NATIONAL SECURITY ASSESSMENT OF THE CARTRIDGE & PROPELLANT ACTUATED DEVICE INDUSTRY ~AN UPDATE~

A Report for the U.S. Department of the Navy

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National Security Assessment of the Cartridge & Propellant Actuated Device Industry -An Update-

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Bureau of Industry and Security*
Office of Strategic Industries and Economic Security
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*The Bureau of Export Administration changed its name to the Bureau of Industry and Security in April 2002.

National Security Assessment of the Cartridge and Propellant Actuated Device Industry ~An Update~

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Executive Summary

This is an update of the 1995 National Security Assessment of the Cartridge and Propellant Actuated Device (CAD/PAD) Industry. The U.S. Department of Commerce, Bureau of Export Administration, Office of Strategic Industries and Economic Security performed this update (and the previous study) at the request of the U.S. Department of the Navy, CAD/PAD Program Office of the Naval Surface Warfare Center (NSWC) located at Indian Head, Maryland. The objective was to update the statistical profile of the industry, identify competitive developments, and assess progress made on the recommendations of the previous study.

Currently, the CAD/PAD industry is comprised of about 30 firms owning 34 establishments. Since 1995, about 10 establishments were closed but no capacity was lost as capital expansion occurred at several locations. Also, shipments expanded. The industry has two major divisions, the aerospace sector and the automotive airbag initiator sector. The two sectors are moving on different trajectories and may soon be considered separate industries despite using a common technology.

Re-enforcing the separation, Swedish company Autoliv, a world leading airbag supplier, purchased OEA (with establishments in the United States and Europe) in May 2000. OEA, along with Special Devices in California and Arizona, are the two major CAD/PAD entries into the airbag market. Both are also major aerospace CAD/PAD firms. Autoliv is in the process of selling OEA's Aerospace Division to B.F. Goodrich. B.F. Goodrich has acquired most of the ejection seat assets in the United States in recent years, and with the purchase of OEA Aerospace (to be affiliated with Upco), will also become the largest CAD/PAD producer.

The aerospace CAD/PAD sector has performed well in the last five years, and is poised for continued growth in the future. All economic indicators are up from the 1995 Assessment. Shipments of aerospace CAD/PADS increased by almost 30 percent during the 1995-1999 period, totaling $247 million by the end of the period. Ninety percent of the value of shipments was for defense applications. This increase in shipments was accompanied by an expanded workforce, which exceeded 2,410 by 1999. Capital outlays were robust at $45 million, and research and development spending was over $37 million. Pre-tax profits averaged more than 8 percent but soared to over 10 percent in the final two years.

Shipments in the automotive airbag initiator sector grew more than 160 percent in the 1995-1999 time period as motor vehicle companies completed installing airbags in all new passenger vehicles in 1999, in compliance with the Inter-modal Surface Transportation Efficiency Act of 1991. Shipments grew from $128 to $334 million. Investment outlays totaled $203 million and research and development was over $54 million. The growth cycle actually ended in 1998, as the necessary new capacity was in place. Prices dropped from $7.75 per initiator in 1993 to less than $3.00 today. Special Devices and OEA account for nearly 90 percent of shipments.

Mergers and acquisitions have played an influential role in improving the industry's competitiveness. For a rather small industry, an astonishing number of mergers and acquisitions occurred in the past decade that have intensified competition and forced many marginal firms to exit the industry. Experience is critical in the CAD/PAD industry. It's clear that existing firms (with experienced people) pose attractive targets for takeover. There were no new start-ups on the aerospace side of the CAD/PAD business.

From an economic point of view, business mergers commonly reduce costs (or increase profits), while maintaining or increasing the combined market share of the merging parties. This does not always work out, of course, but reduced costs put competitive pressure on the remaining competitors to do the same.

This latest round of restructuring mirrors the consolidation of the major aircraft and missile manufacturers. The new giant aerospace firms, primarily Boeing, Lockheed, and Raytheon, face ever-stiffer global competition and new challenges. This forces them to put pressure on prices throughout their subcontracting base in an effort to maintain market share. Moreover, they press for a leaner supply base that can shoulder more responsibility. Strategically, dealing with fewer but larger CAD/PAD firms reduces their transaction costs as well as staffing overhead, and contributes to their drive to focus on core capabilities. The pressure on the CAD/PAD firm is to improve performance and customer service, or risk losing business.

In retrospect, perhaps the major reason for CAD/PAD industry consolidation prior to 1995 was the drop in defense business. Here, stronger, more aggressive firms gobbled up weaker firms. Some CAD/PAD companies did this to maintain or even increase sales in a declining business environment. Consolidations of this kind tend to reduce industry redundancies, and thereby, lower costs. Surviving firms also sought to realign themselves to participate in more promising markets.

Surviving CAD/PAD companies struggled with a number of external forces in the last decade including defense downsizing; larger and more demanding customers; increasingly restrictive environmental policies; a slow-moving export licensing process; a leaner supply base; and various procurement issues. The structure of the industry changed rapidly to meet this new competitive environment, and will likely continue to do so. Larger firms have gained market share, while providing a wider range of products and services. Smaller firms are aggressively holding onto niche markets. Competition for resources (inputs), such as labor and materials, and customers is more aggressive and intense. It also appears that global competition is on the rise, which may have a profound impact on the industry in the future.

Chief concerns of the CAD/PAD industry are the slowness of the export license approval process under the State Department's International Traffic in Arms Regulations list, and lot acceptance testing, which is a point of contention between Indian Head and CAD/PAD companies. Progress on both of these issues since the 1995 report has been very slow, and indeed, nearly non-existent. Recently, Congress increased the budget of the State Department's Office of Defense Trade Control by 50 percent. This may help expedite the process; however, many CAD/PADs are non-lethal munitions and the industry thinks a two-tier system, similar to foreign regimes, would be more appropriate.

The entire industry objects to the Navy's insistence that lot acceptance testing be done at Indian Head. The Air Force allows the companies to perform this test at their facilities. From an economic efficiency standpoint, lot acceptance testing at Indian Head adds costs and delays deliveries.

Most of the large firms in the industry favor performance specifications over build-to-print. Performance specifications would allow CAD/PAD producers to leverage their technical staffs and better utilize their facilities. Some companies argued that performance specifications would increase competition by unfreezing designs. A related issue is best value vs. low bid. It appears that policy momentum favors performance specifications and best value over build-to-print and low bid. Build-to-print appears to have a legitimate place in legacy systems.

Recommendations

1. Convene high level discussions between the State Department's Office of Defense Trade Control and the CAD/PAD industry representatives. Provide State with industry evidence of their experiences. Compare U.S. restrictions with those of our key trading partners.

2. Perform a cost/benefit analysis on lot acceptance testing at company facilities under guidelines set down by 1994 GAO report in A-76 (Government competition with private industry). Consider phasing in lot acceptance testing at company facilities that have an established track record of compliance. Consider random checks and official witness testing at companies' facilities.

3. Schedule a meeting with Indian Head, BXA and the two CAD/PAD companies that have export business concerns involving the Navy.

4. Indian Head should continue to retain a core manufacturing capability to ensure all requirements are covered and to remain an intelligent CAD/PAD center. Industry should continue receiving 90 percent or more of the business.

5. Indian Head should continue hosting Technical Exchange Workshops in the future. These are very useful to industry and government. Topics at the next workshop should include the benefits of performance specifications vs. build-to-print, environmental effects on the CAD/PAD industry, and other topics of interest such as contracting. Companies and other interested parties in related government agencies should be encouraged to participate.

6. With Martin-Baker seemingly locking up the JSF ejection seat business, DoD should consider requiring that a portion of CAD/PADs for the JSF seat be procured from U.S. companies. This could be implemented by a leader-follower acquisition approach similar to the approach initially taken with the Navy Aircrew Common Ejection Seat (NACES) Program.

7. Commerce and the Joint Program should monitor DOT commercial shipment processes for companies to successfully obtain certifications in a timely and efficient manner.

1. Introduction

1.1 Background

This report is an update of a National Security Assessment completed in October 1995 on the Cartridge and Propellant Actuated Device (CAD/PAD) Industry. This update and the previous study were initiated at the request of the U.S. Department of the Navy, Cartridge Actuated Device/Propellant Actuated Device Program Management Office of the Naval Surface Warfare Center (NSWC) located at Indian Head, Maryland.

Cartridge actuated devices (CADs) and propellant actuated devices (PADs) are key military components that use explosive and propellant mixtures to perform a variety of specialized work functions. Functions include the ejection of aircrews from aircraft in emergency situations; initiation of flares or chaff as countermeasures to incoming anti-aircraft missiles; and activation of sonobuoys dropped from aircraft into the ocean to conduct anti-submarine warfare.

The Commerce Department's Bureau of Export Administration is delegated authority under Section 705 of the Defense Production Act (DPA) of 1950, as amended, and by Executive Order 12656, to collect basic economic and industrial information from private businesses that would otherwise not be available. The Office of Strategic Industries and Economic Security (SIES) is the operating unit within BXA with the responsibility for this data collection and analysis. The U.S. Navy and the other Services have an established history of cooperative study efforts with BXA that resulted in more than 30 national security assessments in the past 15 years.

In addition to the previous CAD/PAD report, past assessments include a cross section of the defense industrial base. Included are artificial intelligence, optoelectronics, ball and roller bearings, forgings, composite materials, beryllium, and metal fasteners. A complete listing of assessments is shown in Appendix 5; summaries may also be reviewed online at http://www.doc-bxa.bmpcoe.org/dmrr.html. Assessments generally review defense critical industries experiencing difficulties in their ability to support defense programs. A survey questionnaire is designed to collect information that facilitates this kind of review.

This update of the national security assessment of the CAD/PAD Industry reviewed the five-year period from 1995-1999; the previous assessment covered the period from 1991-1995. The stated objectives of this update were to collect statistical data to provide the

industry with an updated statistical profile, assess the current economic health and competitiveness of the CAD/PAD industry, and determine both the implementation and effectiveness of the 1995 CAD/PAD assessment recommendations.

In the first half of the 1990s, the CAD/PAD industry experienced difficulty adjusting to declines in defense sales. Concerns about retaining technical skills and meeting ever-tougher environmental standards surfaced as many CAD/PAD firms experienced financial stress. Consolidation through plant closings, firms exiting the product line, and mergers and acquisitions became commonplace. In the second half of the 1990s, however, defense sales stabilized and actually increased. This sales increase was related to the expanded application of CAD/PAD technology to modern aircraft. The F/A-18E/F contains up to 10 times as many CAD/PAD items as the A-7 aircraft, still used abroad but no longer in production or DoD inventory, which had only12 items.

Despite an increase in CAD/PAD sales since 1995, merger and acquisition activity has continued, further consolidating the industry and intensifying competition. In addition, investment has been high as some companies grew internally. In 1999, five firms had sales of $20 million or more versus only three in 1993. Since 1995, however, at least 10 establishments ceased making CAD/PADs, relinquishing their market shares to others.

About a half-dozen CAD/PAD companies are involved in the fast-growing motor vehicle airbag initiator and gas inflator sector. Two of these firms, OEA and Special Devices, are dominant. The competitive environment in the airbag market, however, is very different than in the defense side of the business. In several ways, the two segments appear to be incompatible, and many in the industry expect they may become two distinct industries over time. Evidence indicates this may already be happening. Autoliv of Sweden, which purchased America's largest airbag supplier, Morton Technologies in 1997, competed its tender offer to purchase OEA in May 2000. Now, Autoliv has tendered OEA's aerospace division in California to B.F. Goodrich. The sale is likely to be completed in early 2001. Consolidation within the airbag sector is also occurring. Three other CAD/PAD companies in the airbag sector recently elected to exit the airbag business and focus entirely on aerospace CAD/PADs.

1.2 Methodology and Scope

A survey questionnaire was designed and field tested with industry participation to gather necessary statistical and written information from private companies in the industry about their CAD/PAD operations. BXA's Strategic Analysis Division provided a justification

for this data collection to the Office of Management and Budget (OMB) for approval as required under the Paperwork Reduction Act of 1978, as amended (5 CFR 1320). This process took about seven months. A copy of the survey is contained in Appendix 2.

On July 23, 1999, the questionnaire was sent to 33 companies believed to be involved in the manufacture of CAD/PADs in the United States, and an additional two firms in the United Kingdom, for a total of 35 mailings. The UK companies elected not to participate. Of the 33 U.S. companies, three were exempt. Three others did not file a completed survey. One non-respondent was gradually phasing out the CAD/PAD business. Respondents, however, are believed to represent over 95 percent of the industry's total shipment value. The Navy's CAD/PAD Program representatives at Indian Head, Maryland, also completed portions of the survey.

In the previous assessment, a similar survey was sent to 60 CAD/PAD firms. Of the 60 companies, 35 completed the survey, including a partially completed survey submitted voluntarily by a foreign firm. A majority of the 25 companies that did not complete the survey dropped the product line, went out of business, or were absorbed by other firms, or did not produce any CAD/PAD items for several years.

Information gathered from the survey was aggregated into a database that formed the basis of our statistical analysis. This survey information included economic data (shipment, employment, financial, etc.), technical information (production profile and constraints), and written response data. The analysis was supplemented by technical inputs from the Indian Head CAD/PAD Program staff regarding product definitions, applications, trends in defense requirements for CAD/PAD, and other topics. Analysts from BXA also interviewed various government officials in the U.S. Departments of Defense, State, Transportation, Interior, and Labor, and the U.S. Environmental Protection Agency. One plant site visit was undertaken for this updated assessment. Additionally, telephone contacts were made with company officials to clarify survey responses and/or gain further insight into the industry. Several companies provided annual reports, product brochures, and other printed materials that were also useful in this analysis.

1.3 Classification of CAD/PADs

In July 1994, the United States reached agreement with the statistical agencies of Canada and Mexico to standardize industry statistical classifications under NAFTA. The name of the new standard became the *North American Industrial Classification System*

(NAICS). NAICS replaced and updated the *Standard Industrial Classification* (SIC) system by including both new industries and a finer breakout of others. Both classification systems were established under the authority and guidance of the Office of Management and Budget. OMB officially adopted NAICS in April 1997. The Bureau of the Census played a key advisory role in creating the new system and made the transition to the NAICS codes in its 1997 Economic Census.

The NAICS codes remain establishment-based as opposed to company-based. Economic data is collected at the establishment level and organized according to the dominant activity of each establishment. This method allows the separate aggregation of establishment data into industry totals for economic activities from making shoes to petroleum refining or auto assembly. Three-country industry comparisons can be made at the 5-digit level. However, greater in-country detail is represented by 6-digit identification code. Thus, every U.S. establishment has a 6-digit NAICS code, and the NAICS codes combine to form a common basis for the U.S. Government's collecting and organizing economic statistics for the entire economy.

Establishments that produce CAD/PADs (excluding airbag initiators and inflators) as their dominant activity are a segment of the *Explosives Industry* (NAICS code number 325920). Prior to 1997, the same industry was identified by the 4-digit SIC code 2892. The expanded name for the explosives industry in NAICS is: "*Explosives, Propellants, and Blasting Accessories, except those shipped by Government owned, contractor operated plants.*"

Airbag initiators - Statistical information about airbag initiators and other related items is buried deep within NAICS Code 336399. NAICS Product Code 336399-7534, "Motor vehicle air bag assemblies and parts thereof, new" is the closest available data. For 1997 Census data indicated 20 companies shipped $4.13 billion of these items. Based on SIES survey results, CAD/PAD companies shipped about $279 million of airbag initiators in 1997, or about 7 percent of $4.13 billion total.

1.4 Report Organization

This assessment begins with a description of the domestic CAD/PAD industry and the major products and end markets the industry supplies. This section also includes an overview of the ejection seat and automotive airbag markets. The next section looks at competitive considerations, including the impact of mergers and acquisitions, firm size, and company views on their future. Section 4 covers the economic performance of the

aerospace and airbag initiator sectors separately. Trends in shipments, employment, capital outlays, research and development and profits are detailed for each sector. Next, government policies are critiqued by the industry. This examines procurement issues; small business set asides, export controls, lot acceptance testing and other issues important to the companies. Section 6 reviews Indian Head's role as the Joint CAD/PAD Program Office. Discussed are Indian Head's actions to implement the previous report's recommendations, along with CAD/PAD companies' and Indian Head's self assessments of progress on those recommendations. Findings and recommendations are presented at the end of the report.

2. Industry Description

Entering the 1990s, an estimated 60 firms produced CAD/PAD products. Ten years later this number fell by half to about 30 firms. In 1995, 44 establishments produced CAD/PADs. By 2000, 34 establishments remained, scattered about in 20 states. Three establishments were dedicated producers of automotive airbag initiators or inflators. Most of the decline in the establishment population came from the exit of smaller firms.

In the last five years, at least three companies moved into new facilities that replaced older ones. Special Devices moved from Newhall to Moorpark in California. Technical Ordnance moved from St. Bonifacius, Minnesota to Clear Lake, South Dakota and the Accurate Companies purchased Woerner Engineering's operation in Colorado and then moved to McEwen, Tennessee. Additionally, OEA opened a plant in Tremonton, Utah to make airbag inflators.

The CAD/PAD industry appears to be splitting into the aerospace and automotive sectors. Although the technology is common, the two sectors respond to entirely different markets, which appear to be mutually exclusive. Aerospace CAD/PADs are produced in hundreds of varieties by more than two-dozen companies. With such a broader scope and shorter production runs, aerospace CAD/PADs are generally produced using a batch manufacturing process. In contrast, only four or five companies produce airbag initiators in huge numbers and a very limited variety. They generally use a continuous, more automated production process. The two workforces reflect these differences. Aerospace CAD/PADs show a much greater per unit engineering content. Production workers are slightly more than half the total workforce. Production workers in the airbag sector, however, comprise nearly 90 percent of the workforce. The engineering content in airbag initiator production is spread over millions of units and nearly disappears as a cost.

The workforce structure is just one major difference. The two products also vary in plant size and layout, workforce skills, investment requirements, R&D, and profit margins. The competitive situation in each sector is also very different; the one faces government procurement policies, the other the pressures from the globally competitive automotive industry. To aggregate these two sectors would be to distort both. In 1999, shipments by the aerospace sector were almost $250 million; nearly 90 percent were for the military applications. The automotive sector shipped nearly $340 million worth of airbag initiators and inflators. Less than 2 percent of these sales entered military markets.

Because of these differences, the two sectors are presented separately for the most part in this report.

2.1 The CAD/PAD Industry

Although explosives technology is hundreds of years old, the CAD/PAD industry is relatively new. The industry arose shortly after World War II in response to aircrew safety concerns in escaping from new high speed military aircraft. The safety of an aircraft's pilot and crew was always a top priority, but the high air speeds of modern aircraft made escape by simply bailing out extremely hazardous. Designers developed the ejection seat to meet this new problem. The ejection seat employed precision engineered propellants and explosives to propel an aircraft's crewmembers and their seats away from the aircraft. Initially this was little more than an assisted bailout, but as the technology evolved greater reliance was placed on CAD/PADs. CAD/PADs were used to secure the pilot to the seat in the proper position, adjust the attitude of the seat once out of the aircraft, and automatically deploy parachutes. While the ejection seat remains an important use for CAD/PADs, in subsequent years applications of the technology expanded into many other areas.

The military remains the key driver that stimulated development of both the technology and commercial applications. The expanding military requirement in years past pushed research and development and was largely responsible for advancing, proving, and integrating the technology into numerous aerospace as well as non-aerospace military applications. As the industry gained maturity and experience, ways were found to reduce production costs, increase quality, performance and reliability, and develop commercial markets. Today, the experience, technology, and know-how of the industry represent critical assets to the national defense, and are now of great importance in automotive safety. Other commercial areas that have developed include oil production (well perforating guns), the mining industry (detonating cord), fire and rescue operations (fire extinguisher actuators), and aircraft safety (aircraft evacuation slides).

The military end of the CAD/PAD industry is currently comprised of about 30 firms located in 20 states. States with the most production (excluding airbags) are California and Arizona. These two states alone account for almost two-thirds of aerospace CAD/PAD production. In 1999, California led all other states in shipments with 44 percent of the industry total. Arizona added another 21 percent.

Measured against other industries the CAD/PAD industry is quite small. In 1999, combined shipments of aerospace and automotive type CAD/PAD products totaled less than $600 million (about 40 percent defense) and employment was under 4,500. This is much smaller than the smallest company on the Fortune 500 list.

The industry's small size understates the growing importance of CAD/PADs to the national defense and safety of motor vehicles. Over the years thousands of lives have been saved through the application of CAD/PADs. These include pilots and other aircrew who owe their lives to the emergency egress systems and evasive counter measures that use CAD/PADs to thwart incoming-missiles. Second, by improving the survivability of expensive war fighting equipment (i.e., countermeasures), CAD/PADs contributed to saving billions of dollars and additional lives. As military aircraft became more and more expensive, CAD/PADs became increasingly critical. And third, CAD/PADs perform mission-essential functions such as releasing bomb racks or missiles, kicking-out nose cones, or igniting rocket motors. The performance of the weapon system is enhanced, while fewer people are put at risk.

The industry's small size has economic and political consequences. For starters, the industry is generally unable to influence the political or business environment in which it operates. The result is that many issues have festered for years. CAD/PAD companies usually have to adapt to rules made for someone else. For example, the defense procurement regulations, which call for small business set-asides, apparently are unfair to the industry's so-called larger players and allegedly raise the cost of procurement. Some CAD/PAD firms fail to qualify for set-asides simply because they are divisions of larger firms. In addition, the export controls under the Munitions List treat CAD/PADs (excluding airbag initiators) the same as lethal weapons. Despite repeated pleas to somehow expedite the procedure for CAD/PADs, little has changed, and foreign sales have been lost as a result. Meanwhile, many foreign governments define CAD/PADs as a safety item and allow for expedited exports. Also, the environmental rules have tightened, especially in California, where six major CAD/PAD producers account for over 40 percent of industry sales. This can have long-term adverse consequences on competitiveness if other U.S. states or foreign countries have laxer environmental standards that do not impose similar costs on their industry.

Defense Capabilities

Based on reports from 26 CAD/PAD companies a total of $213.3 million in military shipments were completed in 1999. The largest line item was detonating cords and charges, which accounted for $46.2 million, or about 21.7 percent of the total. A close

second was aircraft stores, flares, chaff, and sonobouy ejection cartridges at $39.5 million. Airbag initiators for military vehicles were also included with $5.5 million, less than two percent of total airbag initiators. The table below shows shipment and percentage totals for all the products surveyed.

Number of Companies and Shipments of Military Related CAD/PADs, 1999 (in $000s)			
CAD/PAD Products for Defense	# of Shippers	Shipments ($000s)	Percent of Total
Aircrew Escape Propulsion Subsystem	3	21,752	10.20%
Electrically Initiated Impulse Cartridge	14	21,127	9.90%
Percussion Initiated Impulse Cartridge	8	14,292	6.70%
Initiators (Impulse)	8	16,530	7.75%
Delay Cartridges and Delay Initiators	10	7,276	3.41%
Aircraft Stores, Flares, Chaff, Sonobouy Ejection Cartridges	10	39,508	18.52%
Detonating Cords And Charges	5	46,195	21.65%
Cutters	10	5,869	2.75%
Catapults, Thrusters, Removers	9	21,845	10.24%
Automatic Inflators	2	1,920	0.90%
Gas Generators	6	2,478	1.16%
Automotive Airbag Initiators	2	5,535	2.59%
Laser Initiated Cartridges, Detonators & Initiators	3	3,050	1.43%
Rocket Motor Igniters	3	5,952	2.79%
Totals	26	$213,329	-

Source: US DOC/BXA 1999 Industry Survey

2.2 Manufacturing Process

CAD/PADs cover a wide range of items for which the manufacturing processes vary. A general rule that applies to the assembly of all CAD/PADs is to assemble as much of the cartridge (and/or device) as possible prior to installing or loading the explosive components to minimize the risks. For safety reasons a typical manufacturer occupies several hundred acres with specialized buildings and structures set a safe distance from public thoroughfares.

CAD/PAD production is organized around five specialized activities. These operations, arranged in sequence, are shown on the following table.

