critical Technology Assessment of U.S. Artificial Intelligence - August 1994
Critical Technology Assessment of U.S. Superconductivity - April 1994
- Continued on Next Page -

Critical Technology Assessment of U.S. Optoelectronics - February 1994
Critical Technology Assessment of U.S. Advanced Ceramics - December 1993
Critical Technology Assessment of U.S. Advanced Composites - December 1993
The Effect of Imports of Ceramic Semiconductor Packages on the National Security - August 1993
National Security Assessment of the U.S. Beryllium Industry - July 1993
National Security Assessment of the Antifriction Bearings Industry - February 1993
National Security Assessment of the U.S. Forging Industry - December 1992
The Effect of Imports of Gears and Gearing Products on the National Security - July 1992
Natl. Sec. Assessment of the Dom. and For. Subcontractor Base~3 US Navy Systems - March 1992
Natl. Security Assessment of the U.S. Semiconductor Wafer Processing Equipment Industry - April 1991
National Security Assessment of the U.S. Robotics Industry - March 1991
National Security Assessment of the U.S. Gear Industry - January 1991

Archived Studies	
The Effect of Imports of Uranium on the National Security – Sept. 1989	Investment Castings: A Natl. Security Assessment – Dec. 1987
The Effect of Imports of Crude Oil and Refined Petroleum on Natl. Security – Jan. 1989	Joint Logistics Commanders/DOC Precision Optics Study - June 1987
The Effect of Imports of Plastic Injection Molding Machines on Natl. Security – January 1989	An Economic Assessment of the U.S. Industrial Fastener Industry – March 1987
The Effect of Imports of Anti-Friction Bearings on the Natl. Security - July 1988	Joint Logistics Commanders/DOC Bearing Study - June 1986

For further information about the Division's programs or for additional copies of reports, please visit us at:
http://www.bis.doc.gov/ and select "Defense Industrial Base Programs," or contact:
Brad Botwin, Director, Strategic Analysis Division
Phone: 202-482-4060 Fax: 202-482-5650 E-mail: bbotwin@bis.doc.gov