CAD/PAD PRODUCTION OPERATIONS
1. Blending and Mixing of Propellants and Explosives
2. Manufacture of Metal Parts
3. Subcomponent Processing and Assembly
4. Cartridge Assembly
5. Device or Rocket Motor Assembly

While many firms in the industry have operations in each phase, virtually all firms subcontract portions of the work in each phase to more specialized firms. Several firms reported that metal parts were the most expensive input in CAD/PAD production. The industry practice is to outsource all or most of the fabrication of metal parts to specialized metal workers, or the customer may provide it. Historically the market for CAD/PADs has been too volatile and unpredictable to economically carry the substantial overhead required in metal parts manufacture. Nonetheless, many CAD/PAD firms maintain a (usually small and limited) machine shop.

Airbag initiator producers carry more metal parts manufacturing overhead as necessary to accomplish high volume production. They also use a continuous mixing process as opposed to batching of explosives. Aerospace CAD/PADs are normally built in lots or batches using explosive or propellant charges mixed in a single batch and (frequently outsourced) precision machined metal parts. Most CAD/PAD companies blend and mix propellants and explosives. This is usually done in batches by adding measured amounts of chemical ingredients into a mixer, and then blending and curing the ingredients at controlled temperatures for specific time periods. Further processing in the form of machining or cutting may also be required to get the material into proper form. These energetic materials may then be incorporated into the CADs or PADs as a "dry load" in the form of pellets, particles or powders of predetermined size, or a "wet load" (i.e., viscous fluid), or a pliable semi-solid, which hardens when cured.

Cartridge manufacture begins with the precision machining of metal parts. These parts are cleaned prior to assembly to remove residual oils and particles, which can adversely

affect the performance of explosives and propellants. If the device is to be electrically initiated, the cartridge goes through a glass-to-metal sealing process that seals one end of the cartridge while allowing electrical contact pins to protrude through the seal. This glass seal provides a critical barrier to the ballistic pressure that will occur during firing so it can be channeled to do work. The pins provide the means of connecting the cartridge to the firing circuit.

An electric bridge wire is soldered or welded to the pins inside the case. The bridge wire will eventually be in contact with the primary explosive material. Current through the bridge wire will provide the heat source for igniting the primary explosive. In some cases, the cartridge is percussion primed. Here, the primer is pressed into the primer pocket, which, when struck, will provide the heat source for igniting the primary charge, in place of the bridge wire. An epoxy sealant is used with percussion primers and a glass-to-metal seal is used around the connecting pins.

Each explosive charge (usually several per cartridge) is precisely weighed and segregated. Then, each charge is loaded in each cartridge case of the lot. Some charges such as fine powders are pressed in place during loading. The primary charge (i.e., the most sensitive charge) is loaded next to the primer or bridge wire, then the secondary charge is loaded according to precise measurement. When the charges are loaded, a closure is placed over the cartridge opening. The closure is usually a thin metal disk that is stitch or laser welded to the case, or sometimes held by crimping the case over a seal and the disk; sometimes epoxy is also used to ensure sealing at this end.

2.3 Product Descriptions

Cartridge Actuated Devices (CADs) and *Propellant Actuated Devices* (PADs) are specialized work-performing components used in many modern weapons systems. The cartridges use precisely measured propellant and explosive mixtures of varying compositions and burning characteristics to perform a wide variety of jobs critical to safety, survivability, and weapon system performance. More than 3,100 part numbers are in use by the military. They range in cost from about $1 to over $10,000, and may be purchased one at a time or by the many thousands.

Propellants and *explosives* are chemical compounds or mixtures of compounds that when ignited rapidly produce large volumes of hot gases. Propellants burn at relatively slow rates measured in centimeters per second. Explosives detonate at rates measured in kilometers per second. Pyrotechnic materials evolve large amounts of heat but much less gas than propellants or explosives. *Deflagration* (burning) occurs when the released gases expand at velocities less than the speed of sound (about 1,100 ft/sec. in air at normal temperatures). *Detonation* is the term used to describe expanding velocities greater than the speed of sound.

A key advantage of these energetic materials is the relatively large amounts of energy stored compactly and readily available to perform a variety of work functions. Propellants are used when the energy required is released in milliseconds, such as guns or airbags, and up to seconds in rockets. Propellants are used for moving pistons, shearing bolts and cable, releasing bombs from bomb racks, and starting engines. Explosives are used when energy requirements are instantaneous and of short duration, and more energetic. These include severing panels and fracturing aircraft canopies.

Various types and designs of CAD/PADs are used, sometimes alone or with others to perform a more complex task. CAD/PAD items include, but are not limited to, detonators, detonating and thin layer explosive cords, percussion primers, electric ignition elements, laser initiation, pyrotechnic delays, thermal elements, rocket catapults, under-seat rocket motors, thrusters, cutters, and water-activated devices.

CAD/PADs are used, for example, to supply the muscle to release bombs or missiles from aircraft. They are instrumental in ejecting flares and chaff from aircraft as countermeasures against incoming heat-seeking or radar-directed missiles. Other applications cut helicopter cargo cables or cargo parachute reefing lines in airdrop re-supply, and provide staging operations for unmanned aerial vehicles, like deploying and detaching parachutes, or inflating flotation bags, slides or landing cushions.

With several exceptions, device assembly is normally outside the purview of most CAD/PAD producers. The device manufacturers, however, usually work closely with the CAD/PAD producers to ensure the product is properly engineered. In fact, some device makers have integrated the CAD/PAD producer into their vertical structure. These firms include Walter Kidde, which makes fire extinguishers for gas turbine engines, or Conax with its flotation device for pilots that eject into the water.

Sometimes devices are made or assembled as an integral part of the cartridge by the CAD/PAD producer. These include, for example, cable cutters, detonating cord, and sometimes valves. Other device assembly, such as bomb racks or ejection seats, is conducted by the military or by prime contractors, and often may be one of the last things completed before intended use.

As already noted, over time the number and sophistication of CAD/PAD devices used in air vehicles has increased. This trend appears to be continuing both as new applications are developed and market outlets, such as the space program, continue to expand. The use of initiators and inflators in motor vehicles is also expanding both in the number of vehicles using airbags and the number of airbags per vehicle. The technology these items utilize was taken directly from the CAD/PAD sector. An overview of the markets for ejection seats and automotive airbags is presented in the next section.

Major Markets

As previously stated, over 3,000 CAD/PAD part numbers are in circulation. These are sold into many market areas. Two major markets are ejection seats and automotive airbags. These markets are described in the following two subsections.

2.4 Ejection Seats

Ejection seats constitute the largest end market for aerospace CAD/PAD products. Each seat uses about 15-20 CAD/PAD devices. In total, based on new seats and CAD/PAD replacements, this market may account for about 30-40 percent of the dollar value of aerospace CAD/PAD use. Virtually all ejection seats are used in military aircraft. This market is international in scope. Seats and CAD/PADs are sold domestically and may either piggyback on FMS sales of aircraft or are sold as replacement items for the seats on previously exported aircraft.

Ejection seats are used in combat aircraft by the U.S. Air Force, Navy and Marine Corps, and in training aircraft. The Air Force uses the ACES II (Advanced Concept Ejection Seat). It is used on the A-10, F-15, F-16, F-22, F-117, B-1B and the B-2 aircraft. Nearly 9,000 ACES II seats have been produced since the Air Force selected the seat in 1976. Until recently, McDonnell Douglas Aircraft Corporation manufactured the seat in Titusville, Florida. McDonnell Douglas, along with its ejection seat business, merged with Boeing in August 1997. Boeing sold the ejection seat business to B.F. Goodrich in November 1999.

Today, most of the American ejection seat business is under the corporate control of B.F. Goodrich. Prior to the acquisition of the ACES II seat, Goodrich purchased Universal Propulsion, Inc. (Upco) in October 1998. Upco produces the S-III ejection seat used on the Marine Harrier AV-8B and the Alpha Jet used in Germany and Nigeria, and the T-4 used in Japan. Upco makes the CAD/PADs for ejection seats including the propulsion units used on the S-III, ACES II, and as a second source for the Navy Common Ejection Seat (NACES), which is made by the British firm Martin-Baker. To expand its CAD/PAD capabilities, B.F. Goodrich has now offered to purchase OEA Aerospace from Sweden's Autoliv, pending government review.

In May 2000, Goodrich purchased IBP Aerospace. IBP was established in Connecticut in 1998 with a $7 million state subsidy, to market the Russian seat K-36D and possibly establish a domestic manufacturing capability. The Zvezda (Star) Design Bureau manufactures the K-36D seat near Moscow. Zvezda completed work on a two-year project with then- Rockwell Aerospace to lighten the K-36 seat for American cockpits. The project, sponsored jointly by the U.S. Air Force and Navy for almost $10 million, was called the "3.5 Generation Seat." It was hoped the technology might expand the pilot's survival envelope. The K-36D seat was successfully sled tested at 755 knots, surpassing any western manufactured seat. It remained too heavy, however, for the U.S. Services and has not been selected for any aircraft to date.

The British company Martin-Baker is the largest and most integrated ejection seat producer in the western world. The company has nearly 18,000 seats in use and is the manufacturer of the U.S. Navy's NACES seat used on the F/A-18C/D/E/F, T-45 and F-14D. Since 1985, the company has supplied nearly 1,200 of these seats. In addition, Martin-Baker will supply 1,422 seats for the T-6 Texan II (i.e., Joint Primary Aircraft Training System or JPATS) over about a 20 year period. Martin-Baker was also selected to provide an upgraded seat for 42 T-38 Talon trainers by NASA. Each aircraft uses two seats. A modified version of Martin-Baker's Mark-16 seat will be used. The Air Force is

monitoring developments of the NASA upgrade program. If NASA is successful, the Air Force may use it as leverage to upgrade the 425 T-38's in its fleet.

The big prize, however, is the Joint Strike Fighter (JSF), which is now being competed for by Boeing and Lockheed. Production of the aircraft is slated to begin in 2008, and in the 20 or so years afterwards an estimated 3,000 planes will be built for U.S. military use, and possibly 3,000 more for sale in the international market. The JSF must accommodate pilots ranging in weight from 103-245 pounds, which will require more complex CAD/PAD devices. The plane may displace some existing fighter aircraft, which could disrupt the operations of some CAD/PAD suppliers in the future. At the same time, new opportunities will become available to supply the JSF ejection seat and aircraft.

Martin-Baker was selected to supply its Mark-16 seat for Boeing's JSF concept demonstrator, while Lockheed Martin selected Universal Propulsion's S-III seat for the same purpose. However, Boeing and Lockheed both announced that Martin-Baker will supply a modified version of its Mark-16 ejection seat should their aircraft design win the JSF competition. The JSF winner will be determined in 2001.

Martin-Baker makes its own CAD/PADs in England. The firm announced it would assemble the JSF ejection seats in a new facility in Johnstown, Pennsylvania. This should strengthen opportunities for U.S. CAD/PAD companies to supply CAD/PAD components for the ejection seat.

The U.S. Congress is pushing DoD to keep the ejection seat competition open until 2005 when more modern-performance capable seats should be available. House members stated that "none of the funds in the (Defense Appropriations) act may be used to develop an ejection seat for the JSF other than those developed under the Joint Ejection Seat Program." The JESP was established in 1999 by Congress to involve multiple contractors in the development of 3rd generation-plus seats. These would be operationally ready by 2005.

2.5 Airbag Initiators and Inflators

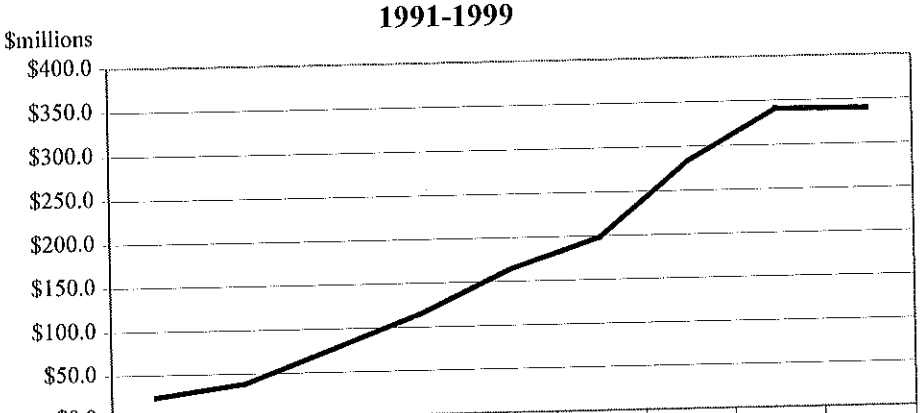
The growth of the market for automotive airbag initiators and inflators has been phenomenal. From 1991 to 1999, this market expanded from $24.5 million to $339.9 million, growing almost 40 percent a year. In 1991, the airbag market was given a major boost by passage of the Inter-modal Surface Transportation Efficiency Act. Section 208 of that Act stipulated that by the 1999 model year all new passenger vehicles sold in the

United States were to be equipped with driver and front seat passenger airbags. This requirement was phased in rapidly beginning with the 1997 model year, which began in September 1996. The Act mandated that inflatable restraint systems must be installed in:

- 95 percent of the 1997 model passenger vehicles sold in the United States;
- 100 percent of the 1998 model passenger vehicles and 80 percent of the vans and pickups sold in the U.S.; and,
- All of the 1999 passenger cars, vans and pickups.

The chart below depicts the growth of shipments (in millions of dollars) of airbag initiators and inflators, including domestic and international sales by U.S. CAD/PAD companies. Imports are excluded, but very few, if any, are imported. The spurt in 1997 was caused by first-stage implementation of Section 208 and an increase in exports. After this spurt (an increase of 43 percent), growth slowed to 19 percent in 1998; shipments actually fell back slightly in 1999.

Shipments of Airbag Initiators and Inflators
1991-1999



	1991	1992	1993	1994	1995	1996	1997	1998	1999
Initiators and Inflators	$24.5	$38.8	$76.8	$115.6	$163.8	$198.4	$283.3	$340.7	$339.9

Source: US Dept. of Commerce, BXA/SIES Survey Data

The growth trajectory would be steeper if the chart were shown in units. (Note: A review of OEA's, Special Devices' and other's publicly available financial statements support the faster "unit" growth. Unit information was not collected by the Commerce Department

for this update.) In the earlier CAD/PAD report, it was noted that the average unit price of an airbag initiator in 1993 was $7.76. By 1999, however, the average price of an initiator was pushing toward $3.00, and it may go still lower according to industry sources. The downtrend in prices conceals a more rapid rise in units that has yet to plateau.

The rapid downtrend in the price is attributable to several factors: the economies of scale that come with higher volume production; increased productivity with experience; and, strong cost reduction pressures passed down from the major auto companies. Based on information in the Annual Report of Autoliv, the producer of about one-third of the world's finished airbags, more than 100 million initiators were produced worldwide in 1999.

Airbag systems have six basic components: 1) initiators; 2) inflators or gas generators; 3) combustion chambers; 4) specially treated fabric bags; 5) sensors; and 6) diagnostic and firing modules. After receiving an electrical signal from the firing module, the initiator ignites the gas generator, which then inflates the bag in a fraction of a second. In addition to airbag systems, CAD/PADs are used in micro gas generator devices used to take the slack from auto seat belts.

While the driver and front seat passenger are protected by a frontal airbag, side airbags designed to protect against side collisions are gaining in popularity. Airbags are now being designed to protect the head and neck against rear-end collisions. Knee bolsters to prevent sliding under the wheel in frontal collisions and back seat airbag protection are also available. Concerns over injuries caused to children and smaller adults by airbag deployment have led to the "smart" airbag system. This airbag can detect the weight and position of the occupant and fire an airbag with full or partial force should the car have a collision of sufficient force. The smart airbag module is equipped with dual chambers and two initiators.

A total of seven U.S. CAD/PAD companies entered the auto safety restraint market in the last 10-15 years. Currently, four remain. Two firms, however, overwhelmingly dominate airbag initiator production. These two companies are OEA in Denver and Tremonton, Utah, and Special Devices, Inc. (SDI) in Moorpark, California and Mesa, Arizona. OEA and SDI account for nearly 90 percent of the total initiator business. SDI is also the leading micro gas generator producer.

OEA entered the field in 1987. In 1994, OEA acquired ET, Inc. in Fairfield, California, and transferred all of its aerospace CAD/PADs to Fairfield. OEA had a separate Denver

facility where all airbag initiator production was consolidated. Transfer of the aerospace operations to ET was completed in early 1995. The Tremonton plant, which became operational in 1998, was OEA's venture into airbag hybrid inflators (i.e., inflators that do not use sodium azide as a propellant). Another inflator facility was constructed in France. Start-up problems caused the company to suffer losses the first two years. As noted previously, in May 2000, Autoliv purchased OEA and in December agreed to sell OEA Aerospace to B.F. Goodrich.

SDI entered the airbag initiator market in 1989, with a five-year contract for initiators from TRW in-hand. SDI has its main plant in Moorpark, which replaced its nearby Newhall plant in 1999. The Moorpark operation produces both airbag initiators and aerospace CAD/PADs. SDI's Mesa facility is dedicated to the manufacture of initiators.

Other CAD/PAD companies still in the auto safety constraint business include Upco and Quantic. Upco has not sold any initiators, but is exploring the technology. Quantic sells a small but growing volume. Other firms that produced initiators included McCormick Selph, Inc., BAE SYSTEMS (formerly Marconi Aerospace), and Talley. For a few years, MSI made micro gas generators for seat belt tensioning, but sold this business to SDI in 1999. The other companies announced their intention to exit the market after current contracts are completed. Active airbag initiator producers in Europe include Nouvelle Cartoucherie de Survilliers (owned by Autoliv of Sweden), Davey Bickford Smith, Patvag, and Pyroindustrie (owned by OEA).

Currently, seven major customers buy initiators and/or inflators from CAD/PAD companies. The two largest customers are Autoliv and TRW. Each had about one-third of the 1999 $6 billion world market for finished airbags. Other companies include Breed Technologies, which emerged from Chapter 11 Bankruptcy in December 2000; Delphi Interior (formerly part of General Motors); and Baico (purchased by Atlantic Research in 1998); Takata and Daicel Chemical Industries in Japan, and the German firm Petri.

3. Competitive Considerations

Surviving CAD/PAD companies struggled with a number of external forces in the last decade, including defense downsizing; larger and more demanding customers; increasingly restrictive environmental policies; a slow moving export licensing process; a leaner supply base; and numerous procurement issues. The structure of the industry changed rapidly to meet this new competitive environment, and will likely continue to do so. Larger firms have gained market share, while providing a wider range of products and services. Smaller firms are aggressively holding onto niche markets. Competition for resources (inputs), such as labor and materials, as well as customers is more aggressive and intense. It also appears that global competition is on the rise, which may have a profound impact on the industry in the future.

3.1 Industry Consolidation

The CAD/PAD industry experienced an astonishing number of mergers and acquisitions in the past decade that intensified competition and contributed to the exit from the industry of many marginal firms. Restructuring of this kind is a vital competitive feature in any industry undergoing rapid change. There was strong competition for the experienced people in sinking firms; since hiring experienced people has a faster payoff than starting a new company and training a workforce from scratch. Hence, there were no new start-ups on the aerospace side of the CAD/PAD business.

Business mergers are almost always proposed to reduce overall costs (or increase profits), while maintaining or increasing the combined market share of the merging parties. This does not always work out, of course, but reduced costs put competitive pressure on those companies remaining in the market to do the same.

This latest round of restructuring mirrors the consolidation of the major aircraft and missile manufacturers. The new giant aerospace firms, primarily Boeing, Lockheed, and Raytheon, face ever-stiffer global competition and new challenges. This forces them to put pressure on prices throughout their subcontracting base in an effort to maintain market share. Moreover, they press for a leaner, more responsive supply base that can wield more responsibility. Strategically, dealing with fewer, but larger, CAD/PAD firms reduces prime contractors' transaction costs as well as staffing overhead, and contributes to their drive to focus on core capabilities. The pressure on the CAD/PAD firm is to improve performance and customer service, or risk losing business.

Looking back, perhaps the major reason for industry consolidation up until 1995 was the drop in defense business. Here, stronger, more aggressive firms gobbled up weaker firms. Some CAD/PAD companies did this to maintain or even increase sales in a declining business environment. Consolidations of this kind tend to reduce industry redundancies, and thereby, lower costs. Surviving firms also sought to realign themselves to participate in more promising markets.

Consolidation Activity Prior to 1995

Major players, who exited the CAD/PAD industry in the first half of the 1990s included Dyno Nobel, ICI, and Dupont. Dyno Nobel was a leading supplier of squibs to the CAD/PAD industry, and Dupont was a major supplier of explosive materials. These firms exited because of the declining market and the emergence of restrictive environmental policies.

Universal Propulsion Company (Upco) became a force in ejection seats when it purchased Stencil (Ashville, NC) in 1986. Stencil's assets were moved to Upco's main facilities in Phoenix along with about 30 people. In 1990, Upco purchased Space Ordnance Systems Company.

In April 1993, Pacific Scientific acquired Unidynamics (Goodyear, AZ) and consolidated assets and people in its nearby plant in Chandler, Arizona. The combined firm is very strong in both defense and commercial markets.

In other consolidation action:

- Quantic Industries purchased Whitaker Ordnance of Hollister, California, in 1991 (Whitaker had previously purchased the Holex Company at the same location). In 1993, Quantic closed plants in Calaveras and Salinas, California, consolidating CAD/PAD operations in Hollister.

- In 1991, Amtex Precision Products purchased the remaining assets of Astra Precision Products (Elgin, IL). Astra sales had plummeted from about $15 million in the late 1980s.

Other shutdowns:

- Maryland Assemblies in Florida.
- Caelus Company in Hollister, California, entered Chapter 11 bankruptcy in 1989, because of contract cancellations by the Navy. Two years later the firm entered Chapter 7 and liquidated. MK Ballistics purchased the assets of Caelus, and later sold portions of the business to a start-up firm named Siebelair.
- MK Ballistics exited the CAD/PAD business after completing a contract in 1996.

Many smaller firms were also affected, sometimes indirectly. For example, during this period a number of firms reportedly started up small businesses taking advantage of the small business set-asides. By some accounts, these firms took business away from more established firms and aggravated their efforts to adjust to a declining market. For example, Siebelair survived on this basis until shutting down (circa 1995). Start-up Byrne Industries shut down in 1994 for non-performance. Start-ups Kenross and Garner-Fairfield shut down for the same reason. Another firm, Rexon of Wayne, New Jersey, was shut down by court order for illegal trade activities.

Consolidation Activity Post-1995

In 1997, Primex purchased Olin and consolidated CAD/PAD operations in Redmond, Washington. Also, GEC (UK) purchased Marconi Aerospace, which produced CAD/PAD, in 1998, and British Aerospace acquired GEC in 1999. Marconi was renamed BAE SYSTEMS. Marconi's San Remon facility in California was closed. Conax was acquired by Cobham (UK). Talley Defense Systems was purchased from Carpenter Technology in an employee buyout in 1999. Also, Fike Corporation acquired Cartridge Actuated Devices in 1999. In 1999, Pacific Scientific became part of the Danaher Corporation, an investment holding company.

As mentioned before, in 1998, B.F. Goodrich acquired Upco. Goodrich went on to acquire most of the ejection seat assets in the United States. Now, Goodrich has an agreement to purchase OEA Aerospace from Autoliv; this should go through early in 2001.

Aside from B.F. Goodrich, another new entry in the consolidation game is the investment equity firm of J.F. Lehman and Company, co-chaired by former U.S. Secretary of the

Navy, John Lehman. An investment equity firm essentially seeks to buy undervalued assets and then sell them at a profit. Both Goodrich and Lehman are profoundly changing the industry's structure. Lehman entered the fray in 1998, when it purchased SDI. In 1993, SDI had acquired Scot, Inc. in Downers Grove, Illinois for $5.3 million. Scot, therefore, came under Lehman's control as well.

SDI specialized primarily in CAD/PAD missile applications and automotive airbags, while Scot specialized principally on CAD/PAD aircraft applications. Both firms were strong in design and engineering and apparently saw no need to integrate their product offerings. In 1999, SDI opened a new plant in Moorpark near Los Angeles, moving both its airbag initiator and aerospace business into the plant from its former location in nearby Newhall. SDI also has a plant in Mesa, Arizona that makes airbag initiators primarily for TRW, a major supplier of complete airbag systems.

In 1999, Lehman purchased McCormick Selph, Inc. (MSI) from Teledyne. With the purchase of MSI, J.F. Lehman and Company controlled three major aerospace CAD/PAD companies, and in SDI, also one of the world's leading airbag initiator firms. MSI's growing micro gas generator business used in seatbelt tensioners was then sold to SDI. MSI could now focus strictly on its aerospace CAD/PAD business. Shortly thereafter, Lehman put MSI and Scot up for sale as a package deal. In September 2000, Wind Point Partners purchased the package.

In other action, Autoliv, headquartered in Sweden, was established as a separate corporation in 1994, after being spun-off from Electrolux. The leading airbag supplier in Europe, Autoliv purchased Morton Auto Safety Products Company located in Ogden, Utah in 1997. Morton was the leading airbag manufacturer in the United States and East Asia. Autoliv purchased OEA in May 2000 in a major upstream step toward vertical integration.

In December, 2000, Autoliv committed to sell OEA's Aerospace Division, located in Fairfield, California, to B.F. Goodrich. This sale, which should be completed early in 2001, will make Goodrich not only the major U.S. factor in ejection seats, but also in aerospace CAD/PADs now that Upco and OEA Aerospace will be affiliates. Goodrich, along with MSI-Scot, will put more pressure on other CAD/PAD producers to lower costs and prices on CAD/PAD items. This could lead to other mergers as various companies look for combinations to reduce costs.

Impacts of Consolidation: Company Views

Survey respondents were asked to comment on the effects of mergers, acquisitions and takeovers on their current business activities. About half of the respondents indicated consolidation activities had no appreciable effect on their operations, while the remaining companies, including nearly all the larger ones, provided written comments to indicate that changes are occurring. Several noted that competition was tightening.

The consolidation had impacts both on the CAD/PAD industry and on the supporting infrastructure (subcontractor base). For example, one company wrote that the reduction of the supplier base has had an adverse impact on component availability and costs. Another firm stated that it was increasingly difficult to track qualified vendors or find new ones when other companies acquire favored vendors. One company reported it was forced to develop a new electronic component in-house when the takeover of a former vendor pushed the product lead time to fifty weeks.

While the overall number of competitors has been reduced, the remaining businesses have become more aggressive. Opportunities for market share are available for the supplier that emphasizes improved product performance and reduced cost. In some cases, customers have become competitors by buying up competition and through vertical integration. The sales volumes increased for companies that evolved from these acquisitions. As a result, fewer producers have in some cases increased or held on to their defense market share even though the total defense market was shrinking.

3.2 Competitive Prospects: Company Views

Each survey participant was asked to rate their company's competitive prospects in areas such as price and technology over the next five years. The degree of competitiveness was measured by asking the participants to select one of five prospective outlooks.

Twenty-six CAD/PAD companies responded to this question. Thirteen of them, representing about 70 percent of the industry's 1999 shipment total, believe their competitive prospects will improve in the next five years. This group's majority share of shipments indicates larger companies are generally more optimistic than the smaller group. Four of these companies had shipments of $20 million or more out of five large companies responding; three were medium sized out of seven responding; and six firms had shipments under $5 million out of 14 smaller sized companies responding. These 13 companies also accounted for 82.2 percent of the "growth" in shipments between 1995

and 1999. This strong performance enabled the group to increase their market share by nearly 3 percent. Their responses are tabulated on the following table:

Competitive Prospect expected to:	Number of Firms Reporting	Percent Distribution
Improve Greatly	4	15.38%
Improve Somewhat	9	34.62%
Stay the Same	7	26.92%
Decline Somewhat	3	11.54%
Decline Greatly	3	11.54%

Source: U.S. DOC/BXA CAD/PAD Industry Survey

The seven firms that reported their prospects would *stay the same* accounted for about 19.1 percent of the 1999 shipment total, but only 9.1 percent of the 5-year growth total. The seven included one large firm, two medium and four small companies. All of the group's growth was achieved in 1999. This was not enough to regain or retain the market share they commanded in 1995, however, as their overall market share dropped 2.4 percent from 1995. The six companies that reported *declining prospects* represented 11.1 percent of 1999 shipments, compared to 11.6 percent in 1995. This entire drop in market share occurred between 1998 and 1999, when shipments for the group fell almost 25 percent. Five of these firms were small and one, medium-sized.

Improve Greatly

Four companies (3 large, 1 medium) believe their competitive prospects will improve "greatly" over the next five years. One company mentioned that competition in their specialization is decreasing. Two companies mentioned that their business would increase due to beneficial mergers and acquisitions, which will enable them to expand

into new business endeavors or strengthen their focus on aerospace. Two firms also attribute their bright outlook to internal improvements in the application of production technology and marketing.

Improve Somewhat

Nine companies (1 large, 2 medium, 6 small) believe their competitive prospects will improve "somewhat." The smaller companies in this group appear to be the survivors. Most are old-line producers. They noted that many smaller firms have exited the market in recent years, and others will probably follow in the future. This has created a shortage of suppliers and improved their competitive position. Two of the companies indicated they have increased automation. Two others relocated to areas that will result in lower costs. Another explained that smaller firms are more agile and quicker to respond to customer's needs.

The larger companies in this group noted that total life cycle costs favor firms with larger engineering departments. The market seems to be moving toward best value. One of the firms noted that new products are helping it to expand market opportunities. In addition, a firm noted that its new independent status after divestiture from a larger corporation allows focus on core capabilities.

Stay the Same

Seven companies reported that their competitive prospects would stay the same. The smaller companies in this group noted that new competitors are appearing in their markets, making competition more intense. One firm noted that Defense purchases too little of its product, and sees little prospect of an increase. Another firm is dependent on its owner's business, which appears to be stable for now. The larger companies noted that demand for their products was in equilibrium. Competition also has become very aggressive for these larger companies. Any gains will have to come at the expense of others. One firm that said it is pursuing market share, has established itself as a leader in its product line.

Decline Somewhat

Three companies (1 medium, 2 small) see their competitive prospects for the next five years declining somewhat. Two of these companies reported that the small business set-asides were a hindrance, noting that the program supports less-than-capable suppliers. It was also noted that competition has intensified as a result of consolidation. One of these firms indicated that foreign markets and commercial market opportunities for their product line have declined.

Decline Greatly

Three smaller firms reported their competitive prospects would decline greatly. These firms see the market declining and profit potential deteriorating.

3.3 Firm Size

At almost $600 million in annual shipments, the CAD/PAD market is not large. Compare this to the oil refining market, which is over 260 times larger ($160 billion in annual U.S. shipments). The size and number of firms in an industry depends first of all on the size of the salient market. This tells us that no CAD/PAD company could be larger than $600 million. But monopolies are extremely rare, and require very special market conditions to exist. More commonly, the size distribution of firms in an industry is related to an assortment of sub-market conditions. These can range from high to low production volumes, large to small size units, complex to simple items, and new products to old. A monopoly market, in contrast, would have very narrow conditions. Whatever the complexity of the market mix, firms in an industry must be responsive to every possible transaction that comes along; and this presumably at a reasonably optimal cost. Thus, a variety of firms must squeeze into an industry in such a way that each can survive and make profits, and meet the requirements of their customers.

On the aerospace side of the CAD/PAD market, many smaller firms participate in various niches, specializing in one or two CAD/PAD product families. They may also find a home making legacy items in which larger firms are no longer interested. Alternatively, they can provide a valuable build-to-print for the replacement market without the burden of high overhead.

Larger aerospace CAD/PAD firms typically produce a wider variety of CAD/PAD products, and offer more services to the customer. Several of the larger firms produced

CAD/PAD items in eight, nine, or even ten of the reporting categories. These firms are masters of the technology and wield the engineering staff to be formidable competitors. They flourish in an open, best-value type market. Some 3,100 military part numbers are in circulation. Considering that many of these part numbers are produced in small quantities, large firms must widen their product range to effectively employ a technical staff.

Also, about half the military market is for replacement CAD/PADs, some of which are for 30 and 40 year old systems. After-market parts typically are priced higher than initial sales to original equipment manufacturers. Although the situations vary, firms can price initial sales lower, even at a loss, in hopes of realizing profits later on aftermarket sales. This again opens doors for low overhead firms as typified mostly by smaller producers, and may carry risk.

On the automotive side, airbag initiator companies' customers are ultimately the (huge) auto companies. Economies of scale are the very foundation of their existence. They come very close to monopoly market conditions: it is also evident that only a few CAD/PAD firms can possibly exist in this market, based on what has already happened. Three entries into the airbag market have now dropped out. Only two companies became dominant. There may not be room for a third, except in a more restricted side of the market. The companies that make airbag initiators must produce large volumes to achieve low costs or find themselves unable to compete.

With the above as background, the table on the following page shows the number of CAD/PAD firms by sales ranges as compiled for 1993 and 1999. The shipment totals for the firms in each range are shown with their percentage of the industry's total shipments displayed in the final two columns. While all respondents are included, airbag initiator shipments were removed because their inclusion would greatly overwhelm the firm size distribution profile of the aerospace sector. In fact, the largest division (firms over $20 million) would rise to almost 80 percent from its aerospace level of about 54 percent.

In 1993, 33 surveyed firms averaged $7.1 million in sales. This compares to 26 firms averaging $9.4 million in 1999. This is a nearly one-third increase in average shipments. The decline in the number of firms is fully accounted for by the drop in firms with sales of less than $10 million, which fell from 24 in 1993, to 15 in 1999.

Number of Firms by Range of Total Sales, Selected Years (Aerospace CAD/PAD Only)				
Sales Range of CAD/PAD Products	Number of Firms		1999 Data	
	1993	1999	Shipments (in $000)	% of Total
over $20 million	3	5	$141,907	54.52%
over $10 to $20 million	6	6	$89,395	34.34%
over $5 to $10 million	6	1	$8,334	3.20%
over $1 to $5 million	8	6	$14,830	5.70%
less than $1 million	10	8	$5,822	2.24%
Total Firms	33	26	$260,288	100.00%

Source: U.S. DOC/BXA CAD/PAD Industry Survey

The defense market for CAD/PAD products is not excessively concentrated compared to most industries based on establishments (as opposed to companies that might have more than one establishment). In 1993, shipments by the four largest establishments totaled $85 of $191 million, or about 45 percent. Six years later, in 1999, the four largest establishments totaled $104 of $213 million, or about 49 percent. If concentration were instead measured by corporate ownership, where some firms control more than one CAD/PAD establishment, the former number would remain about the same, while the 1999 number rises to 61.8 percent.

3.4 Benchmarking CAD/PADs

Comparison of 1993 and 1999 Data

Many changes took place between 1993 and 1999. Shipments grew from $334 million to $557.6 million, an increase of almost 76 percent. Defense shipments also increased modestly by 19 percent. The largest increase was in commercial shipments, which rose 153 percent, from $142.7 to $360.5 million. Airbag initiators accounted for the bulk of the increase. Airbag initiators rose from $77 to $340 million. The major increase on the commercial side resulted in a decline in the percentage of industry shipments to the Defense Department. The defense share sank from 57.3 percent of the total in 1993, to 38.7 percent in 1999.

Income for the industry remained about the same between the two years, but fell as a percentage of total shipments primarily because of low levels in the auto sector. The percentage decline was from 7.74 to 4.57 percent. Employment rose from 3,364 to 4,376, mostly from gains in the auto sector. Aerospace sector employment, however, also grew. The number of production workers grew more than twice as fast as total employment. The number of production workers increased from 1,831 to 3,105, a gain of 70 percent. The production workforce increased from 54 percent of the total workforce to 71 percent. Shipments per employee grew from about $99 thousand in 1993 to $134 thousand in 1999. This 35 percent increase was due mostly to the auto sector's greater weight in the numbers in 1999.

Profile of CAD/PAD Industry in 1993 and 1999 (in $000s unless stated otherwise)					
Comparison Parameters	1993		% Change 1993 to 1999	1999	
Total Shipments	$334,034		75.90%	$587,550	
Defense Shipments / Share of Total	$191,303	57.27%	18.69%	$227,064	38.65%
Commercial Shipments / Share of Total	$142,731	42.73%	152.56%	$360,486	61.35%
Net Income / Share of Shipments	$25,854	7.74%	3.80%	$26,836	4.57%
Workforce (number)	3,364		30.08%	4,376	
Production Workers / Share of Workforce	1,831	54.43%	69.58%	3,105	70.97%
Shipments per Employee (actual $)	$99,297		35.22%	$134,266	
Capital Expenditures / Share of Shipments	$19,942	5.97%	11.73%	$22,281	3.79%
Brick and Mortar / Share of Investment	$8,674	43.50%	-26.23%	$6,399	28.72%
Mach. & Equip. / Share of Investment	$11,268	56.50%	40.95%	$15,882	71.28%
R&D / Share of Shipments	$16,038	8.46%	-12.94%	$13,962	2.38%
Defense R&D / Share of R&D	$12,236	43.30%	-43.67%	$6,892	49.36%
Commercial R&D / Share of R&D	$3,802	13.46%	85.95%	$7,070	50.64%

Source: US DOC/BXA Industry Surveys, 1994 and 1999

Capital expenditures remained roughly the same the two years, rising modestly by about 12 percent. As a share of shipments the capital spending dropped from 6 percent to about 3.8 percent. This drop was precipitated by completion of major capacity expansions in the automotive sector and a sharp decline in aerospace. Investment in 1999 was an anomaly compared to previous years, when expenditures approached $100 million per year. The distribution of spending between new machinery and equipment and brick and mortar is also telling. Brick and mortar investment dropped sharply in the latter year both as a percentage of total capital outlays and in absolute terms from 1993. Research and

development expenditures also declined somewhat, down about 13 percent. Commercial R&D gained considerably.

Comparison of Aerospace CAD/PADS with Airbag Initiators

The 1999 data shown above was distorted by commingling the aerospace and automotive sectors. This was less true of the 1993 data, before the auto sector became the major subsector. What follows is a breakout of 1999 data for the two sectors to more clearly show the distinctions. The 1999 data for the automotive sector follows an enormous burst of growth in this sector. Some of the ratios, such as capital spending and R&D, may actually reflect a post build up slowdown.

Profile of CAD/PAD Industry Sectors in 1999 (in $000s unless stated otherwise)					
Comparison Parameters	Aerospace		% Aerospace of the total	Automotive	
Total Shipments / Share of Grand Total	$247,621		42.14%	$339,929	
Defense Shipments / Share of Total	$221,529	89.46%	97.56%	$5,535	1.63%
Commercial Shipments / Share of Total	$26,092	10.54%	7.24%	$334,394	98.37%
Net Income / Share of Shipments	$26,434	10.68%	98.50%	$403	0.12%
Workforce (number)	2,291		52.35%	2,085	
Production Workers / Share of Workforce	1,263	55.15%	40.68%	1,842	88.35%
Shipments per Employee (actual $)	$108,084		-	$163,035	
Capital Expenditures / Share of Shipments	$5,734	2.32%	25.73%	$16,547	4.87%
Brick and Mortar / Share of Investment	$2,003	34.92%	31.30%	$4,396	26.57%
Mach. & Equip. / Share of Investment	$3,732	65.08%	23.50%	$12,150	73.43%
R&D / Share of Shipments	$7,599	3.07%	54.43%	$6,363	1.87%
Defense R&D / Share of R&D	$6,892	90.70%	100%	0	0
Commercial R&D / Share of R&D	$707	9.30%	10.00%	$6,363	100%

Source: US DOC/BXA 1999 Industry Survey

In 1999, aerospace CAD/PAD shipments accounted for 42 percent of total shipments of CAD/PAD products. However, aerospace accounted for almost 98 percent of the military market, while only 7 percent of the commercial sales. Profits before taxes for the aerospace sector came to $26.4 million (11 percent of sales), while profits in the auto sector were negligible ($403 thousand). The workforces of the two sectors were roughly equal, but nearly 60 percent of the production workers could be found in the automotive sector. The percentage of production workers to all employees was only 55 percent in the aerospace segment, while over 88 percent in the automotive. Shipments per employee

were $108 thousand in the aerospace sector and $163 thousand in the auto sector. The auto sector eclipsed the aero sector by 51 percent.

The aerospace sector accounted for 26 percent of total capital expenditures, although 1999 was a sub-par year for both sectors as previously indicated. Spending of $5.7 million by the aerospace sector was only 2.3 percent of shipments. This percentage has averaged over 4 percent in the past five years. Capital outlays by the automotive sector were $16.5 million and 4.9 percent of shipments. This figure is far below the 21 percent average this sector experienced since 1995. However, this extremely high rate witnessed in previous years will not be sustained in the future. The indications are that airbag initiator capacity and demand are now roughly equal. Total spending on research and development in the two sectors are roughly comparable. However, the aerospace sector performs nearly all the defense R&D, and the automotive sector performs nearly all the commercial R&D.

3.5 Certifications

Survey respondents were asked to identify certifications for which they were qualified or were working toward. All 26 respondents answered the question. Respondents were divided into two groups: one with 1999 shipments over $10 million (11), the other everyone else (15). These certifications included ISO 9001, Six Sigma, Mil-Q-9858A, and NASA Handbook 5300. Eighteen companies were certified for Mil-Q-9858A, which covered DoD applications until about five years ago. It is still used as a guideline for many firms. No firm reported working to become certified in this category. The fastest growing certification is ISO 9001, which is globally recognized. Nine of 10 firms with over $10 million in 1999 CAD/PAD shipments have been certified as ISO 9001 capable and one other is working toward becoming certified. Also, three small CAD/PAD firms (less than $10 million) are certified and six more are working to become so. Three smaller firms indicated no interest.

Six Sigma is a special qualification designed to produce virtually no defective parts. Only one firm reported itself qualified under this standard. Three others were working toward it. Another three reported no interest. The four involved firms were each over $10 million in sales in 1999. Six firms were also certified to the NASA Handbook 5300; no one was working toward it. All six firms of these firms were over $10 million.

Certifications, CAD/PAD Firms w/sales >$10 million			
Category	Yes	No	Working Toward
ISO 9001	9	0	1
Six Sigma	1	3	3
Mil-Q-9858A	9	0	0
NASA Handbook 5300	6	1	0
Certifications, CAD/PAD Firms w/sales <$10 million			
Category	Yes	No	Working Toward
ISO 9001	3	3	6
Six Sigma	0	6	0
Mil-Q-9858A	9	4	0
NASA Handbook 5300	0	6	0

Source: U.S. DOC/BXA CAD/PAD Industry Survey

Customer Technical Capabilities

In a related topic, some CAD/PAD companies expressed concern that the technical capabilities of their customers may be eroding. This was in light of reduced defense procurement and apparently the dislodgement of experienced personnel from key positions in the wake of aerospace industry mergers and restructuring activities. Responses to the survey appear to confirm this trend. An additional, and perhaps connected, trend is the growing need for CAD/PADs to perform under more challenging conditions. This has implications for the future for the CAD/PAD companies in terms of taking on more responsibility and in providing customers with more service.

More than one-third of the CAD/PAD companies reported the technical capabilities of their customers were eroding. Slightly over 55 percent saw them as remaining about the same and only eight percent saw improvement. The questions on technical trends dealt with four aspects of technical know-how. The first part addressed the customer's capability to prepare technical specifications. Of 24 respondents, only two saw this customer capability as improving. Seven reported it was eroding, while 15 said it was about the same. The customer's technical knowledge of CAD/PAD products was slightly worse. Only two firms saw improvement, while nine reported erosion and 13 say it remained the same.

According to CAD/PAD companies, customers' ability to discuss ordnance applications in their own systems has also deteriorated. Here only one firm reported customer

improvement (4.2 percent of respondents), while one-third saw it as eroding. Fifteen firms reported it has stayed the same. The fourth and last category concerned the customer's ability to evaluate proposed designs and compare them to others. Nearly 46 percent of the respondents reported this capability was eroding. The following table presents these results.

Trends in Customer Technical Capabilities			
Technical Capability	It has Improved	Remained the Same	It has Eroded
Preparation of Technical Specifications	2	15	7
Technical Knowledge of Your Product	2	13	9
Technical Discussion of Ordnance Application in Their System	1	15	8
Technical Ability to Evaluate Proposed Design and Compare	3	10	11
Total	8	53	35
Percentage Distribution			
Preparation of Technical Specifications	8.3%	62.5%	29.2%
Technical Knowledge of Your Product	8.3%	54.2%	37.5%
Technical Discussion of Ordnance Application in Their System	4.2%	62.5%	33.3%
Technical Ability to Evaluate Proposed Design and Compare	12.5%	41.7%	45.8%
Total	8.3%	55.2%	36.5%

Source: U.S. DOC/BXA CAD/PAD Industry Survey

3.6 Supply Shortages

Most of the CAD/PAD companies reported some concern about supply base. Many vendors have dropped out or been merged with other firms and exited the market. The number of sole sources has increased, and with that lead times have stretched out. A number of firms are considering foreign sources.

Of 22 respondents, about one-third reported no problems in the vendor base. Several companies noted that propellants are no longer available and no substitutes are allowed without an extensive requalification program, which the contractor must fund. A few firms cited the closing of the Kenville facility as eliminating a source of propellants. Two firms also mentioned sources of RD 1333 lead azide are vanishing despite the demand for the material. Another firm reported difficulty locating MIL-S-5626 certified steel. The company also reported difficulties locating certain sealers and locking compounds due to obsolete specifications.

3.7 Effects of International Trade

Twenty-two comments were received, of which 16 reported either no or insignificant effects from international trade. By and large the CAD/PAD companies reported no positive effects of international trade. Two companies, however, noted that certain supplies, notably lead azide (RD 1333) were in short supply in the United States, and that a possible remedy would be to establish the capabilities of foreign suppliers.

Several negative effects and problems with international trade were cited. Two companies noted that the cost of shipping and handling pyrotechnic materials has caused them to lose international sales. Another company reported that foreign competition is sometimes state sponsored and occasionally sold under a Memorandum of Understanding between the U.S. Government and the foreign government. A fourth company stated that competing internationally is very expensive, and it has reached the point where they usually no longer even bid. Others reported that the export licensing process is time consuming, and often disqualifies U.S. products from competing internationally.

Additionally, a firm opined that imported CAD/PADs would destroy the industrial base. The firm also noted that propellants needed to conclude an export were not made available by Indian Head, and a foreign firm, supplied by Indian Head, got the sale. Another firm reported that shipping costs could make foreign purchases cost prohibitive. A fourth firm noted that sourcing from the United Kingdom is made difficult because U.S. flag vessels will not handle hazardous material, and commercial airfreight is prohibited. The company added that using military air is costly, cumbersome and very slow.

4. Economic Performance, 1995-1999

This section reviews the statistical trends for the CAD/PAD industry from 1995-1999. The aerospace and automotive sectors are addressed separately for reasons previously discussed. Shipments, employment, capital expenditures, research and development spending, and profitability are reviewed. More information was gathered about the aerospace sector simply because all 26 survey respondents supplied aerospace-type CAD/PADs, compared to only four or five companies in the automotive sector. Thus, the aerospace side of the business will be discussed more thoroughly.

4.1 Aerospace CAD/PAD Sector

The aerospace CAD/PAD sector grew healthier and more competitive in the last five years. The overall numbers indicate solid growth and profits. The future appears promising, as defense spending is likely to increase moderately over the next several years.

The industry faces very large and concentrated customers in Boeing, Lockheed and Raytheon, who directly or indirectly account for most of the business. The advent of ultra-large and heavily concentrated end users puts added pressures on prices, quality and delivery, but can also lead to large fluctuations in orders for individual CAD/PAD companies. These forces can work counter to each other. Pressure on prices, for example, requires CAD/PAD companies to invest in productivity and efficiency, while the possibility of large changes in orders can add risk to new investments.

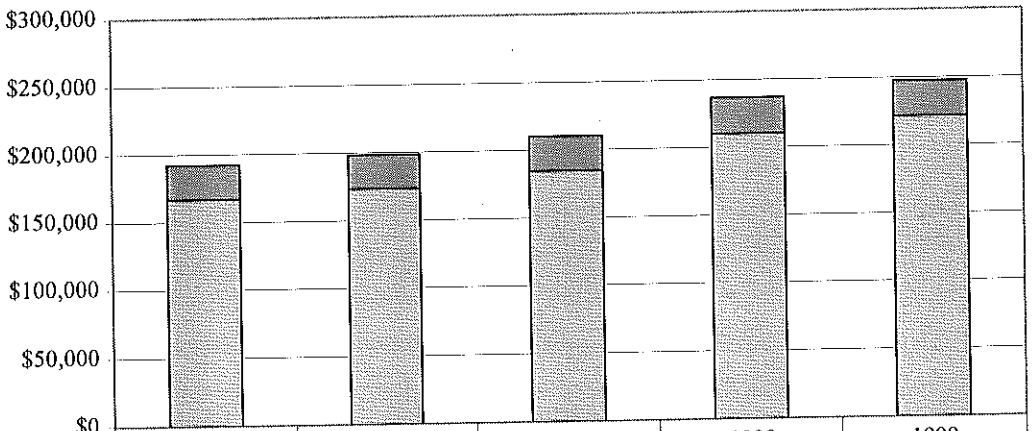
In a changing business environment, investment remained high and reported company profits (before taxes) were strong during the 1995-1999 period. As stated before, competition has intensified, and business conditions seem to have spawned a new round of consolidation still in progress. This could lead to greater emphasis on cost cutting. However, product innovation will remain extremely critical.

4.1.1 Shipments

Total shipments of aerospace CAD/PADs rose from $192.2 million in 1995, to $247.6 million in 1999. This was an increase of 28.9 percent. Expansion in defense related shipments accounted for most of the gain. Defense shipments rose from $166.8 million to $221.5 million, up 32.8 percent. Commercial (non-defense) shipments fluctuated between $24.8 and $26.4 million, showing almost no growth. Based on survey responses, the commercial portion includes mostly civilian aerospace, but also some mining industry applications. The defense increase was related to expanded use of CAD/PADs on newer models of combat aircraft, upgrades in older models, and growth in space applications. In addition, overall defense procurement turned upwards in 1998 and 1999. The military market represented a larger share of the overall business, rising from 86.8 percent in 1995 to nearly 90 percent by 1999.

The following chart shows shipments of defense and commercial aerospace CAD/PADs for the 1995-1999 period.

Shipments of Aerospace CAD/PADs
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Commercial	25,382	24,771	25,547	26,405	26,092
Defense	166,779	173,492	184,728	210,322	221,529

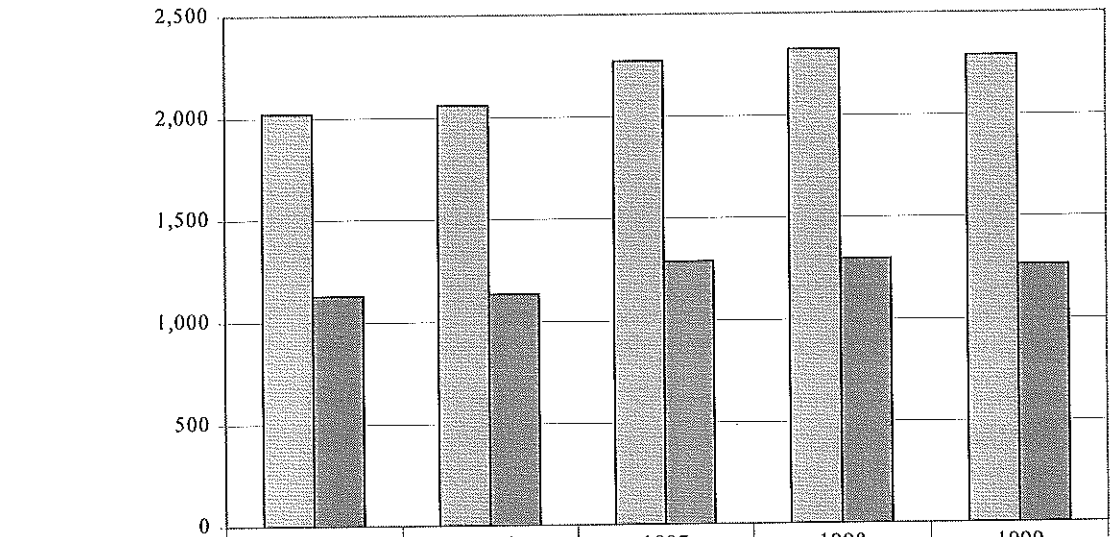
Source: US DOC/BXA CAD/PAD Survey, 1999

4.1.2 Employment

Employment in the aerospace CAD/PAD industry rose from 2,022 individuals in 1995, to 2,291 in 1999, an increase of more than 13 percent. Employment peaked in 1998, before backing off slightly in 1999. The number of production workers also increased, rising from 1,129 to 1,263, up 11.9 percent. As a percentage of all employees production workers averaged about 55.7 percent of the total workforce with little variation over the period. This percentage is lower than most manufacturing industries because of the large technical staff required for CAD/PADs.

Productivity (measured as output per employee) rose moderately in the 1995-1999 timeframe. Overall, it was up 13.8 percent (unadjusted for inflation). Output per employee increased from about $95,000 in 1995, to $108,100 in 1999. The low for the period was in 1997, when the indicator fell to $92,575. In 1997, however, the industry expanded employment by over 10 percent. That year alone the number of production workers increased 13.5 percent. New hires require time to become productive. In the next two years, output per worker it jumped back almost 17 percent.

Employment in the Aerospace CAD/PAD Sector



	1995	1996	1997	1998	1999
All Employment	2,022	2,062	2,271	2,322	2,291
Production Workers	1,129	1,136	1,289	1,297	1,263

1995-1999

Source: US DOC/BXA CAD/PAD Survey, 1999

Comparatively, aerospace CAD/PAD productivity (output) per employee is about half that of all manufacturing. This can be interpreted to mean that CAD/PAD production is considerably more labor intensive than the majority of manufacturing industries. Lower rates of productivity indicate that labor (i.e., payroll and other compensation) is a higher proportion of overall costs for the CAD/PAD sector. This applies mostly to the technical, engineering, and other overhead staff that represents a very significant portion (45 percent) of the workforce.

Efforts to automate the process are somewhat discouraged by the wide range of part numbers and batch process nature of CAD/PAD production, which works to keep productivity levels low. This could change, but it would take closer collaboration between CAD/PAD buyers and sellers to increase production runs of individual part numbers or families of part numbers. Performance specifications may also enhance productivity by promoting best value (i.e., in terms of manufacturability). In addition, further advances in computer technology, such as robotics, could make automation (or productivity) more likely in the CAD/PAD industry.

Employment increased in most occupation categories in the 1995-1999 time frame. The largest increase (44 percent) was in program management. This group increased from 71 to 102 individuals. Other large increases occurred in sales and marketing (28 percent) and design engineering (also 28 percent). Contracts administration was the only occupation category to decrease (down 7 percent). Overall, non-manufacturing personnel increased from 895 to 1,028 (15 percent) between 1995 and 1999. The absolute increase of 133 was about equal to the increase in manufacturing personnel (134). The use of outside consultants increased sharply (155 percent) from 11 to 28 people. The table below shows these trends for the five years 1995-1999. The definitions of the occupations are provided beneath the table for the reader's convenience.

These trends indicate increased product complexity and a changing competitive environment. As noted previously, firm size and scope has increased, which requires more technical staff. Moreover, large customers are looking for more service, promoting best value criteria and demanding efficient production. Companies are responding by hiring more professional staff and making use of consultative expertise.

Information was also collected on the experience level of *design engineers*. As shown on the table on the next page the number of design engineers increased steadily from 154 to 196 people over the five years. The 42 person increase includes new recruits and new

hires from other industries. In addition, some shifting of people within the CAD/PAD industry apparently also takes place, but the amount is unknown.

Employment by Occupation 1995-1999						
Occupation Category	1995	1996	1997	1998	1999	Change 99/95
Management	89	86	86	82	89	0.00%
Program Management	71	72	75	81	102	43.60%
Contracts Administration	61	65	69	62	56	-6.80%
Purchasing/Procurement	73	71	78	69	85	16.60%
Sale/Marketing	33	34	31	38	42	28.10%
Design Engineering	154	160	170	189	196	27.60%
Manufacturing	1,129	1,136	1,289	1,297	1,263	11.90%
Quality	209	205	230	261	220	5.20%
Test	109	116	117	130	125	15.60%
Finance/Accounting	96	117	127	115	112	16.40%
Total Direct Employees	2,024	2,062	2,272	2,324	2,291	13.30%
Outside Consultants	11	13	11	16	28	154.50%
Grand Total	2,035	2,075	2,283	2,340	2,319	19.50%

Occupation Description	Occupation Definition
Management	President, Vice President, Director
Program Management	Typically used in matrix organization includes managers, program administrators, program budget analysts
Contracts Administration	Including managerial, contracts administrators
Purchasing/Procurement	Including managers, buyers
Sales/Marketing	Marketing and sales staff plus related secretarial, advertising, trade show, market admin personnel
Design Engineering	Direct charge
Manufacturing	Includes managers, supervisors, leads, all non-exempt, production control and other direct mfg.
Quality	Includes quality engineers, all incoming and in -process inspectors
Test	Includes test engineers, technicians, test equipment operators
Finance/Accounting	Includes all accounting functions including payroll,
Outside Consultants	Any technical, business, quality, legal, or other capacities

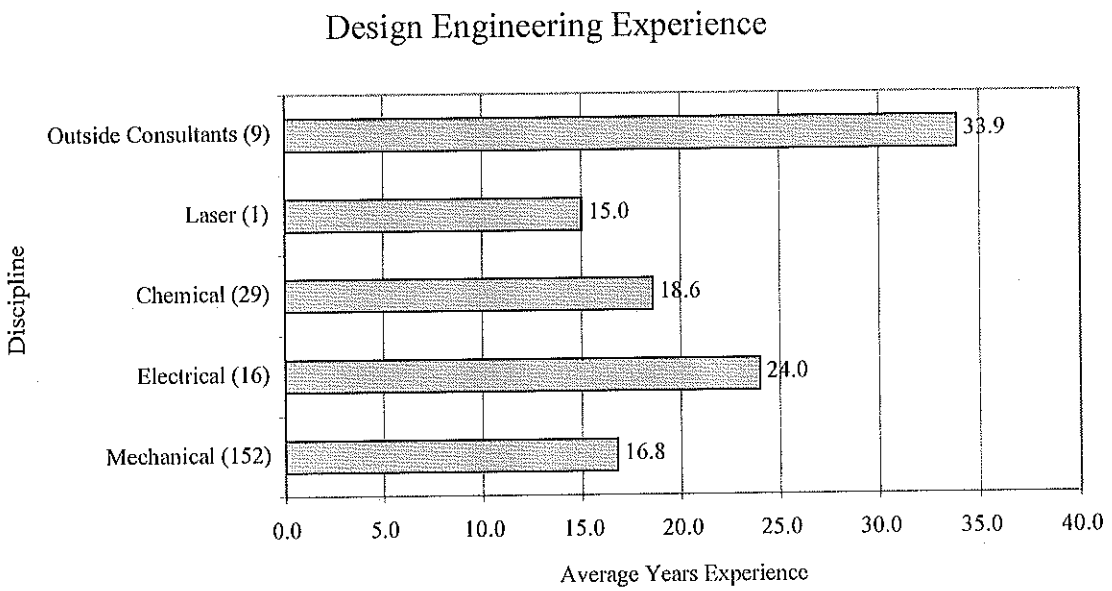
Source: U.S. DOC/BXA CAD/PAD Industry Survey

Experience in design engineering is a key competitive concern of CAD/PAD firms. The table below shows the experience level (in years) based on five ranges: less than five years; 5-10 years; 10-20 years; 20-30 years; and, more than 30 years experience. To tally an average based on these ranges the mid-point was selected, except for "over 30 years",

where 40 was used. These averages were then multiplied by the number of people in each range, and divided by the total # of design engineers in each discipline to calculate an overall average for each discipline. Using this method, average experience for four design engineering disciplines was 17.6 years. Incomplete data was reported on consultants (only 9 people of 28 identified). Average experience for these nine consultants was 33.9 years. The consultants are not necessarily design engineers, but the age information was collected in the survey so their averages are presented also.

Experience Level of Design Engineering Staff, 1999							
Design Engineer Discipline	Number of Design Engineers	Experience Level, in Years					
		< 5	5-10	10-20	20-30	> 30	Average
Mechanical	152	23	26	58	25	20	16.8
Chemical	30	1	2	18	6	3	18.6
Electrical	15	0	0	9	1	5	24.0
Laser	1	0	0	1	0	0	15.0
Total	198	24	28	86	32	28	17.6
Outside Consultants	9	0	0	1	2	6	33.9

Source: U.S. DOC/BXA CAD/PAD Industry Survey



Source: U.S. DOC/BXA CAD/PAD Industry Survey

The largest group of design engineers fell in the mechanical discipline, with 77 percent of all design engineers reported. They also were the least experienced with an overall average of 16.8 years. Within the experience ranges, mechanical types accounted for 96 percent of the lowest range (less than 5 years) and 93 percent of the 5-10 year range. Almost one-third of their total had less than 10 years of experience. The following chart is provided to better view these experience levels. We do not know the age of these individuals, but it's probably 25-30 years greater than their experience. Laser engineers, a growing area of expertise, were not fully reported.

Other Labor Issues

About two-thirds of the CAD/PAD firms, representing about one-half of the aerospace CAD/PAD shipments, did not report any labor concerns. The other one-third reported labor problems related to high turnover rates, layoffs, and retirements. Competition from other industries, such as the computer and software industries, made it difficult for some firms to hire and retain professionals. Several firms reported a shortage of qualified ordnance professionals as an immediate problem, or that it will be a problem in the next several years. The low national unemployment rate has also caused some difficulty in retaining line workers who can be hired away by higher hourly rates offered by other manufacturers competing in the same labor market. Higher salary levels maintained by computer and software companies make it more difficult to compete for entry-level professionals.

4.1.3 Capital Expenditures

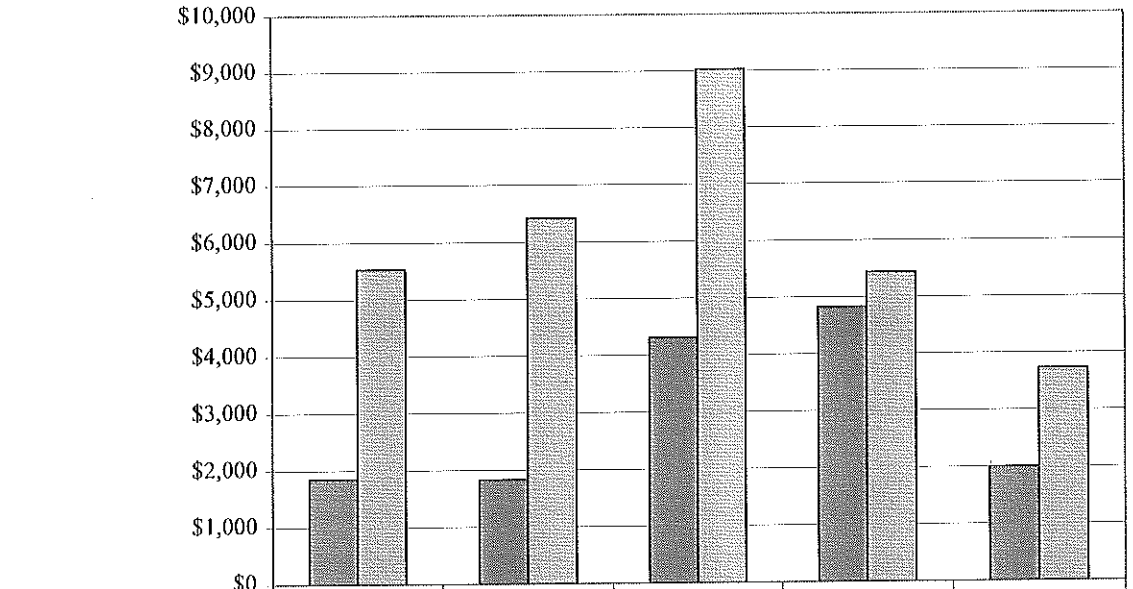
Capital outlays on new plant and equipment by the aerospace CAD/PAD sector totaled $45 million over the 1995-1999 period, for an average of $9 million per year. This equaled 4.14 percent of total reported shipments, exceeding the average for all manufacturing (3.88 percent) and for the explosives industry (3.91 percent).

Investment expenditures peaked in 1997, when they reached $13.3 million, but then sank to a five-year low in 1999, at $5.7 million. Overall, plant investment (i.e., brick and mortar) accounted for about one-third of investment outlays, while machinery and equipment accounted for the remainder. Special Devices constructed a new facility at Moorpark during this period, which currently houses both aerospace CAD/PAD and automotive airbag initiators production. (The airbag initiators were factored out of the

new investment numbers.) Other activity saw Technical Ordnance move into a new facility in South Dakota. In addition, several firms expanded or upgraded facilities.

The following chart shows capital investment in plant and equipment for the period.

Capital Expenditures in the
Aerospace CAD/PAD Sector
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Brick and Mortar	1,858	1,833	4,303	4,826	2,003
Machinery & Equipment	5,537	6,418	9,034	5,433	3,732

Source: U.S. DOC/BXA CAD/PAD Industry Survey

Survey respondents were asked to identify and rank their investment strategies based on the last three years of investment experience. Twenty-three firms completed the query. The results are shown below. Firms were asked to select five strategies listed on the table and rank them from one to five by order of importance. For example, six firms ranked "Improve Productivity" as number one. These six firms accounted for over 30 percent of all investment during the three years. Seven firms reported "Expand Capacity" as number one. These seven, however, accounted for only about 12 percent of the

investment. Investment weighted rankings were balanced in this manner across all the responses to derive an industry rank from 1 to 7 as shown on the table. Three major investment motives were: 1) Improve Productivity; 2) Upgrade Technology; and 3) Add New Capabilities.

Use of a weighted average gave larger companies (1999 sales more than $10 million) greater leverage in the overall strategy results. They made the bulk of the new investments (81 percent). Fourteen of the companies had sales of less than $10 million. These companies, whose total leverage was only 19 percent, had a very different profile than the nine larger companies. The highest ranked strategy for the smaller firms was to "Meet Specific Customer's Requirement." Their weighted percentage for this strategy was 22.3 percent compared to only 1.5 percent for the larger firms.

Strategies for New Investment	Top Five Rankings					
	Weighted %	1	2	3	4	5
1. Improve Productivity	22.7%	6	5	4	2	4
2. Upgrade Technology	21.7%	4	5	3	3	6
3. Add New Capability	19.2%	4	5	4	3	2
4. Expand Capacity	11.7%	7	0	3	5	1
5. Replace Old Equipment	11.3%	3	3	1	4	5
6. Comply with Environmental/Safety Requirements	7.9%	2	3	2	1	4
7. Meet Specific Customer's Requirements	5.5%	2	1	5	1	1

Source: U.S. DOC/BXA CAD/PAD Industry Survey

4.1.4 Research and Development

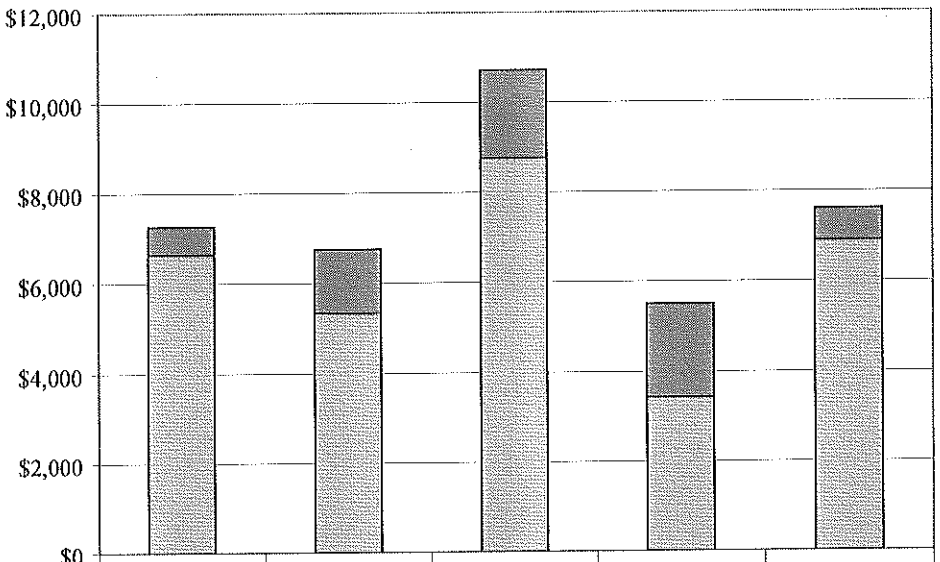
Research and development spending by the aerospace CAD/PAD sector totaled an estimated $37.8 million for the five-year period 1995-1999, for an average of $7.6 million per year. Most of the spending (82.1 percent) was for defense purposes. In estimating these numbers, all defense R&D was allocated to aerospace CAD/PADs and 90 percent of the commercial R&D was allocated to the airbag sector.

Aerospace CAD/PAD R&D peaked in 1997 at over $10.7 million, and then reached a low the next year at $5.5 million. Most of the R&D was focused on development for both defense and commercial; about two-thirds of total R&D was used for this purpose. Roughly 14 percent of defense R&D was allocated to materials research and another 19 percent to process technologies. The mix was similar for commercial research.

Funding for R&D came mostly from in-house and customer sources. The Federal Government supplied about 20 percent of the defense funding. In-house sources supplied nearly half the funds used for R&D, including about 90 percent of the commercial funds. Customers were also very active in funding about 30 percent of the total for defense.

The following chart shows aerospace CAD/PAD R&D by defense and commercial totals.

Research and Development Spending
in the Aerospace CAD/PAD Sector
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Commercial R&D	615	1,408	1,949	2,073	707
Defense R&D	6,636	5,340	8,763	3,429	6,892

Source: U.S. DOC/BXA CAD/PAD Industry Survey

R&D Crossover Between Military and Commercial Applications

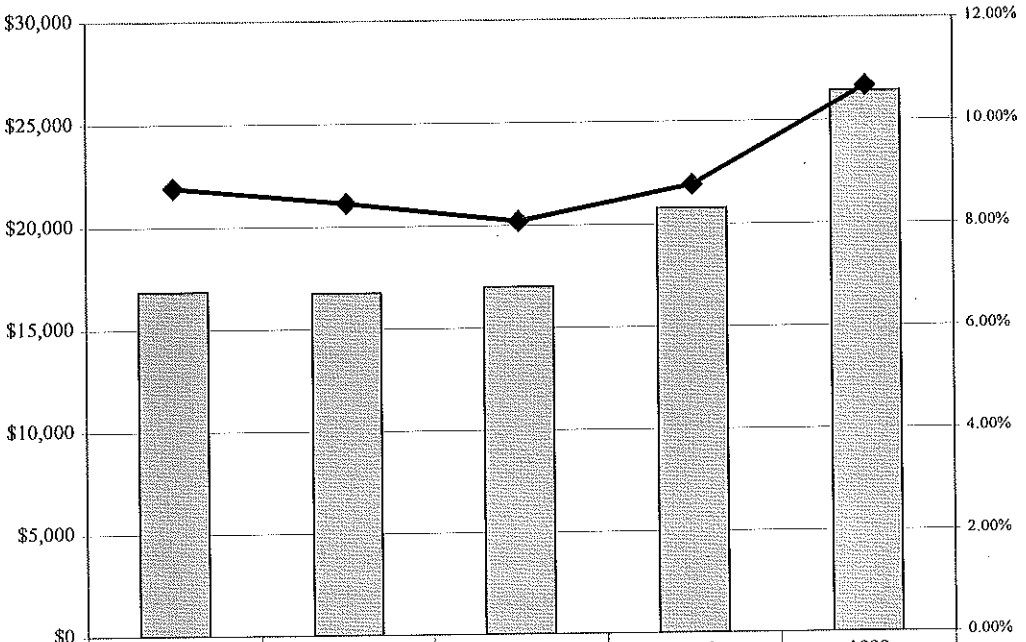
Most companies actually engaged in R&D reported they were involved primarily in military production with little or no involvement in commercial contracts. Consequently, little or no crossover could be reported between military and commercial R&D by these firms. Ten of these companies reported some crossover, while two reported no crossover.

Three other companies reported that the technology could generally be applied equally to commercial or military applications. Another 10 companies were either not involved in R&D or did not respond to the question.

4.1.5 Profitability

During the 1995-1999 period aerospace CAD/PAD before-tax profits totaled $97.8 million for an average of almost $19.6 million per year. This was an average return of about 9 percent on total revenue. Profits tumbled a bit until 1997, and then rose sharply to nearly 10.7 percent in 1999. Many new hires and a revving up of production to meet a growing backlog or orders precipitated the drop in the mid-years. The chart below presents profits by dollar value (left axis) and percent of CAD/PAD revenues (right axis).

Aerospace CAD/PAD Profits
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Pre Tax Profits	16,839	16,762	16,993	20,769	26,434
% of Revenues	8.76%	8.45%	8.08%	8.77%	10.68%

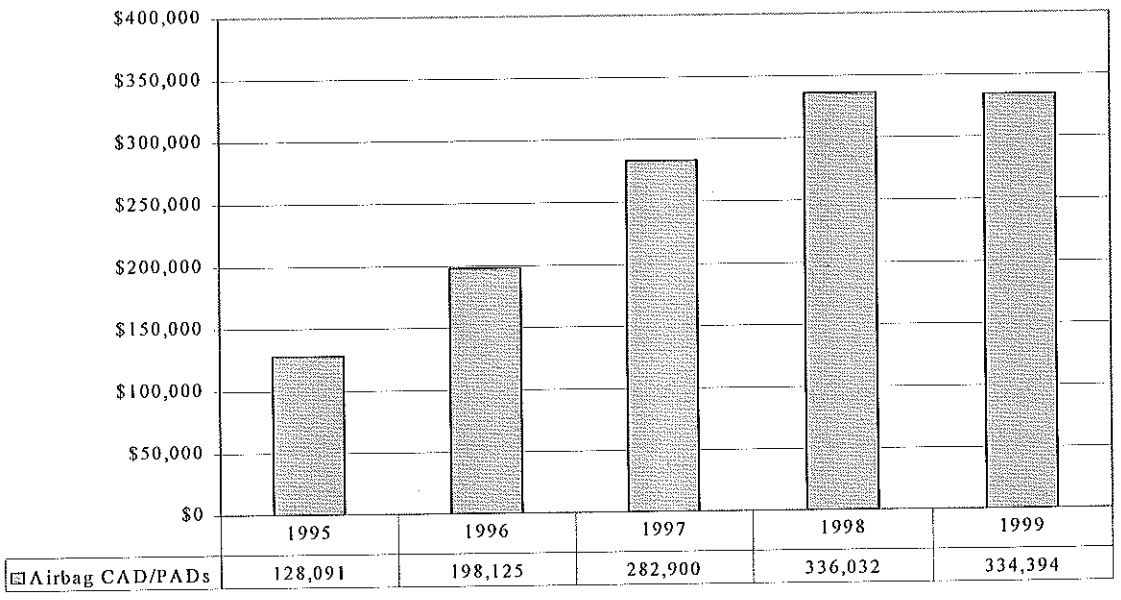
Source: U.S. DOC/BXA CAD/PAD Industry Survey

4.2 Airbag CAD/PAD Performance, 1995-1999

The airbag initiator market has been one of the great growth stories of the past decade. We have already discussed how this market contributed mightily to the restructuring of the overall CAD/PAD industry. Emerging out of these changes is a stronger and more concentrated aerospace sector and a world-class group of airbag initiator companies. In contrast to the aerospace side, the airbag companies are much closer to the commercial market. This means accepting lower profits and continuous improvement (i.e., Kaizen). The auto companies are in an overcapacity condition worldwide and have faced a slowdown in the second half of 2000. The demand for lower prices throughout their supplier base may enter another cycle. In the past the auto companies were known to "require" a step down of 5-10 percent in prices over a series of years. This is a very tough market.

4.2.1 Shipments of Airbag Initiators and Inflators

Shipments of airbag initiators and inflators
1995-1999
(in $000s)



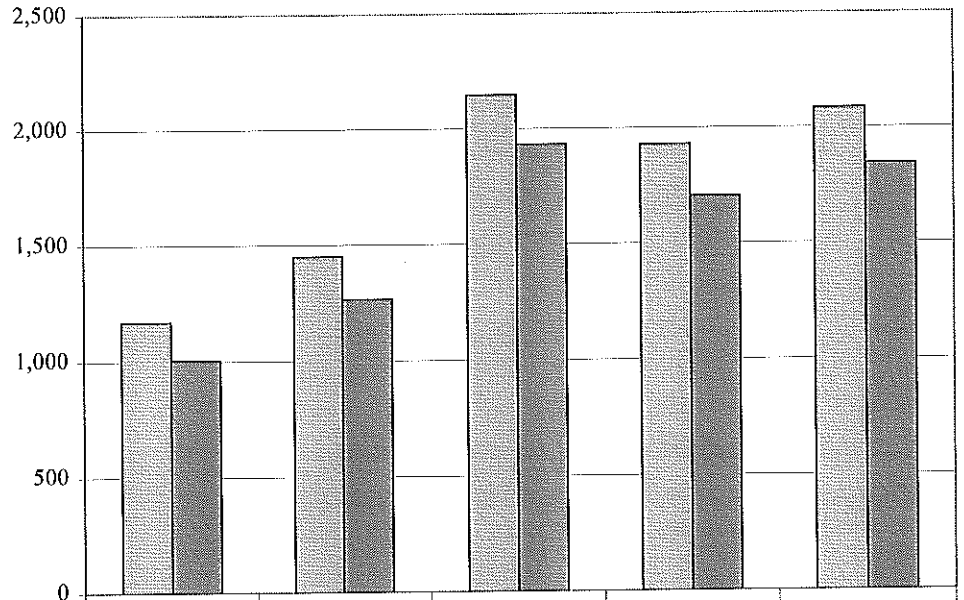
Source: U.S. DOC/BXA CAD/PAD Industry Survey

Shipments of airbag initiators and inflators grew more than 160 percent from 1995 to 1999. Shipments increased from $128 to $334 million and were destined, almost totally for the commercial market. OEA and Special Devices probably accounted for about 90 percent of the total based on public reports. Shipments measured in dollars actually peaked in 1998, although units continued to rise as the unit price came down. The chart shows this growth.

4.2.2 Employment

Airbag initiator and inflator employment grew by more than 78 percent during the 1995-1995, peaking in 1997 at 2,146 people. The production workforce represents about 90 percent of the total. Productivity in the sector shot up from $109,000 per employee in 1995 to $174,000 in 1998, and then backed off to $160,000 in 1999 because of the pricing phenomena - the unit price came down faster than the unit volume increased. The leading companies in this sector are far down the learning curve and may not be catchable at this point by new entrants.

Airbag Initiator and Inflator Employment
1995-1995



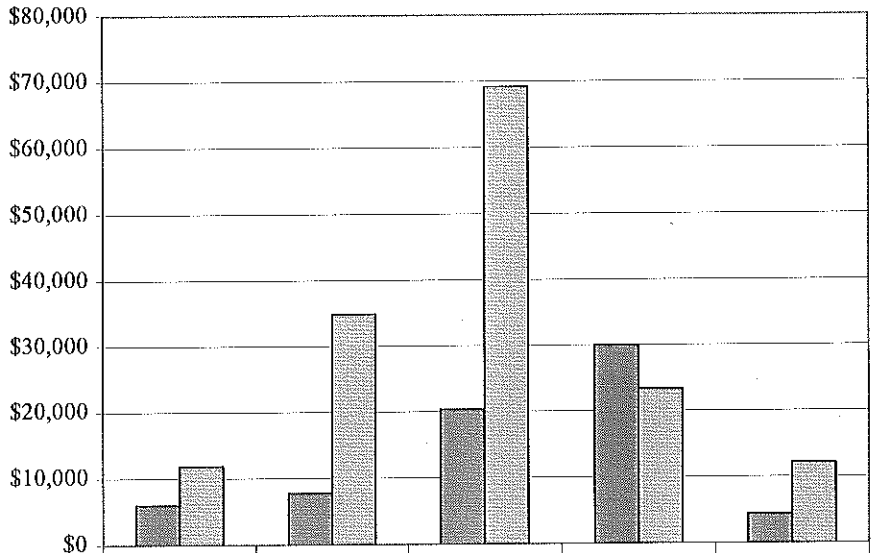
	1995	1996	1997	1998	1999
All Employment	1,170	1,450	2,146	1,929	2,085
Production Workers	1,005	1,264	1,932	1,702	1,842

Source: U.S. DOC/BXA CAD/PAD Industry Survey

4.2.3 Capital Expenditures

Capital investment in the airbag initiator business totaled $203 million in the 1995-1999 period. Outlays in 1997 alone totaled $89.6 million, followed by another $53.3 million in 1998. For the five years, capital expenditures were 21.5 percent of shipments, reflecting a rapid expansion of new capacity. About 30 percent of the investment was in new brick and mortar, while the remainder was in new machinery and equipment. Investment per employee averaged over $30,000 during this period. This far exceeded the aerospace CAD/PAD rate of $7,400.

Airbag Initiator and Inflator Capital Expenditures
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Brick and Mortar	5,983	7,736	20,340	29,955	4,396
Machinery & Equipment	11,851	34,873	69,133	23,331	12,150

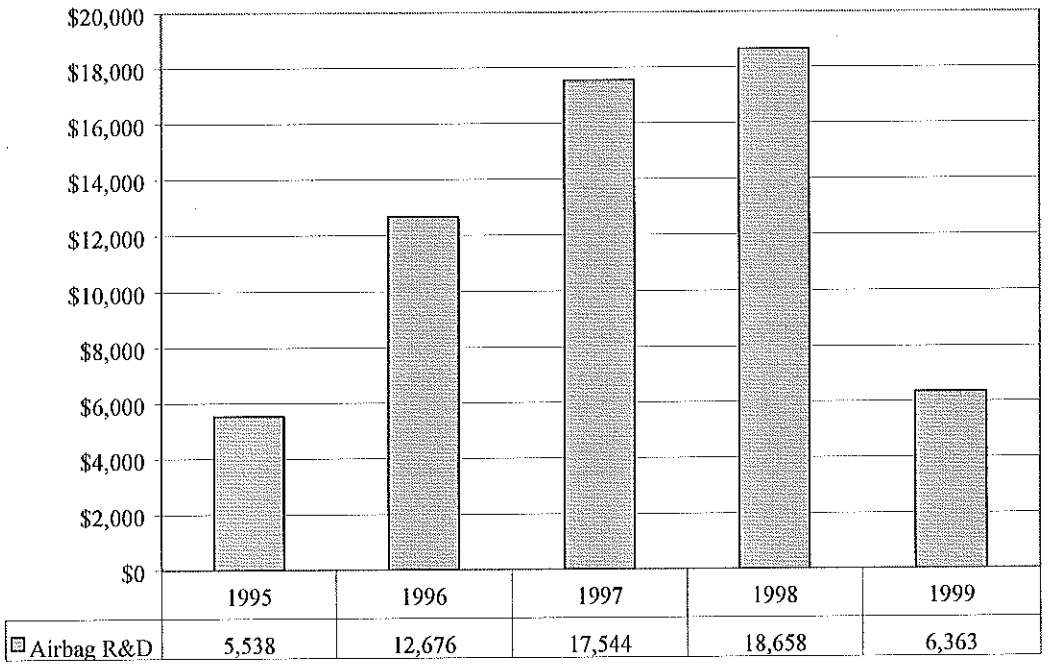
Source: U.S. DOC/BXA CAD/PAD Industry Survey

In 1999, investment spending dropped sharply as most of the expansion cycle was completed. Capital outlays in 1999 totaled $16.5 million, only 5 percent of shipments. Outlays per employee that year were just under $8,000. In addition, profits were squeezed sharply in the last two years, which also contributed to the slowdown. Investment spending is shown on the following chart.

4.2.4 Research and Development

Research and development spending in the airbag market totaled $54.4 million in the 1995-1999 period. This was $16.5 million more than in the aerospace CAD/PAD sector, and averaged about $10.9 million per year. Nearly all the R&D was financed in-house, although customer funding also accounted for a small percentage. R&D peaked in 1998, when it reached $18.7 million, up moderately from the $17.5 million in 1997. Spending then dropped sharply in 1999 to $6.4 million, only about one-third that of the previous year. The following chart presents R&D spending between 1995-1999.

Airbag Initiator and Inflator Research and Development Spending
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Airbag R&D	5,538	12,676	17,544	18,658	6,363

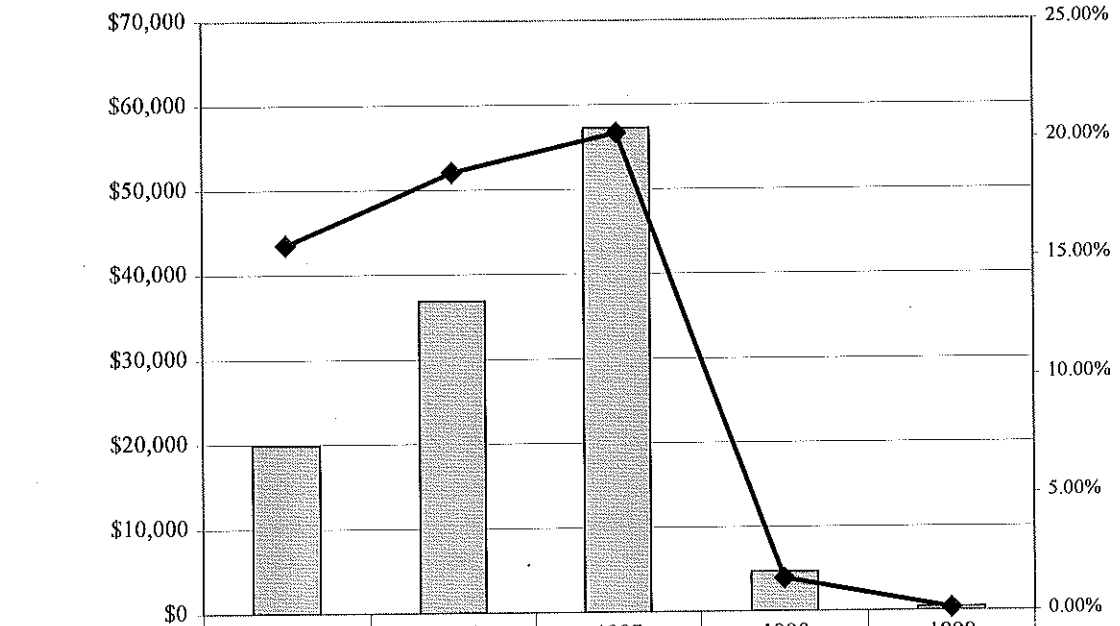
Source: U.S. DOC/BXA CAD/PAD Industry Survey

4.2.5 Profitability

Pre-tax profits in the airbag initiator and inflator sector plummeted sharply in 1998 and 1999 following start-up problems at OEA's new Tremonton facility. Special Devices profits were also lower as unit prices for initiators were squeezed. Autoliv's takeover of OEA will likely put additional pressure on Special Devices to further lower prices, along with all other companies in this market around the world.

Profits for the five years totaled $119 million, averaging $23.8 million per year. This was 12.6 percent of shipments. Profits peaked in 1997 at $57.2 million. This was followed by a free-fall in 1998 to only $4.7 million. In 1999, pre-tax profits fell again to only $403,000. This was an anomaly, because of OEA's temporary problems, so profits should improve in the future. It is doubtful, however, they will again reach the high levels of the earlier growing years. The following chart presents profits in dollars on the left axis and as a percentage of shipments on the right axis.

Airbag Initiator and Inflator Pre-Tax Profits
1995-1999
(in $000s)



	1995	1996	1997	1998	1999
Pre Tax Profits	19,885	36,849	57,249	4,675	403
% of Revenues	15.52%	18.60%	20.24%	1.39%	0.12%

Source: U.S. DOC/BXA CAD/PAD Industry Survey

5. Summary of Industry Comments

5.1 Government Policies

The CAD/PAD companies (excluding airbag initiator production, which is not affected) were asked to comment on various government policies, which are listed on page 13 of the Industry Survey (Appendix 2). They also follow here in sequence beginning with procurement issues. The responses largely reiterate statements made in the course of the 1995 CAD/PAD assessment, although progress in some areas can be reported. The two most serious issues from the industry's point of view appear to be lot acceptance testing (sub section 5.1.5) and export controls (sub section 5.1.8). The companies argue that they should do their own lot acceptance testing, rather than having Indian Head do it, and they want the export control process to be streamlined and more responsive to their international business concerns.

5.1.1 Procurement

A total of 19 companies responded to this question. Five others, one large and four small firms, did not comment. The responses can be summarized as follows.

a. Buy Best Value - Seven companies expressed a desire to see contracts awarded based on best value. Comments included: use qualified suppliers; reward quality and on time delivery; and, include past performance in the selection criteria. Three firms also suggested that low bid as sole criteria for awarding contracts should be eliminated. Two others thought the small business set-asides should be modified or eliminated.

b. Streamline the Process - Four companies, separate from the seven above, thought the procurement process is to slow. One company said the process could last more than a year. Another reported that excessive regulation clogs the process and much of it could be revised or eliminated.

c. Miscellaneous - The other eight companies provided the following comments and suggestions.

- Establish some type of reward for exceptional company performance.

- Best value can be used subjectively.
- Relax documentation and testing requirements.
- Maintain a mobilization base by using the procurement system to help smaller firms survive.
- Reduce tariffs on imported material and eliminate transportation costs for piece parts and material in the bidding process.

5.1.2 Small Business Set Asides

Ten 10 companies responded to this question; 14 companies made no comment. This is an indication that the issue is perhaps not as contentious as five years ago, when a greater number of respondents offered opinions on this program. Many of the smaller businesses folded or exited the product line in recent years. Of the ten respondents, eight favored modification or elimination of the SBSA, while two favored its continuance.

The Small Business Administration (SBA) Set-Aside Program was developed to allow certain government contracts to be awarded exclusively to small businesses. The program's goal is to help grow and develop small businesses and to ensure small businesses have an opportunity to participate. The set-aside program requires that the small business be price and quality competitive, and be capable of producing the quantities and meeting delivery schedules prescribed in the government contract. The Federal Acquisition Streamlining Act of 1994 raised the dollar value of government contracts automatically set aside for small businesses from $25,000 to $100,000. Contracts over $100,000 may also be set aside for small firms when there is a prospect that bids will be received from two or more responsible small businesses.

In addition to the set-aside, the SBA 8(a) Contracting Program also directs work toward small firms. It takes its name from section 8(a) of the Small Business Act and Public Law 95-507. Small, socially and economically disadvantaged firms that are certified by SBA are eligible to receive non-competitive Federal contracts for up to $5 million if a manufacturing firm ($3 million for a service firm).

5.1.3 Small Business Innovative Research Program

Only four companies commented on this program, which is specifically targeted at small companies. One company said the program should be open to all CAD/PAD companies

regardless of size. Another company suggested the program be modified and based on specific facilities, not based on overall corporate size.

5.1.4 Build-to-Print vs. Performance Specifications

A total of 19 companies responded to this question. Five companies, one midsize and four small, did not respond. In brief, build-to-print provides a manufacturing recipe to the CAD/PAD firm. Performance specifications give the CAD/PAD firm latitude in how to make the CAD/PAD with full engineering knowledge of the end use application. The end user may specify some characteristics.

Arguments Favoring Performance Specifications

Eleven companies favor moving toward performance specifications. The 11 included all but one of the larger CAD/PAD companies, as well as several midsize and smaller companies. Performance specifications would allow flexibility in the production process and promote process innovation and productivity improvement. By not locking in procedures, some sole sourcing could be eliminated, especially where a special machine or patented formulation is specified. This would result in more competition, lower costs to Defense, and leaner, more specialized CAD/PAD companies. Moreover, adoption of performance specifications will favor companies with more design experience and know-how.

Three companies alluded to the fact that there is no such thing as a perfect build-to-print. What it does is constrain new technology. Build-to-print data is not always complete. One firm said build-to-print packages rarely, if ever, truly get "debugged." Also, they can be so restrictive that there is only one way to build the part. Another firm said the build-to-print mentality is obsolete.

Arguments Favoring Build-to-Print

Five companies favor retaining build-to-print specifications. They included one large company and four small firms. One of these companies based its position on only one product group, without any further comment. Two firms stated that the government should update data packages. Another said it should be allowed to build-to-print as a system manufacturer. Lastly, a firm said performance specifications

favor larger companies; build-to-print "creates more competition" by allowing smaller firms with lower overhead to compete.

Other Responses

Three firms were uncommitted. One claimed to not understand the system. A second firm said it could see no difference. The third firm was concerned that existing build-to-print programs should not switch in midstream. If switched, however, the relevant contract should also be modified to fully reflect the change.

5.1.5 Lot Acceptance Testing

Issue: Should CAD/PAD companies be permitted to test and certify their own production? A total of 17 companies responded to this question. Seven firms - one midsize, the others small – did not respond.

a. Perform Lot Acceptance Testing at the Contractor's Facility – Fifteen of the respondents were for lot acceptance testing at the contractor's facility. This was the most lopsided response. None of the 17 respondents suggested lot acceptance testing ought to be done at Indian Head. One spokesman for the industry observed that in a war situation, this test could be waived, especially if production is backed up. The fact that Indian Head performs the tests for the Navy, while the Air Force allows the companies to perform the tests requires the companies to maintain the testing capability at their facilities. The requirement for Indian Head testing adds cost, but not value, to the parts. These added costs include time, transportation, and extra people. Relying on contractor testing will cut costs; reduce lead times; and enable the contractor to maintain this capability more efficiently at his facility.

   In the 1995 CAD/PAD study, several industry comments focused on the fact that the cost (to the taxpayer) of government product testing is considerably higher than at private firms. Therefore, testing should be left to the manufacturer of the product, who has both a reputation to uphold and a vested interest in repeat business. However, Indian Head requires acceptance testing to be performed at its test facility. The companies stated that Indian Head's facilities for testing duplicate those of private firms. Further, this duplication of testing can increase transportation costs and add in excess of 60 days to a delivery date schedule. Moreover, government test results frequently do not agree with results obtained

by the contractor. This results in more time delays and additional costs associated with verifying the test data.

b. Reduce Testing Requirements - Two responses were for reducing or simplifying testing requirements; the issue of lot acceptance testing was not explicitly addressed.

5.1.6 Competitive Bidding

Issue: How should competition be conducted? A total of 12 companies responded to this question. Twelve companies, including one large, one medium, and 10 small, made no comments.

Of 12 responses, five firms said competitive bidding should be on a best value basis, two companies said only qualified suppliers should participate, and five others said various other things. Three of the five mentioning best value also mentioned that qualified suppliers should compete in the bidding process. Four of the five other comments included suggestions that:

a. competitive bidding be streamlined;
b. export controls be relaxed on CAD/PAD products;
c. government competition be eliminated; and
d. small business set-asides should continue.

A fifth comment favored staying with the current system. (See Part 5.1.1 Procurement, for more information.)

5.1.7 Government Competition

Issue: Should the Navy compete with private industry? A total of the 10 companies responded to this question. Fourteen companies did not answer.

Eight companies indicated that Indian Head should be out of the competitive picture. Two of these said the government should not compete in the international market. One company suggested that Indian Head compete on the same basis as private firms, and produce only if the lowest cost to the American taxpayer. Another company saw Indian Head as part of the mobilization base.

The fact that 15 firms did not respond to the question may indicate that animosities have subsided somewhat since the 1995 report. On the other hand, this may also reflect the stronger market of today, and/or the realization that Indian Head is more sensitive to the situation. The export issue remains a serious concern for some firms.

Two companies said government-directed Foreign Military Sales have interfered with their competing in foreign markets. One firm reported that after an export license has been obtained, they should be permitted to sell directly to the foreign buyer without interference from Indian Head. Several firms said that competition from Indian Head should be reduced and ultimately phased out.

In the 1995 CAD/PAD study, 25 of the 35 firms surveyed reported that Indian Head was competing with them in at least one of the following CAD/PAD areas: manufacturing; testing; or R&D. Indian Head pointed to a 1993 Government Accounting Office (GAO) investigation that reported a small degree of actual competition and that the nature of Indian Head's activities were within acceptable bounds under the Office of Management and Budget (OMB) Policy Circular No. A-76. The purpose of the circular was to establish Federal policy regarding the government's performance of commercial activities. Procedures are outlined for determining whether commercial activities should be performed under private contract or in-house using Government facilities and personnel. The general policy states that the Government should not compete with private industry; rather, it is to rely on commercial sources to supply needed products and services.

However, the A-76 policy does set forth certain conditions where government performance of a commercial activity is authorized. These exceptions include the manufacture of mission-essential items, acceptance testing, depot maintenance, and research and development. The GAO analysis revealed that the concerns regarding Indian Head competing with private industry were areas exempt under the A-76 policy. Counter to this the industry claimed that:

1) Production and rework done at the Indian Head facility can be done more cheaply by private firms (claimed by 16 firms);

2) Many firms perform lot acceptance testing at their own facilities both more quickly and less expensively than does Indian Head (claimed by 11 firms); and

3) R&D could be contracted to private industry more cheaply and with quicker results than if done by the government (claimed by 7 firms).

(Item 2 has now grown to 15. See Part 5.1.5 Lot Acceptance Testing above.)

The A-76 policy document, however, provides a contractor with a legal basis to challenge government competition only when a comparison of the cost of contracting and the cost of in-house performance is affected. In its findings, the GAO recognized that because the same work is being performed both by private industry and Indian Head, there is duplication of production facilities, an added cost borne by the taxpayer. In view of this, the GAO recommendations emphasized the need for an ongoing analysis of the duplication of costs as well as an analysis on the necessity of Indian Head keeping core capabilities.

In separate conversations with OMB, BXA analysts sought further clarification of the exceptions criteria used by GAO. OMB reported Circular A-76 is a "broad policy statement" by the Office of President of the United States that seeks to achieve the lowest cost for the taxpayer in government procurement. It, however, is not a legal requirement backed by legislation. The "manufacture of mission essential items" refers to products and research and development uniquely for defense that: 1) cannot be contracted to a private firm(s), or 2) that can be produced cheaper in-house by the government than by a private firm.

Additional comments by individual firms covered other aspects of competition. For example, one firm reported that the Federal Government controls materials for cartridges, and can prevent private firms from selling directly to foreign markets. Eight of the respondents referred to Indian Head as being both a supplier and a competitor with private industry. It was also mentioned that Indian Head prepares requirements and then competes against industry to satisfy those requirements. Also, several firms wrote that private industry is not allowed to bid on certain government contracts, which are only open to selected U.S. Government arsenals that produce products at a higher price.

Indian Head contends that a core capability in CAD/PAD technology has inherent benefits to the national defense. It ensures a warm base and retention of the skills and technical knowledge needed to produce, handle and use CAD/PADs. It provides insight into the production processes and technology of CAD/PADs that helps channel R&D to where it is needed. And, it makes Indian Head procurement personnel "smarter" buyers.

5.1.8 Export Controls

Issue: CAD/PAD exports are controlled by the U.S. Department of State under the International Traffic in Arms Regulations. The process can be slow and burdensome. One-half of the companies surveyed responded to this question.

In brief, eight companies said the single most important reform is to streamline the export controls. Two firms think the licensing requirements at the U.S. State Department should be liberalized. Two other firms mentioned that government competition in the international markets has cost them business. One of these companies lost export sales to a foreign competitor because Indian Head would not sell them propellant. The other company said the government should not compete in international markets.

Since the 1995 report, export controls on CAD/PAD items have not changed. In a telephone interview, one respondent to the survey gave several examples that covered a wide range of the problems that CAD/PAD companies encounter with export controls, remarking that export licensing delays are costing his company business and are inadvertently creating competition abroad. The problems can be traced to the three types of licenses the State Department requires of U.S. CAD/PAD exporters: 1) approval for a bid proposal; 2) an export license; and 3) a re-export license.

1. Approval for a Bid Proposal - Some purchasers of U.S. CAD/PAD products are major foreign aerospace companies that use CAD/PADs in aircraft they sell worldwide. The U.S. CAD/PAD company needs pre-authorization from State prior to submitting an official bid to such a potential foreign buyer. Foreign located CAD/PAD competitors often do not face this procedure. The foreign buyer has to wait for up to a few months for the U.S. company's proposal to be approved. A company recently lost a $10 million bid to supply a European company because the approval for the bid took six months.

2. Export License Issues - If a foreign buyer waits for a U.S. company's bid and then chooses to source from them, the U.S. company needs to apply for an export license. As stated in the prior study, this can be a lengthy process and a license may not be approved. If rejected, the foreign firm would have to choose another supplier. Also, foreign buyers of U.S. CAD/PAD components must know who the eventual end user will be at the time of purchase and that end user must be an approved destination in order for the U.S. company to be able to obtain the export license.

3. Re-Export Licenses - Having the export license and selling the product is not the end of the export licensing issue. Foreign firms often sell their items worldwide, sometimes to customers unknown at the time an export license is issued. The CAD/PAD component is now part of a foreign product, but needs a re-export license from the State Department in order to sell to its additional foreign buyers. So if the customer is on the denied persons list or is from a country the U.S. does not allow exports to, the buyer will not be able to fulfill its orders, even though it is not a U.S. company.

Simply buying a U.S. CAD/PAD component makes the foreign company's goods subject to U.S. export controls. They cannot escape the re-export licensing process by pre-ordering these items and holding them in inventory. Also, they cannot put them into their products until they have obtained the necessary licenses.

Foreign buyers have purchased U.S. CAD/PADs less frequently, preferring to avoid the U.S. export control system. A particularly large European buyer of these products has recently developed its own in-house unit to produce this item in order to avoid U.S export controls on CAD/PAD devices. A U.S. manufacturer has now lost a large portion of its sales. Some other buyers around the world now prefer to buy from this new manufacturer to avoid the U.S. export controls. The U.S. company claims to be losing millions of dollars each year due to this new competition. The company would like the government to give assistance in this area. By maintaining such lengthy approval times for export controls, U.S. businesses are less competitive against European firms.

In another case, a U.S. company manufacturing CAD-actuated valves for commercial satellites reported a problem with a commodity jurisdiction determination between the Commerce and State Departments. Eventually it was determined that the product would require a State Department export license; the U.S. company then discovered that the processing times varied, taking three to four months or longer. The time period between submission and the final licensing determination was so long and inconsistent that the company could not commit to customer delivery times. The end result was a weakened position in the international marketplace for this manufacturer.

Another manufacturer of sonobouy release initiators successfully marketed this item to the Netherlands. The only source for the propellant used in the manufacture of the initiators was Indian Head. In 1998, Indian Head restricted the sale of the propellant to U.S. companies, allowing sales only for DoD contracts. Safety and security reasons were sighted for this change in policy. However, Indian Head can sell the propellant to other governments for the purpose of in-country production. When the U.S. firm recently

received a purchase offer from the government of Taiwan for initiators, it was unable to purchase the propellant to fill the order. A Canadian firm, SNC, was able to win the Tiawan contract and export the initiators without restriction from its government, after purchasing the propellant from Indian Head.

Several firms suggested that export control policy could be revised to accommodate non-lethal CAD/PADs, and the policy could also be modified to make allowances for parts readily available from foreign competitors. U.S. suppliers should have the same opportunities to compete in the international market as their foreign counterparts. At a minimum, when a license is required for export it should be issued by the Office of Defense Trade Controls (ODTC) within a reasonable time period so that the exporter can compete on a level field with potential foreign suppliers.

Congress has recently increased the budget for ODTC by fifty percent in an effort to provide more resources to significantly reduce the processing times for munitions export licenses obtained through the Department of State. Both the State and Defense Departments will be increasing the size of their license review staff and upgrading computer systems in an effort to reduce processing times of license applications.

5.1.9 Environmental and Safety Regulations

Issue: Environmental and safety standards are not evenly applied across states or localities. They can affect competitive outcomes. A total of 12 companies responded; 12 companies did not comment. Six companies reported that environmental and safety regulations are too burdensome. Two firms said California faces higher costs and stricter requirements than other areas.

Environmental and safety regulations are described as burdensome and an added cost of conducting business. Simplified regulations and procedures would enable companies to understand and comply with environmental policy. Companies cited the difficulty of complying with the strict environmental regulations in California. Some areas within the state are even more restrictive than others. Performance-oriented packaging should be valid for seven years. Reduction of EPA restrictions regarding burning of small quantities of explosive materials. EPA should work in conjunction with DoD in formulating policy that is applicable to the unique explosive/pyrotechnic conditions that are found in the CAD/PAD manufacturing environment.

5.2 Classification for Commercial Shipping and the Bureau of Explosives

Issue: New commercial shipments require Department of Transportation certification to transport. This can be a costly and lengthy process, which can discourage CAD/PAD firms from participation in commercial markets.

The DOT regulations that apply to new explosives shipments are codified in Title 49, Section 173.356 of the Code of Federal Regulations (see Appendix C). These regulations require a letter of "Recommendation for Classification" from a designated testing facility, followed by a letter of "Competent Authority" to ship from DOT's Office of Hazardous Materials. The CAD/PAD companies usually go to the American Association of Railroads, Bureau of Explosives (BOE), a private association located in Short Hills, New Jersey. The examiner at the BOE is Dr. Chang, who has more than 25 years experience.

Dr. Chang prepares letters of recommendation to DOT for firms after completion of tests and analysis of the product. The actual tests can be conducted at the firm's own test site in the presence of a BOE official, or at a testing site designated by BOE such as Universal Technologies in Riverton, Kansas. DOT's Office of Hazardous Materials will then review the case file and normally issue a letter of Competent Authority based on the letter of recommendation. In a small percentage of cases (about 1 in 20), DOT may not accept the recommendation and require further clarification that causes additional delays to private shippers.

The duration of the review process at DOT has fluctuated in recent years. Until mid-1994 the DOT required 6-8 weeks to provide a letter of Competent Authority after receipt of a letter of recommendation. Currently, DOT is providing letters of Competent Authority in about one week, and is working to further decrease the time required to process such requests. DOT is also attempting to lessen the burden on industry by permitting items to be classified by "grouping," "worst case," or "blanket classifications" for like items when the items may be grouped in a manner that permits identification of all possible combinations. The "worst case" or "grouped" items are identified on the examination report before the final classification is prepared to preclude unnecessary testing and loss of time.

The regulations provide for two methods of classification. The more expensive method applies to "new explosives." This method (49 CFR 173.56(b)1) requires physically testing samples of the product under a variety of conditions to establish its shipment classification. The second method is by "analogy." This method (49 CFR 173.56(a)2) permits BOE to confirm in writing to DOT that no significant differences in hazard

characteristics exist from the explosive in question and an explosive previously approved. The analogy method may only be applied when requested by a firm that also received the original classification. Most classifications are done by the analogy method.

In 1991, the United States implemented the United Nations' standards for classifying hazardous materials. This harmonized the U.S. transportation classification of explosives with other UN signatories, and will eliminate most of the double classification of internationally traded products. DOT's Office of Hazardous Materials now recognizes the authority of its counterparts in foreign countries to issue letters of Competent Authority and will generally honor them by issuing its own letter to the company presenting it. However, DOT and its foreign counterparts reserve the right to question or elicit clarification on such requests. In practice, the government agencies that administer these controls vary from country to country in both scope and authority, and therefore, may scrutinize more than just the transportation classifications in their reviews.

Alternatives to BOE Letters of Recommendation

In January 1995, DOT entered into a separate agreement with the Canadian Explosives Research Laboratory (CANMET) in Ottawa, Canada whereby CANMET may also test explosives for U.S. shippers and issue a letter of "Competent Authority." The agreement permits CANMET to authorize the shipment of samples for testing. DOT will in most cases then issue a letter of Competent Authority to the firm based on CANMET's letter.

In a separate action, the Energetic Materials and Research Center of New Mexico Tech in Albuquerque, New Mexico is under consideration as a Competent Authority. Both entities require DOT authorization before they can write letters of recommendation. BOE now often uses Universal Tech's testing facility in Riverton, Kansas for testing new explosives.

Most of the CAD/PAD companies expressed admiration for the job that Dr. Chang of the American Association of Railroads, Bureau of Explosives, has accomplished over the years. Dr. Chang provides recommendations to the Department of Transportation for the packaging of new explosive materials for commercial transport. Dr. Chang can retire anytime he wishes. Many CAD/PAD companies believe that he is their sole ally on this issue, and an irreplaceable source of institutional knowledge. The alternatives for packaging are very expensive, and in many cases prohibitive. Therefore, the impact of Dr. Chang's retirement could be adverse for many CAD/PAD companies, especially the smaller ones.

Some companies suggested that Indian Head become a replacement or alternative to Dr. Chang. This was suggested in the 1995 study, but Indian Head was unable to obtain the status. Other CAD/PAD firms would like to serve in this role, but the Department of Transportation wants neutral parties, and a couple of CAD/PAD firms stated they would not want a competitor testing their product.

Since the 1995 CAD/PAD report, the U.S. Department of Interior, Bureau of Mines facility in Bruceton, Pennsylvania, no longer provide the service. However, two new facilities, sanctioned by DOT, opened in Utah and Arizona, and another is available in Canada. The chief complaint about these other facilities is their very high costs and their backlog of cases. Also, they tend to deal with much larger and better-financed firms. Others said Dr. Chang is occasionally backed-up and sometimes difficult to reach; Dr. Chang responded that he almost never exceeds six months, and usually makes a recommendation much quicker. He is also training his son to take his job when he retires. Several companies stated that more people should be doing this work with Dr. Chang, although it takes years to achieve the experience.

Nearly half of the CAD/PAD survey respondents described a lengthy and burdensome process to obtain U.S. Department of Transportation (DOT) classification approval to transport new explosives. Since any design change requires reclassification, it is crucial to delivery that the 90-day turnaround not be exceeded.

6. Progress on Previous Report's Recommendations

Based on the 1995 CAD/PAD report, Indian Head has instituted changes to improve relations with the CAD/PAD industry. A major milestone occurred in 1998 with the approval and implementation of the CAD/PAD Joint Program (see Section 7).

The CAD/PAD companies were given the opportunity to evaluate progress they have witnessed at Indian Head. The companies evaluated the criteria listed below which were generated from the findings and recommendations of the 1995 report. Progress, or lack thereof, has been the responsibility of NSWC, Indian Head, as well as the Joint Program since 1998. The results of that evaluation are as follows:

Evaluation Criteria	Yes	No	Unknown	Not Applicable
1. Have you experienced an **improvement** in your relations with NSWC, Indian Head?	9	10	6	1
2. Has NSWC, Indian Head provided Defense Budget **forecasts** for CAD/PAD devices?	3	15	8	0
3. Has NSWC, Indian Head briefed you on **technical developments** and new requirements?	5	17	4	0
4. Has NSWC, Indian Head provided a **forum** for you to discuss and address grievances?	8	8	8	1
5. Have you experienced an improvement in your relations with the Labor Dept.'s Occupational Safety and Health Admin. **(OSHA)**?	5	3	11	7
6. Have you experienced an improvement in your relations with the State Dept.'s **Export** Control Branch?	4	10	7	5
7. Have you experienced an improvement in your relations with the Environmental Protection Agency **(EPA)**?	6	5	11	4
8. Has NSWC, Indian Head implemented a policy of **longer-term contracts** for CAD/PAD devices?	1	12	13	0
9. Has NSWC, Indian Head contracted out a larger portion of **R&D** to the CAD/PAD industry?	1	6	19	0
10. Have NSWC, Indian Head and Hill AFB effectively **consolidated operations** to form a Joint Program Office?	3	10	12	0
11. Has NSWC, Indian Head implemented other policies that improved the CAD/PAD **procurement environment**?	2	8	16	0

Source: U.S. DOC/BXA CAD/PAD Industry Survey

In assessing the evaluation results and discussing them with Indian Head and the Joint Program, several findings became apparent:

1. **Improved relations.** This is perhaps the most telling. Nine firms reported improved relations, indicating progress has been made, but the 10 firms who did not report an improvement indicates that more can be accomplished. (Two of the 10 said relations were already good and so they responded with a qualified no.)

2. **Budget forecasts.** Indian Head was surprised that Defense budget forecasts ranked so low. Air Force-Army-Navy/Marine out-year acquisition planning data was distributed to industry representatives at the September 1998 Survival and Flight Equipment (SAFE) Symposium hosted by the Joint Program. Only three firms acknowledged these forecasts. We suspect the persons filing the BXA survey at various companies were unaware that these forecasts exist. In follow-up meetings (see 4 below), only one company indicated any benefit in these acquisition data forecasts. The other companies stated they could take advantage of selective data requests. Therefore, the need for out-year updates does not appear justified.

3. **Technical developments – new requirements.** Indian Head was again surprised by these results. Since the 1995 report, they hosted three CAD/PAD Technical Exchange Workshops (August 1996, June 1998, May 2000) addressing new developments and requirements. Again, we suspect the people filing the BXA survey at various companies were unaware of these workshops.

4. Attendees representing industry have ranged from 28 – 40 companies for individual workshops. For CAD/PAD companies, the range was 13 – 18. The number of individual presentations by industry at the three workshops has been five, four and 17 respectively at the last workshop.

5. **Forum for grievances.** During 1999 – 2000, Joint Program representatives increased the frequency of meetings with companies to address various topics. These meetings have served as a forum for grievances. In the future, the plan is to expand the number of companies involved.

6. 5-7. **OSHA, Export, EPA.** Perhaps the most contentious of these is export control issue; see discussion at 5.1.8..

7. **Longer – term contracts policy.** Many companies reported that they do not want long-term contracts because that locks up the business for an extended period, hindering their ability to take on other work..

8. **R&D Contracting.** To be fair, some progress made by Indian Head on promoting research and development contracts received very little response from industry. In fact, the last five tenders for R&D solicited by Indian Head received no response from industry. This should be a topic at the next technical exchange workshop. Indian Head indicated that new R&D contracts over the past few years included alternate pyrotechnic time delay composition technology insertion; laser detonator development; toxic materials replacement; rocket motor propellant system improvements; and propellant second sourcing.

9. **Joint Program consolidation.** The Joint Program Office related that consolidated initiatives with Hill AFB have taken place and are underway, with more to be accomplished. Specific examples include combining project staff assignments, shared funding for projects, and consolidated contracting. They indicated that some efforts might be transparent to industry.

10. **Other policies improving procurement environment.** The Joint Program hosted an Industry Summit (January 1999) which included participation by the contracting offices at Navy Inventory Control Point (NAVICP), Mechanicsburg, Pennsylvania, and Hill AFB. The need was recognized to launch a government-industry Acquisition Reengineering. The most important categories identified by government and industry attendees included testing, processes, e-commerce, standardized requirements, and second sourcing.

11. The Joint Program recognizes the need for follow-up and will consider including and expanding sessions at the 2002 Technical Exchange Workshop to address industry topics.

7. CAD/PAD Joint Program

7.1 Introduction

The CAD/PAD Joint Program was established by the approval of a Business Plan on April 16, 1998. Final signatories included the Commander, Air Force Aeronautical Systems Center, and Navy Program Executive Officer, Tactical Aircraft Program (PEO (T)).

The Joint Program consolidated the remaining separate Air Force and Navy programs for the sustainment of CAD/PAD. Sustainment includes the range of activities needed to maintain a military system in operational usage, including replenishment acquisition, quality assessment, maintenance, repair, and product improvement.

This final consolidation has resulted in a true life-cycle commodity management program. It encompasses 3,100 distinct DoD CAD/PAD items whose applications include air, surface, and underwater platforms. Approximately 11,000 aircraft are supported which represent 550,000 installed items. The total Fiscal Year 2000 operating budget for the Joint Program was approximately $120 million of which $70 million was earmarked for acquisition involving 400 contracts including 1,400 line items.

7.2 Background

Life Cycle Responsibilities

CAD/PADs are normally developed as a component of a system, with life cycle responsibility residing with the system's acquisition program manager. However, day-to-day CAD/PAD sustainment responsibilities have been delegated within each Service to achieve economies of scale. Navy responsibilities reside with the Conventional Strike Weapons Program Manager (PMA-201), Patuxent River, Maryland that reports to the Program Executive Officer, Strike Weapons and Unmanned Aviation, PEO (W). The Indian Head Division, Naval Surface Warfare Center (NSWC) at Indian Head, Maryland, is responsible for Navy program execution. Prior to this agreement, Air Force responsibility resided with the Air-to-Surface Product Group Manager (PGM) at Ogden Air Logistics Center (ALC), Hill Air Force Base, Utah.

Earlier Consolidation Efforts

In 1974, the Joint Logistics Commanders agreed to consolidate most Army CAD/PAD functions within the Navy and at Indian Head, except requirements determination, budgeting, and inventory control, which continue to be the responsibility of the Operations Support Command, Rock Island, Illinois. The agreement served as the starting point on a long road toward full consolidation of CAD/PAD functions. Subsequent agreements among DoD agencies and organizations involved in CAD/PAD further strengthened the multi-service nature of the program and broadened the Navy's full life cycle role.

Joint Program Initiative

As a result of downsizing in the 1990s, the Air-to-Surface PGM at Ogden ALC suggested a study to evaluate the feasibility of a Joint Program. Over 1995-1997, an Indian Head and Ogden ALC Implementation Team conducted studies and demonstrations. The Team eventually decided that a Joint Program would be feasible, with the best alternative being the Navy as lead Service, and would boost efficiency. The Team identified several potential benefits, including preserving operational readiness and flight safety; unifying life cycle management and program consolidation; minimizing duplication and optimizing resources; standardizing policies and processes; and effectively managing the industrial base.

Organizational Aspects

Under the Joint Program agreement, the Navy is Lead Service for all CAD/PAD sustainment activities DoD-wide. An important effect of the agreement is to give the Navy responsibility for CAD/PAD sustainment decisions that can affect the readiness of Air Force aircraft. Army CAD/PAD sustainment was previously consolidated under the Navy.

The CAD/PAD Joint Program, based at Indian Head, is structured as an integrated product team managed by a small, jointly manned Program Office, reporting to PMA-201. The Program Office directs a competency-based organization at Indian Head and Ogden ALC, composed of acquisition, logistics, engineering, test and evaluation, and

manufacturing. Administrative reporting and support relationships remain unchanged by Joint Program implementation.

Advisory Group

The CAD/PAD Joint Program Advisory Group (JPAG) provides advice to the Joint Program, and accomplishes coordination of CAD/PAD program and technical matters within DoD. The overarching Group functions are to coordinate and harmonize the Service's CAD/PAD programs, ensure timely exchange of program information among the Services; reduce the proliferation of items across the Services; and monitor the health of the industrial base.

From 1992 – 2000, this Group was chartered as the Joint Ordnance Commanders Group, CAD/PAD Ad Hoc Group. It was reconstituted as the JPAG under PEO(W), PMA-201 in 2000. Principal members and their Service organizations are listed in the table below.

Military Service Organization	Principal Member Organization
USAF Aeronautical Systems Center , Wright Patterson AFB, OH	Engineering Directorate, Aircrew Systems Division
USAF Human Systems Wing, Brooks AFB, TX	Engineering
USAF Ogden Air Logistics Center, Hill AFB, UT	Munitions Directorate, CAD/PAD Division
USA Aviation and Missile Command, Redstone Arsenal, AL	Aviation Directorate, Weapons Division
USA Operations Support Command, Rock Island, IL	Production (Munitions Acquisition) & Logistics - Surveillance Directorates
USNMC Conventional Strike Weapons PM, Patuxent River, MD	USNMC CAD/PAD Deputy Program Manager
Indian Head Div, Naval Surface Warfare Center, Indian Head, MD	CAD/PAD Joint Program & Program Management

8. Findings and Recommendations

8.1 Findings

1. The CAD/PAD industry is doing well compared to the previous study covering the period, 1991-1995. Shipments of aerospace CAD/PADs grew nearly 29 percent from 1995-1999 to $247.6 million. The increase was related to the greater use of CAD/PADs in modern weapon systems and a slight increase in Defense procurement in 1998 and 1999. The future should see further gains. Pre-tax profits are also up.

2. The airbag initiator business is traveling a different path from aerospace CAD/PADs. Shipments rose more than 160 percent from 1995-1999 to $334.4 million, but stalled in 1999. Two companies dominate the business, Special Devices and OEA. Autoliv, a world leading airbag maker, purchased OEA in May 2000 to integrate upstream. The airbag initiator business saw massive investments in new capacity during the period, but now the growth cycle appears completed. The future hinges on developing new airbag applications in autos, such as back seat and side protection.

3. Mergers and acquisitions have rapidly restructured the CAD/PAD industry. Leading forces in this restructuring have been B.F. Goodrich and J.L. Lehman. B. F. Goodrich has acquired most of the ejection seat assets in the United States. The firm now has an agreement to purchase OEA Aerospace from Autoliv. Lehman, an investment equity company, purchased Special Devices, Scot and McCormick Selph. Scot and McCormick Selph were then sold as a package to Wind Point Partners in September 2000. It remains to be seen what Lehman wants to do with Special Devices, a leading producer of aerospace CAD/PADs and airbag initiators.

4. Various forces are driving the consolidation and restructuring in the CAD/PAD industry. Larger firms are being created as a possible counterweight to the larger and more demanding customers (Boeing, Lockheed, and Raytheon). Also, the only way to gain market share is at the expense of, or by purchasing, competitors.

5. Export controls under the State Department's Munitions List remains a major concern of the CAD/PAD companies. CAD/PAD companies said the single most

important reform in this area would be to streamline the issuance of bid proposals and export licenses. Aside from that, two firms think the export licensing process at the U.S. State Department should be liberalized. Two others mentioned that government competition in the international markets has cost them business.

6. Another lingering issue is lot acceptance testing. The entire industry differs with the U.S. Navy's insistence that lot acceptance be done at Indian Head facilities. The Air Force allows companies to perform this testing at their facilities. Companies claim lot acceptance testing at Indian Head adds costs and delays deliveries.

7. Most of the large firms in the industry favor performance specifications over build-to-print. Performance specifications would allow CAD/PAD producers to leverage their technical staffs and better utilize their facilities. Firms also argue that performance specifications will increase competition by unfreezing designs. A related issue is best value vs. low bid. Policy momentum seems to favor performance specifications and best value over build-to-print and low bid. Build-to-print appears to have a legitimate place in legacy systems.

8. Indian Head (and subsequently the Joint Program) has made progress in addressing the industry's concerns as expressed in the 1995 Commerce report recommendations.

8.2 Recommendations

1. Convene high level discussions between the State Department's Office of Defense Trade Control and the CAD/PAD industry representatives. Provide State with industry evidence of their experiences. Compare U.S. restrictions with those of our key trading partners.

2. Perform a cost/benefit analysis on lot acceptance testing at company facilities under guidelines set down in A-76. Consider phasing in lot acceptance testing at company facilities that have an established track record of compliance. Consider random checks and official witness testing at companies' facilities.

3. Schedule a meeting with the Navy, BXA and the two CAD/PAD companies that have export business grievances involving the Navy.

4. Indian Head should continue to retain a core manufacturing capability to ensure all requirements are covered and to remain an intelligent CAD/PAD center. Industry should continue receiving 90 percent or more of the business.

5. Indian Head should continue hosting Technical Exchange Workshops in the future. These are very useful to industry and government. Topics at the next workshop should include the benefits of performance specifications vs. build-to-print; environmental policy and the CAD/PAD industry; and other topics of interest such as contracting. Companies and other interested parties in related government agencies should be encouraged to participate.

6. With Martin-Baker seemingly locking up the JSF ejection seat business, DoD should consider requiring that a portion of CAD/PADs for the JSF seat be procured from U.S. companies. This could be implemented by a leader-follower acquisition approach similar to the approach initially taken with the Navy Aircrew Common Ejection Seat (NACES) Program.

7. Commerce and the Joint Program should monitor DOT commercial shipment processes for companies to successfully obtain certifications in a timely and efficient manner.

Appendix A

Letters Requesting and Accepting Updated Assessment

DEPARTMENT OF THE NAVY
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
101 STRAUSS AVE
INDIAN HEAD MD 20640-5035

8900
Ser JP/18
July 15, 1998

U.S. Department of Commerce
Bureau of Export Administration
ATTN: Roger Majak
Assistant Secretary for Export Administration
Room 3886
Washington, D.C. 20230

Dear Mr. Majak:

A national security assessment was initiated in December 1993, at the request of the Cartridge Actuated Device/Propellant Actuated Device (CAD/PAD) Program Office of the Naval Surface Warfare Center, Indian Head Division (NSWC, INDIAN HEAD DIVISION). The results from this study, to analyze the long-term health and competitiveness of the CAD/PAD industry and to develop recommendations to ensure the continued ability for the industry to support defense missions and programs, was very useful to us. Because of the success of this study, we would like to request an update of the numbers provided. Competition in the CAD/PAD industry has caused many changes since the study was completed. An updated study would show us how we are doing in reducing or eliminating potential shortfalls and other problems in this industry.

I would be glad to come meet with you and brief you on this request. I'll make myself available at your convenience. Please call me at (301) 743-6499 with an appointment date.

Sincerely,

DENNIS P. CHAPPELL, Director
CAD/PAD Joint Program Office
By direction of the
Commanding Officer

cc:
Brad Botwin

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Export Administration
Washington, D.C. 20230

July 31, 1998

Mr. Dennis P. Chappell
Director
CAD/PAD Joint Program Office
U.S. Department of the Navy
Naval Surface Warfare Center
101 Strauss Avenue
Indian Head, MD 20640-5035

Dear Mr. Chappell:

I was pleased to learn that the Cartridge and Propellant Actuated Device (CAD/PAD) study which we conducted on your behalf has been useful for your organization. That study ultimately led us to conduct a similar study for the Air Force on ejection seats.

We would be pleased to meet with you to hear more about progress which you and the industry have made using the analysis which we provided. We would also welcome the opportunity to work with you further to update the information to assist you in your CAD/PAD program objectives. We appreciate the continued working relationship which we have with you.

My staff has scheduled a meeting for us to talk further about the latest CAD/PAD developments and your further information needs on Wednesday, August 19. If we can be of further assistance in the interim, please contact Brad Botwin at 202-482-4060. I look forward to seeing you on the 19th.

Sincerely,

R. Roger Majak
Assistant Secretary

Appendix B

Survey

OMB Control 0694-0116
Expires 06/30/02

U.S. Department of Commerce
Bureau of Export Administration

NATIONAL SECURITY ASSESSMENT OF THE U.S. CARTRIDGE AND PROPELLENT ACTUATED DEVICE INDUSTRY

PURPOSE OF THIS ASSESSMENT

The U.S. Department of Commerce/Bureau of Export Administration and the U.S. Department of Defense/Naval Surface Warfare Center/Indian Head Division are working together to update the 1995 National Security Assessment of the U.S. CAD/PAD industry. The goal of this update is to collect statistical data and provide the industry with a statistical profile, assess the current economic health and competitiveness of the CAD/PAD industry, and determine both the implementation and effectiveness of the recommendations made in the 1995 Assessment.

YOUR RESPONSE IS REQUIRED BY LAW

This assessment is conducted persuant to the Defense Production Act of 1950, as amended (DPA) (50 U.S.C.A. app. section 2061 et. seq. (1997) and as delegated to the Secretary of Commerce in section 401(4) of Executive Order 12656 (3 C.F.R. 585 (1988)). Your response to this questionnaire is required under section 705 of the DPA (50 U.S.C.A. app. section 2155). Any information submitted in response to this questionnaire will be deemed **BUSINESS CONFIDENTIAL** and treated in accordance with section 705 of the DPA.

Burden Estimate and Request for Comment: Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act unless that collection of information displays a currently valid OMB Control Number.

Public reporting burden for this collection of information is estimated to average 5 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 estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to BXA Reports Clearance Officer, Room 6881, Bureau of Export Administration, U.S. Department of Commerce, Washington, DC 20230, and/or to the Office of Management and Budget, Paperwork Reduction Project (OMB Control #0694-0116), Washington, DC 20503.

EXEMPTION

If your firm has not produced Cartridge or Propellant Actuated Devices in the United States since January 1, 1995, you are not required to complete this form. If this is the case, please provide the information requested below and return this page.

Name of Company	**Address (City, State)**
Signature of Authorized Official	**Date**
Name of Official- Please Print	**Phone**

Survey Contents

GENERAL INSTRUCTIONS

1. Please complete this questionnaire in its entirety as it applies to your company's Cartridge and Propellant Actuated Device (CAD/PAD) operations. The questionnaire has 6 parts as follows:

PART I	Firm Identification
PART II	Statistical Profile
PART III	Competitiveness
PART IV	Effectiveness of Previous Recommendations

2. It is not our desire to impose an unreasonable burden on any respondent. IF INFORMATION IS NOT READILY AVAILABLE FROM YOUR RECORDS IN EXACTLY THE FORM REQUESTED, FURNISH ESTIMATES AND DESIGNATE BY THE LETTER "E".

3. Report calendar year data, unless otherwise specified in a particular question. Please make photocopies of forms if additional copies are needed.

4. Please use the list of codes on the attached "List of Product Codes" to identify devices in Parts I, II, and III.

5. Questions related to the questionnaire should be directed to John Tucker, Senior Industry Analyst, (202) 482-3984, or David Villarreal, Industry and Trade Analyst, (202) 482-3795 at the U.S. Department of Commerce. You may also fax questions to (202) 482-5650, or use e-mail address: jtucker@bxa.doc.gov

6. Before returning your completed questionnaire, be sure to sign the certification on the last page and identify the person and phone number to be contacted (if necessary) at your firm. Return questionnaire within 30 days to :

Mr. Brad Botwin
Director, Strategic Analysis Division
Room 3876, BXA/SIES
U.S. Department of Commerce
Washington, DC 20230

PRODUCT CODES

1. **AIRCREW ESCAPE PROPULSION SYSTEM:** A rocket powered device employed in aircrew escape systems to perform such functions as propulsion, acceleration, deceleration, ejection seat divergence, man-seat separation, parachute deployment, stabilization, etc., including rocket catapults and underseat rocket motors.

2. **IMPULSE CARTRIDGES:** A cartridge-type item employing propellant or explosive materials to release energy. This category includes fire extinguisher cartridges, ignition elements, squibs, detonators and blasting caps, but **excludes** cartridges that incorporate pyrotechnic delay material(s) to effect the timing of the output charge initiation, see product code #4. Also exclude aircraft stores release cartridges and aircraft cartridges and aircraft countermeasure cartridges such as chaff and flare ejection cartridges and sonobouy ejection cartridges (see PRODUCT CODE #5).

   2A. **ELECTRICALLY INITIATED CARTRIDGES:** Devices using electrical energy to initiate the energetic material.

   2B. **PERCUSSION INITIATED CHARGES:** Devices using percussion primers to initiate the energetic material.

3. **INITIATORS (IMPULSE):** Devices employing energetic materials such as propellants or explosives to: generate the initial or sustaining pressure within a ballistic gas system, or to initiate a signal transmission line such as shielded mild detonating cords, thin layered explosive transmission lines, etc. **Exclude** cartridge type devices which are employed in igniters or other explosive devices to ignite propellants or explosives, as well as, initiators which effect the timing of the output charge initiation by use of pyrotechnic delay material(s) (see PRODUCT CODE #4).

4. **DELAY CARTRIDGES AND DELAY INITIATORS:** Devices similar to PRODUCT CODES #2A, #2B AND #3 that incorporate pyrotechnic delay material(s) to effect timing of the output charge initiation. This category includes electrically and percussion primed delay cartridges and delay initiators.

5. **AIRCRAFT STORES/ FLARES/ CHAFF/SONOBUOY EJECTION CARTRIDGES:** Cartridges and ignition elements, employing energetic materials such as propellants and explosives, used to eject bombs, sonobuoys, missiles, etc., from combat aircraft. This category includes cartridges to launch or eject aircraft flares or chaff for anti-aircraft missile countermeasures, but not the flares themselves.

6. **DETONATING CORDS AND CHARGES:** This category includes the following devices; shielded mild detonating cord, mild detonating cord, linear shape charge, flexible linear shape charge, mild detonating fuse, and thin layered explosive lines. Also included in this group are transfer assemblies and other assemblies that employ these type of cords or lines, (for example, window severance assemblies). **Exclude** bulk explosives.

7. **CUTTERS:** Devices which employ energetic materials and a cutting blade to sever a bolt, wire, cable suspension lines etc.

8. **CATAPULTS, THRUSTERS, REMOVERS:** Devices using energetic materials and employing captured or ejected telescoping-type tubes to perform functions such as separation, ejection, thrusting, movement, etc.

9. **OTHER:** This category includes all other cartridges, cartridge actuated devices and other pyrotechnic devices of similar design and used in a similar manner.

9A. Automatic Inflators
9B. Gas Generators
9C. Automotive Airbag Initiators
9D. Laser Initiated Cartridges, Detonators, and Initiators
9E. Rocket Motor Igniters

DEFINITIONS

CARTRIDGE - An energy source utilizing one or more energetic materials such as pyrotechnic, propellant or explosive ingredients.

CARTRIDGE ACTUATED DEVICE (CAD)- A device releasing cartridge energy to perform a controlled system or work function.

DEFENSE SHIPMENTS - Direct and indirect military shipments, including domestic and international shipments for military use. These include: 1) weapon systems, support equipment, and all other defense related end-use devices, identified by purchase orders bearing a DO or DX rating and/or a contract number from the Department of Defense, Nuclear Regulatory Commission, Central Intelligence Agency, Federal Aviation Administration, National Security Agency or the National Aeronautics and Space Administration; 2) the orders of your customers which you can identify as producing products for defense purposes; and 3) devices tested and certified to military specifications.

ESTABLISHMENT - All facilities in which CAD/PADs are produced. Includes auxiliary facilities operated in conjunction with (whether or not physically separate from) such production facilities. Does not include facilities solely involved in distribution.

FIRM - An individual proprietorship, partnership, joint venture, association, corporation (including any subsidiary corporation in which more than 50 percent of the outstanding voting stock is owned), business trust, cooperative, trustees in bankruptcy, or receivers under decree of any court, owning or controlling one or more establishments as defined above.

OFFSET AGREEMENTS - Offsets are defined as industrial or commercial compensation practices required by foreign governments as a condition of purchase of military imports. Common types of offsets include licensed production of the defense item (or parts thereof) in the purchasing country, technology transfer, foreign investment, and countertrade.

PROPELLANT ACTUATED DEVICE (PAD) - A rocket powered device releasing controlled propellant energy to perform a work function. This device provides propulsion for acceleration/deceleration, stabilization, divergence or deployment.

RESEARCH AND DEVELOPMENT - includes basic and applied research and product development in the sciences and in engineering, and design and development of prototype products and processes. For the purposes of this questionnaire, research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, if the purpose of such activity is to do one or more of the following things:

1. Pursue a planned search for new knowledge, whether or not the search has reference to a specific application.

2. Apply existing knowledge to problems involved in the creation of a new product or process, including work required to evaluate possible uses.

3. Apply existing knowledge to problems involved in the improvement of a present product or process.

SHIPMENTS - Domestically produced products shipped by your firm during the reporting period. Such shipments should includes inter-plant transfers, but should exclude shipments of products produced by other manufacturers for resale under your brand name. Do not adjust for returned shipments. (See definition of DEFENSE SHIPMENTS above.)

UNITED STATES - Includes the fifty States, Puerto Rico, the District of Columbia, and the Virgin Islands.

"BUSINESS CONFIDENTIAL"

PART I: FIRM IDENTIFICATION

1. COMPANY NAME AND ADDRESS: Please provide the name and address of your firm or corporate division that is engaged in CAD/PAD operations.

_____
Company Name

_____
Street Address

_____
City, State, Zip Code

Percent of Company's or Corporate Division's business that is CAD/PAD related:_____%. What other business activities does your company do? (If none, please check here: ☐)

_____

_____

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

_____
Company Name

_____
Street Address

_____
City, State, Zip Code (Country)

Extent of Ownership:_____% Year acquired _____

Percent of Parent's business that is CAD/PAD related:_____%

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

"BUSINESS CONFIDENTIAL"

PART I: FIRM IDENTIFICATION

3. ESTABLISHMENTS: Please identify the location of each of your U.S. CAD/PAD manufacturing establishments currently in operation on the top portion of the table, and any CAD/PAD establishments closed or sold since January 1, 1995 on the lower portion. Indicate the product types produced at each using the product codes listed at the beginning of the survey.

Establishment Locality	State	Zip	Product Type(s)
1.			
2,			
3.			
4.			
Closed or Sold Establishments	**State**	**Zip**	**Product Type(s)**
1.			
2.			
3.			
4.			

4. PRODUCTION CAPABILITIES: For CAD/PAD products you ceased producing since January 1, 1995, please place a check mark (✓) in column headed "Ceased Production". In the column headed "Could Produce", place a check mark by those CAD/PAD products your firm could manufacture (excluding products listed under Product Types, in question #3 above) with current equipment and facilities that you are not producing now and the estimated investment required to do so.

CAD/PAD Product	Ceased Production	Could Produce	Estimated Investment
1. Aircrew Escape Propulsion System			
2a. Electrically Initiated Impulse Cartridges			
2b. Percussion Initiated Impulse Charges			
3. Initiators (Impulse)			
4. Delay Cartridges And Delay Initiators			
5. Aircraft Stores/ Flares/ Chaff/ Sonobouy Ejection Cartridges			
6. Detonating Cords And Charges			
7. Cutters			
8. Catapults, Thrusters, Removers			
9a. Automatic Inflators			
9b. Gas Generators			
9c. Automotive Airbag Initiators			
9d. Laser Initiated Cartridges, Detonators, and Initiators			
9e. Fire Extinguisher Cartridges			

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

PART I: FIRM IDENTIFICATION

5. REASONS FOR CLOSING OR SELLING ESTABLISHMENTS OR CEASING PRODUCT PRODUCTION: For establishments closed or sold, or product lines no longer produced since January 1, 1995, please cite the reasons for the action below. You may use the codes a-e as shown below if they apply; otherwise please use "f" and briefly explain your answer.

a. Loss of market share to imports	d. Inability to comply with environmental regulations
b. Loss of market share to domestic competition	e. Inability to comply with safety regulations
c. Declining demand	f. Other (Please explain in space provided below)

Establishment Closed or Sold*	Year	Reason (use codes)
Product Lines no longer produced	**Year**	**Reason (use codes)**

* If an establishment was sold, please indicate to whom in the column headed, "Establishment Closed or Sold".

6. MERGERS, ACQUISITIONS AND TAKEOVERS: Please document on the following table any mergers, acquisitions, takeovers, or divestitures that affected the CAD/PAD operations your company was involved in since January 1, 1995.

Year	Name of Other Firm(s)	Type of Deal*	Objective of Deal*

* You may use the following letter codes:

Type of Deal: a. Merger, b. Acquisition, c. Takeover, d. Divestiture e. Other: (specify)

Objective of Deal: a. Expand product offerings, b. Increase share in existing markets, c. Acheive economics of scale, d. Acheive other efficiencies, e. Gain expertise, f. Gain new markets g. Other (specify)

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

PART II: STATISTICAL PROFILE

The following two pages contain tables to be completed for 1) Total CAD/PAD Shipments (Table 1) and 2) CAD/PAD Exports (Table 2).

Table 1 -

1. **TOTAL CAD/PAD SHIPMENTS, INCLUDING EXPORTS:** Please report separately your total defense (upper portion of table) and non-defense (lower portion of table) shipments for each of the listed CAD/PAD devices in the designated areas of the table for the years 1995-1998, and estimated totals for 1999.

   Please include exports to foreign defense or military applications as defense shipments and include in upper portion of table.

   At the bottom of the table, report, 1) the combined total of all CAD/PAD shipments, and 2) net income before taxes for your CAD/PAD operations.

   Please report values in thousands ($000's) of dollars, except for net income, which should be reported as a percentage of CAD/PAD shipments.

Table 2 –

2. **TOTAL EXPORTS:** Please report separately defense (upper portion of table) and non-defense (lower portion of table) exports of CAD/PAD devices manufactured by your firm for the years 1995-1998, and the estimated totals for 1999, on the table below.

   At the bottom of the table, please report total exports.

   Please report values in thousands ($000's) of dollars.

Note: Please ensure exports are included total shipments in your response to Table 1.

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PART II: STATISTICAL PROFILE

TABLE 1. TOTAL DEFENSE or MILITARY RELATED SHIPMENTS (in $000s)					
Products	**1995**	**1996**	**1997**	**1998**	**E 1999**
1. Aircrew Escape Propulsion Subsystem					
2a. Electrically Initiated Impulse Cartridge					
2b. Percussion Initiated Impulse Cartridge					
3. Initiators (Impulse)					
4. Delay Cartridges And Delay Initiators					
5. Aircraft Stores, Flares, Chaff, Sonobouy Ejection Cartridges					
6. Detonating Cords And Charges					
7. Cutters					
8. Catapults, Thrusters, Removers					
9a. Automatic Inflators					
9b. Gas Generators					
9c. Automotive Airbag Initiators					
9d. Laser Initiated Cartridges, Detonators, and Initiators					
9e. Rocket Motor Igniters					
TOTAL NON-DEFENSE or COMMERCIAL RELATED SHIPMENTS (in $000s)*					
Products	**1995**	**1996**	**1997**	**1998**	**E 1999**
2a. Electrically Initiated Impulse Cartridge					
2b. Percussion Initiated Impulse Cartridge					
3. Initiators (Impulse)					
4. Delay Cartridges And Delay Initiators					
6. Detonating Cords And Charges					
7. Cutters					
9a. Automatic Inflators					
9b. Gas Generators					
9c. Automotive Airbag Initiators					
9d. Laser Initiated Cartridges, Detonators, and Initiators					
9e. Rocket Motor Igniters					
Grand Total and Net Income	**1995**	**1996**	**1997**	**1998**	**E 1999**
CAD/PAD Shipments: Grand Total					
CAD/PAD Net Income before taxes**	%	%	%	%	%

Note that Products #1, 5, and 8, which are solely for the military, are excluded from the non-defense portion of the table
**Please express (or estimate) net income as a percent return on CAD/PAD shipments (e.g., 8 = 8 percent)

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

PART II: STATISTICAL PROFILE

TABLE 2. DEFENSE or MILITARY RELATED EXPORTS (in $000s)					
Products	**1995**	**1996**	**1997**	**1998**	**E 1999**
1. Aircrew Escape Propulsion Subsystem					
2a. Electrically Initiated Impulse Cartridge					
2b. Percussion Initiated Impulse Cartridge					
3. Initiators (Impulse)					
4. Delay Cartridges And Delay Initiators					
5. Aircraft Stores, Flares, Chaff, Sonobouy Ejection Cartridges					
6. Detonating Cords And Charges					
7. Cutters					
8. Catapults, Thrusters, Removers					
9a. Automatic Inflators					
9b. Gas Generators					
9c. Automotive Airbag Initiators					
9d. Laser Initiated Cartridges, Detonators, and Initiators					
9e. Rocket Motor Igniters					
NON-DEFENSE or COMMERCIAL RELATED EXPORTS (in $000s)*					
Products	**1995**	**1996**	**1997**	**1998**	**E 1999**
2a. Electrically Initiated Impulse Cartridge					
2b. Percussion Initiated Impulse Cartridge					
3. Initiators (Impulse)					
4. Delay Cartridges And Delay Initiators					
6. Detonating Cords And Charges					
7. Cutters					
9a. Automatic Inflators					
9b. Gas Generators					
9c. Automotive Airbag Initiators					
9d. Laser Initiated Cartridges, Detonators, and Initiators					
9e. Rocket Motor Igniters					
Grand Total and Net Income	**1995**	**1996**	**1997**	**1998**	**E 1999**
CAD/PAD Exports: Grand Total					

* Note that Products #1, 5, and 8, which are solely for the military, are excluded from the non-defense portion of the table

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PART II: STATISTICAL PROFILE

3. NUMBER OF EMPLOYEES BY OCCUPATION: Please enter the number of employees by occupation as shown below for year end 1995-1998, and estimates for 1999, for your US CAD/PAD operations, as requested below.

NUMBER OF EMPLOYEES BY OCCUPATION					
Occupation	**1995**	**1996**	**1997**	**1998**	**E 1999**
Management					
Program Management					
Contracts Administration					
Purchasing/Procurement					
Sales/Marketing					
Design Engineering					
Manufacturing					
Quality					
Test					
Finance/Accounting					
Total Direct Employees					
Outside Consultants					
Total, with Consultants					

Definitions:

Management	President, Vice President, Director
Program Management	Typically used in matrix organization includes managers, program administrators, program budget analysts
Contracts Administration	Including managerial, contracts administartors
Purchasing/Prrocurement	Including managers, buyers
Sales/Marketing	Marketing and sales staff plus related secretarial, advertising, trade show, market admin personnel
Design Engineering	Direct charge
Manufacturing	Includes managers, supervisors, leads, all non-exempt, production control and other direct mfg.
Quality	Includes quality engineers, all incoming and in -process inspectors
Test	Includes test engineers, technicians, test equipment operators
Finance/Accounting	Includes all accounting functions including payroll,
Human Resources	Overhead staff
Outside Consultants	Any technical, business, quality, legal, or other capacities

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PART II: STATISTICAL PROFILE

4. **TECHNICAL SKILLS BASE:** What is the number and current experience profile of your design and engineering technical staff? Please identify below only design engineering staff, excluding engineers in support of manufacturing, testing, quality, and other operations.

Design Engineering Staff Experience						
Degree/Capacity	**Number Employed**	**Years of Experience**				
		<5	**6 - 10**	**11 - 20**	**21 - 30**	**>30**
Mechanical						
Electrical						
Chemical						
Laser						
Subtotal						
Outside Consultants						
Total						

5. **CUSTOMER TECHNICAL CAPABILITY: Based on your experience,** what trends have you observed about the following technical capabilities within the Department of Defense/Primes in the:

a. **Preparation of technical specifications**:
It has improved☐ It has remained about the same☐ It has eroded ☐

b. **Technical knowledge of your product**:
It has improved☐ It has remained about the same☐ It has eroded ☐

c. **Technical discussion of ordnance application in their system**:
It has improved☐ It has remained about the same☐ It has eroded ☐

d. **Technical ability to evaluate proposed design and compare**:
It has improved☐ It has remained about the same☐ It has eroded ☐

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PART II: STATISTICAL PROFILE

6. OTHER LABOR CONCERNS: If in the **last five years** you experienced any labor concerns, such as shortages of certain skills, excessive turnover, retirement of experienced workers, liability claims, etc. that adversely affect(ed) your CAD/PAD manufacturing or R&D operations, please describe them below:

_____

_____

_____

_____

7. INVESTMENT: Enter expenditures for plant, new machinery and equipment, and used or rebuilt machinery and equipment (in $000) from 1995 to 1998, and projected amounts for 1999, on the table below.

New Investment in CAD/PAD Operations					
Type Investment	**1995**	**1996**	**1997**	**1998**	**Est. 1999**
Plant					
Machinery and Equipment					
Total New Investment					

8. STRATEGIES FOR INVESTMENT: Based on your last three years experience, please rank from 1-5, the top five motives for investment as shown in the left column. If the motives shown do not apply to all situations, please use "other" reasons.

Motives for New Investment	Top Five Ranking (1 to 5)
Replace old equipment.	
Improve productivity.	
Expand capacity.	
Add new capability.	
Upgrade technology.	
Meet specific customer's requirements.	
Comply with environmental or safety requirements	
Other (specify):	
Other (specify):	

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PART II: STATISTICAL PROFILE

9. CAD/PAD RESEARCH AND DEVELOPMENT EXPENDITURES: Please enter your firm's CAD/PAD related research and development (R&D) expenditures from 1995-1998, and projected for 1999 as requested below. Please report your defense related R&D on the bottom half of the following table. Enter separately the dollar amounts (in $000) expended for: 1) materials, 2) processing, and 3) product development. (See definition of Research and Development.)

COMMERCIAL RESEARCH AND DEVELOPMENT EXPENDITURES (in thousands of dollars)					
Commercial	**1995**	**1996**	**1997**	**1998**	**Est 1999**
Materials					
Production Processing					
Product Development					
Total					
DEFENSE RESEARCH AND DEVELOPMENT EXPENDITURES (in thousands of dollars)					
Defense	**1995**	**1996**	**1997**	**1998**	**Est 1999**
Materials					
Production Processing					
Product Development					
Total					

10. R&D APPLICATIONS: To what extent is R&D conducted for defense projects applicable to your commercial operations, and to what extent is commercial R&D of use in your defense operations?

_____

_____

_____

_____

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PART II: STATISTICAL PROFILE

11. SOURCES OF R&D FUNDING: Please enter research and development expenditures, by source of funding, from 1995 through 1999 (estimated).

(THOUSANDS OF DOLLARS)

Sources of CAD/PAD R&D Funding					
FUNDING FOR COMMERCIAL R&D					
Funding Source	**1995**	**1996**	**1997**	**1998**	**Est. 1999**
In-House (self-funded)					
Customer					
Federal Government					
Other:					
Total Funding					
FUNDING FOR DEFENSE R&D					
Funding Source	**1995**	**1996**	**1997**	**1998**	**Est. 1999**
In-House (self-funded)					
Customer					
Federal Government					
Other:					
Total Funding					

12. QUALITY STANDARDS: Is your firm certified to the following quality standard(s)? (Please place a check mark (✓) in the appropriate box below.)

ISO 9001	Yes ☐ No ☐ working toward ☐
Six Sigma	Yes ☐ No ☐ working toward ☐
Mil-Q- 9858A	Yes ☐ No ☐ working toward ☐
NASA Handbook 5300	Yes ☐ No ☐ working toward ☐
Other (specify:_____)	Yes ☐ No ☐ working toward ☐

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PART III: COMPETITIVENESS

1. COMPETITIVE PROSPECTS: How do you foresee the competitive prospects for your firm's U.S.-based CAD/PAD production operations over the next five years? (Please check (✓) appropriate box)

My firm's competitiveness should:

Improve greatly☐	Improve somewhat☐	Stay the same☐	Decline somewhat☐	Decline greatly☐

Please discuss the basis for your answer.

_____

_____

_____

_____

2. MERGERS AND ACQUISITIONS: What is the impact on your company of recent consolidations among competitors? Do you think it will significantly affect your ability to remain competitive?

_____

_____

_____

_____

3. AAR, BUREAU OF EXPLOSIVES REVIEWS: What impact do you foresee when Dr. Chang of the BOE no longer reviews and issues shipping classifications? What would you recommend as an alternate policy?

_____

_____

_____

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PART III: COMPETITIVENESS

GOVERNMENT POLICIES: With respect to CAD/PAD operations, what reasonable adjustments could be made to the following U.S. Government policies laws, and regulations that would moderate any competitive disadvantages that U.S. firms might face as a result of these policies, laws, and regulations? (Please attach additional sheets if you require additional space.)

a. Procurement:_____

_____

b. Small Business Set Asides:_____

_____

c. Small Business Innovative Research Program:_____

_____

d. Build to Print vs. Performance Specifications:_____

_____

e. Lot Acceptance Testing:_____

_____

f. Competitive Bidding:_____

_____

g. Government Competition:_____

_____

h. Export Controls:_____

_____

i. Environmental and Safety Regulations:_____

_____

j. Other:_____

_____

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

PART III: COMPETITIVENESS

5. EFFECTS OF IMPORTS ON CAD/PAD MANUFACTURING: How have imports of CADs and PADs (including those for your own use) positively and negatively affected your domestic manufacturing operations?

a. **Positive Effects:** (e.g. lower costs, expanded markets, improved efficiency, access to foreign markets, etc.) Please explain below:↓

b. **Negative Effects**: (e.g. product lines dropped, customers lost, retired capacity, laid-off work force, etc.). Please explain below.↓

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PART III: COMPETITIVENESS

6. SHORTAGES OF PURCHASED MATERIALS, PARTS AND COMPONENTS: If you experienced any shortages or supply interruptions of materials, parts and components or other essential supplies in the last five years that adversely affected, or that continue to adversely affect your U.S. manufacturing operations, please describe them below, and the actions you took to resolve them.

_____

_____

_____

_____

7. FOREIGN SOURCES: Please complete the following table for materials, parts, and manufacturing equipment used in your CAD/PAD operations from foreign sources.

CAD/PAD Item	Foreign Producer	Country of Origin	Reason Foreign Sourced*

*Reason Foreign Sourced:

a. No known domestic source, b. Domestic source inadequate, c. Supplement to domestic source, d. Lower cost, e. Quicker delivery, g. Better quality/reliability, h. Other (specify)

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PART IV: EFFECTIVENESS OF PREVIOUS RECOMMENDATIONS

EVALUATION OF PREVIOUS RECOMMENDATIONS (COMPANY PERSPECTIVE):
The 1995 CAD/PAD Assessment made several recommendations, such as improving communication between the CAD/PAD companies and the Naval Surface Warfare Center, Indian Head, Maryland, and with other Federal Agencies that impact the CAD/PAD business. Please review the questions in the left column and check (✓) the appropriate box on the right column with respect to your experience with the implementation of the 1995 CAD/PAD Assessment recommendations.

1. Have you experienced an improvement in your relations with NSWC, Indian Head?	Yes☐ no☐ do not know☐ not applicable☐
2. Has NSWC, Indian Head provided Defense Budget forecasts for CAD/PAD devices?	Yes☐ no☐ do not know☐ not applicable☐
3. Has NSWC, Indian Head briefed you on technical developments and new requirements?	Yes☐ no☐ do not know☐ not applicable☐
4. Has NSWC, Indian Head provided a forum for you to discuss and address grievances?	Yes☐ no☐ do not know☐ not applicable☐
5. Have you experienced an improvement in your relations with the Labor Dept.'s Office of Safety and Health Admin. (OSHA)?	Yes☐ no☐ do not know☐ not applicable☐
6. Have you experienced an improvement in your relations with the State Dept.'s Export Control Branch?	Yes☐ no☐ do not know☐ not applicable☐
7. Have you experienced an improvement in your relations with the Environmental Protection Agency (EPA)?	Yes☐ no☐ do not know☐ not applicable☐
8. Has NSWC, Indian Head implemented a policy of longer-term contracts for CAD/PAD devices?	Yes☐ no☐ do not know☐ not applicable☐
9. Has NSWC, Indian Head contracted out a larger portion of R&D to the CAD/PAD industry?	Yes☐ no☐ do not know☐ not applicable☐
10. Have NSWC, Indian Head and Hill AFB effectively consolidated operations to form a Joint Program Office?	Yes☐ no☐ do not know☐ not applicable☐
11. Has NSWC, Indian Head implemented other policies that improved the CAD/PAD procurement environment?	Yes☐ no☐ do not know☐ not applicable☐

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

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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. The U.S. Code, Title 18 (Crimes and Criminal Procedure), Section 1001, makes it 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.

_____ _____

Signature of Authorized Official Date

_____

Area Code/Telephone Number

_____

Type or Print Name and Title of Authorized Official

_____

Type or Print Name and Title of Person to Contact re this Report

_____

Area Code/Telephone Number

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

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GENERAL COMMENTS

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

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

Appendix C

Statistics

Total CAD/PAD Aerospace + Automotive

YEAR	Total Shipments	Defense Shipments	Commercial Shipments	Net Income	Total Employment	Production Workers	Capital Expenditures	Plant	Mach. & Equip	R&D	Defense R&D	Commercial R&D
1995	356,010	167,079	188,931	36,724	3,192	2,134	25,229	7,841	17,388	12,789	6,636	6,153
1996	396,623	173,727	222,896	53,611	3,512	2,400	50,860	9,569	41,291	19,424	5,340	14,084
1997	493,575	185,128	308,447	74,242	4,418	3,221	102,910	24,643	78,167	28,257	8,763	19,494
1998	577,459	215,022	362,437	25,444	4,252	2,998	63,555	34,781	28,764	24,160	3,429	20,731
1999	587,550	227,064	360,486	26,836	4,376	3,105	22,281	6,399	15,882	13,962	6,892	7,070
Totals:	2,411,217	968,020	1,443,197	216,857	19,748	13,858	264,835	83,233	181,492	98,592	31,060	67,532
Average:	482,243	193,604	288,639	43,371	3,950	2,772	52,967	16,647	36,298	19,718	6,212	13,506
99/95:	65.04%	35.90%	90.80%	-26.92%	37.08%	45.53%	-11.68%	-18.39%	-8.66%	9.17%	3.86%	14.90%

Total CAD/PAD Aerospace

1995	192,161	166,779	25,382	16,839	2,022	1,129	7,393	1,858	5,537	7,251	6,636	615
1996	198,263	173,492	24,771	16,762	2,062	1,136	8,251	1,833	6,418	6,748	5,340	1,408
1997	210,275	184,728	25,547	16,993	2,271	1,289	13,336	4,303	9,034	10,712	8,763	1,949
1998	236,727	210,322	26,405	20,769	2,322	1,297	10,270	4,826	5,433	5,502	3,429	2,073
1999	247,621	221,529	26,092	26,434	2,291	1,263	5,734	2,003	3,732	7,599	6,892	707
Totals:	1,085,047	956,850	128,197	97,796	10,968	6,113	44,985	14,823	30,152	37,813	31,060	6,753
Average:	217,009	191,370	25,639	19,559	2,194	1,223	8,997	2,965	6,030	7,563	6,212	1,351
99/95:	28.86%	32.83%	2.80%	56.98%	13.28%	11.92%	-22.44%	7.80%	-32.60%	4.80%	3.86%	14.90%

Total CAD/PAD Automotive

1995	163,849	300	163,549	19,885	1,170	1,005	17,836	5,983	11,851	5,538	0	5,538
1996	198,360	235	198,125	36,849	1,450	1,264	42,609	7,736	34,873	12,676	0	12,676
1997	283,300	400	282,900	57,249	2,146	1,932	89,574	20,340	69,133	17,544	0	17,544
1998	340,732	4,700	336,032	4,675	1,929	1,702	53,285	29,955	23,331	18,658	0	18,658
1999	339,929	5,535	334,394	403	2,085	1,842	16,547	4,396	12,150	6,363	0	6,363
Totals:	1,326,170	11,170	1,315,000	119,061	8,780	7,745	219,850	68,410	151,340	60,779	0	60,779
Average:	265,234	2,234	263,000	23,812	1,756	1,549	43,970	13,682	30,268	12,156	0	12,156
99/95:	107.46%	1745.00%	104.46%	-97.98%	78.23%	83.28%	-7.23%	-26.52%	2.52%	14.90%		14.90%

Total CAD/PAD Aerospace + Automotive

Times 1.4

YEAR	Total Shipments	Defense Shipments %	Commercial Shipments %	Net Income %	Total Employment	Production Workers %	Capital Expenditures% of Shipmts	Plant % of Total	Mach. & Equip % of Total	R&D % of Shipmts	Defense R&D % of Total	Commercial R&D % of Total
1995	356,010	46.93%	53.07%	10.32%	3,192	66.85%	7.09%	31.08%	68.92%	3.59%	51.89%	48.11%
1996	396,623	43.80%	56.20%	13.52%	3,512	68.35%	12.82%	18.81%	81.19%	4.90%	27.49%	72.51%
1997	493,575	37.51%	62.49%	15.04%	4,418	72.90%	20.85%	23.95%	75.96%	5.72%	31.01%	68.99%
1998	577,459	37.24%	62.76%	4.41%	4,252	70.53%	11.01%	54.73%	45.26%	4.18%	14.19%	85.81%
1999	587,550	38.65%	61.35%	4.57%	4,376	70.97%	3.79%	28.72%	71.28%	2.38%	49.36%	50.64%
Totals:		40.15%	59.85%	8.99%		70.17%	10.98%	31.43%	68.53%	4.09%	31.50%	68.50%

Total CAD/PAD Aerospace

1995	53.98%	86.79%	13.21%	8.76%	2,022	55.82%	3.85%	25.13%	74.89%	3.77%	91.51%	8.49%
1996	49.99%	87.51%	12.49%	8.45%	2,062	55.10%	4.16%	22.22%	77.78%	3.40%	79.13%	20.87%
1997	42.60%	87.85%	12.15%	8.08%	2,271	56.74%	6.34%	32.26%	67.74%	5.09%	81.80%	18.20%
1998	40.99%	88.85%	11.15%	8.77%	2,322	55.83%	4.34%	46.99%	52.90%	2.32%	62.32%	37.68%
1999	42.14%	89.46%	10.54%	10.68%	2,291	55.15%	2.32%	34.92%	65.08%	3.07%	90.70%	9.30%
Totals:	45.00%	88.19%	11.81%	9.01%		55.74%	4.15%	32.95%	67.03%	3.48%	82.14%	17.86%

Total CAD/PAD Automotive

												=90%
1995	46.02%	0.18%	99.82%	12.14%	1,170	85.91%	10.89%	33.55%	66.45%	3.38%	0	5,538
1996	50.01%	0.12%	99.88%	18.58%	1,450	87.20%	21.48%	18.15%	81.85%	6.39%	0	12,676
1997	57.40%	0.14%	99.86%	20.21%	2,146	90.00%	31.62%	22.71%	77.18%	6.19%	0	17,544
1998	59.01%	1.38%	98.62%	1.37%	1,929	88.22%	15.64%	56.22%	43.79%	5.48%	0	18,658
1999	57.86%	1.63%	98.37%	0.12%	2,085	88.35%	4.87%	26.57%	73.43%	1.87%	0	6,363
Totals:	55.00%	0.84%	99.16%	8.98%		88.21%	16.58%	31.12%	68.84%	4.58%		

	Total CAD/PAD Aerospace + Automotive		Total CAD/PAD Aerospace		Total CAD/PAD Automotive	
	Shipments per Employee	Shipments per Prod. Worker	Shipments per Employee	Shipments per Prod. Worker	Shipments per Employee	Shipments per Prod. Worker
1995	111,535	166,849	95,030	170,250	140,066	163,030
1996	112,947	165,243	96,160	174,527	136,819	156,900
1997	111,724	153,254	92,575	163,143	131,988	146,656
1998	135,825	192,590	101,932	182,589	176,627	200,208
1999	134,282	189,215	108,103	196,027	163,043	184,543
Average:	122,097	173,992	98,926	177,490	151,044	171,231
99/95:	20.39%	13.40%	13.76%	15.14%	16.40%	13.20%

ALL MANUFACTURING

Times 1.4

YEAR	Total Shipments	Defense Shipments	Commercial Shipments	Net Income	Total Employment	Production Workers	Capital Expenditures	Plant	Mach. & Equip	R&D	Defense R&D	Commercial R&D
1995	3,594,360				17,419,200	12,253,100	128,473	20,493	107,980			
1996	3,715,428				17,326,300	12,167,800	139,323	23,623	115,700			
1997	3,845,570				16,885,806	12,126,220	151,735	23,348	128,387			
1998	3,914,816				17,056,922	12,276,393	151,905	23,692	128,213			
Totals:	15,070,174				68,688,228	48,823,513	571,436	91,156	480,280			
Average:	3,767,544				17,172,057	12,205,878	142,859	22,789	120,070			
98/95:	8.92%				-2.08%	0.19%	18.24%	15.61%	18.74%			

	Shipments per Employee	Shipments per Prod. Wker	Production Workers %	Capital Expenditures% of Shipmts	Plant % of Total	Mach. & Equip % of Total	=90%
1995	206,345	293,343	70.34%	3.57%	15.95%	84.05%	
1996	214,439	305,349	70.23%	3.75%	16.96%	83.04%	
1997	227,740	317,129	71.81%	3.95%	15.39%	84.61%	
1998	229,515	318,890	71.97%	3.88%	15.60%	84.40%	
Total:	219,400	308,666	71.08%	3.79%	15.95%	84.05%	

EXPLOSIVES INDUSTRY

Times 1.4

YEAR	Total Shipments	Defense Shipments	Commercial Shipments	Net Income	Total Employment	Production Workers	Capital Expenditures	Plant	Mach. & Equip	R&D	Defense R&D	Commercial R&D
1995	1,134,300				8,800	6,300	52,700	12,500	40,300			
1996	1,276,000				8,500	6,100	46,500	11,600	34,900			
1997	1,447,274				8,972	6,648	44,209	8,491	35,718			
1998	1,247,881				8,410	6,039	56,374	12,938	43,438			
Totals:	5,105,455				34,682	25,087	199,783	45,529	154,356			
Average:	1,276,364				8,671	6,272	49,946	11,382	38,589			
98/95:	10.01%				-4.43%	-4.14%	6.97%	3.50%	7.79%			

	Shipments per Employee	Shipment per Prod. Wker	Production Workers %	Capital Expenditures% of Shipmts	Plant % of Total	Mach. & Equip % of Total	=90%
1995	128,898	180,048	71.59%	4.65%	23.72%	76.47%	
1996	150,118	209,180	71.76%	3.64%	24.95%	75.05%	
1997	161,310	217,701	74.10%	3.05%	19.21%	80.79%	
1998	148,381	206,637	71.81%	4.52%	22.95%	77.05%	
Total:	147,208	203,510	72.33%	3.91%	22.79%	77.26%	

Appendix D

List of Prior National Security Assessments

OFFICE OF STRATEGIC INDUSTRIES AND ECONOMIC SECURITY
STRATEGIC ANALYSIS DIVISION
PUBLICATIONS LIST

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, and other interested parties. The assessments are completed with the assistance of industry experts, both from the private sector and other government agencies.

Italics indicate forthcoming studies

PUBLICATION TITLE	*GPO ORDER #*	*PRICE*
Critical Technology Assessment: U.S. Biotechnology Industry - Winter 2003		
National Security of the U.S. Maritime Shipbuilders' Supplier Base – Fall 2002		
National Security of the U.S. Maritime Research & Education – Fall 2002		
National Security Assessment of the Air Delivery (Parachute) Industry – Spring 2002		
Critical Technology Assessment: Assistive Technology - Spring 2002		
Offsets in Defense Trade - Conducted under Section 309 of the Defense Production Act of 1950-January 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 Military Explosives & Components Sector –June 2001	003-009-00714-3	$22.00
National Security Assessment of the U.S. Shipbuilding and Repair Industry- May 2001	003-009-00719-4	$22.00
Statistical Handbook of the Ball and Roller Bearing Industry (Update) - June 2001	Available on SAD Website	
Offsets in Defense Trade - Conducted under Section 309 of the Defense Production Act of 1950-May 2001	003-009-00722-4	
National Security Assessment of the Cartridge and Propellant Actuated Device Industry: Update - Dec. 2000	003-009-00710-1	
The Effect on the National Security of Imports of Crude Oil and Refined Petroleum Products-November 1999	003-009-00723-2	
Offsets in Defense Trade - Conducted under Section 309 of the Defense Production Act of 1950-October 1999	003-009-00677-5	$9.50
Critical Technology Assessment: Optoelectronics - October 1998	003-009-00678-3	$7.00
Offsets in Defense Trade - Conducted under Section 309 of the Defense Production Act of 1950 - August 1998	003-009-00674-1	$7.50
National Security Assessment of the Emergency Aircraft Ejection Seat Sector - November 1997	003-009-00680-5	$10.00
Offsets in Defense Trade - Conducted under Section 309 of the Defense Production Act of 1950 - August 1997	003-009-00681-3	$9.50
Critical Technology Assessment of the U.S. Semiconductor Materials Industry - April 1997	003-009-00682-1	$1.50
Offsets in Defense Trade - Conducted under Section 309 of the Defense Production Act of 1950 - May 1996	003-009-00683-0	$9.50
National Security Assessment of the Cartridge and Propellant Actuated Device Industry - October 1995	003-009-00676-7	$14.00

The Effect of Imports of Crude Oil and Petroleum Products on the National Security - December 1994	003-009-00684-8	$10.00
Critical Technology Assessment of U.S. Artificial Intelligence - August 1994	003-009-00685-6	$19.00
Critical Technology Assessment of U.S. Superconductivity - April 1994	003-009-00706-2	$7.00
Critical Technology Assessment of U.S. Optoelectronics - February 1994	003-009-00686-4	$13.00
Critical Technology Assessment of U.S. Advanced Ceramics - December 1993	003-009-00687-2	$9.00
Critical Technology Assessment of U.S. Advanced Composites - December 1993	003-009-00688-1	$28.00
The Effect of Imports of Ceramic Semiconductor Packages on the National Security - August 1993	003-009-00689-9	$15.00
National Security Assessment of the U.S. Beryllium Industry - July 1993	003-009-00690-2	$9.00
National Security Assessment of the Antifriction Bearings Industry - February 1993	003-009-00691-1	$13.00
National Security Assessment of the U.S. Forging Industry - December 1992	003-009-00692-9	$10.00
The Effects of Imports of Gears and Gearing Products on the National Security - July 1992	003-009-00693-7	$15.00
Natl. Security Assessment of the Dom. and For. Subcontractor Base~3 US Navy Weapon Systems - March 1992	003-009-00695-3	$16.00
National Security Assessment of the U.S. Semiconductor Wafer Processing Equipment Industry - April 1991	003-009-00694-5	$9.00
National Security Assessment of the U.S. Robotics Industry - March 1991	003-009-00696-1	$13.00
National Security Assessment of the U.S. Gear Industry - January 1991	003-009-00697-0	$14.00
Effects of Imports of Uranium on the National Security - September 1989	003-009-00698-8	$6.50
Effects of Crude Oil and Refined Petroleum Product Imports on the National Security - January 1989	003-009-00699-6	$10.00
Effects of Imports of Plastic Injection Molding Machines on the National Security - January 1989	003-009-00700-3	$14.00
Effects of Imports of Anti-Friction Bearings on the National Security - July 1988	003-009-00701-1	$24.00
Investment Castings: A National Security Assessment - December 1987	003-009-00702-0	$13.00
Joint Logistics Commanders/DOC Precision Optics Study - June 1987	003-009-00703-8	$15.00
An Economic Assessment of the U.S. Industrial Fastener Industry - March 1987	003-009-00704-6	$6.50
Joint Logistics Commanders/DOC Bearing Study - June 1986	003-009-00705-4	$15.00

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