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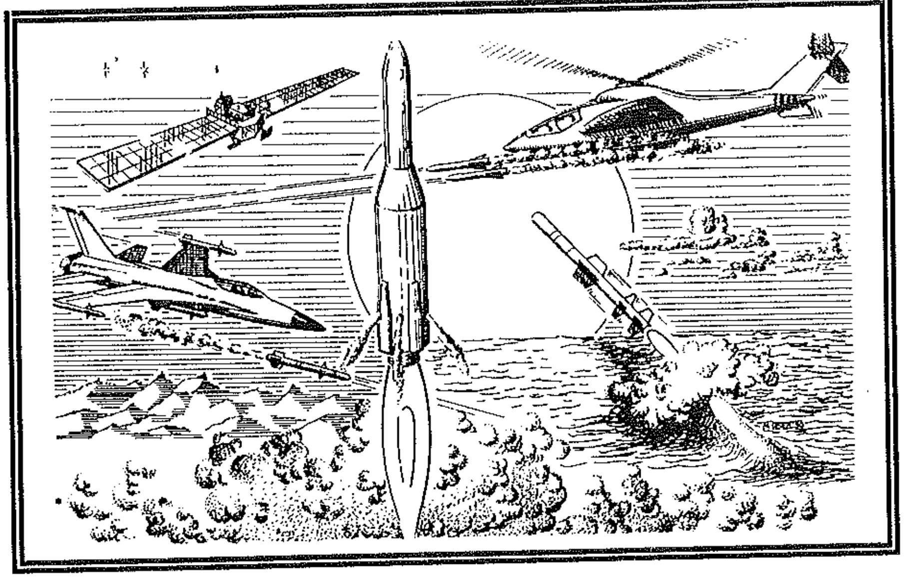
NATIONAL SECURITY ASSESSMENT OF THE CARTRIDGE & PROPELLANT ACTUATED DEVICE INDUSTRY

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



U.S. DEPARTMENT OF COMMERCE
BUREAU OF EXPORT ADMINISTRATION
OFFICE OF STRATEGIC INDUSTRIES AND ECONOMIC SECURITY

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National Security Assessment of the Cartridge & Propellant Actuated Device Industry

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

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Table of Contents

EXECUTIVE SUMMARY

Background

This assessment was initiated in December 1993, at the request of the U.S. Navy's Naval Surface Weapons Center (NSWC) at Indian Head, Maryland. The Navy's request to the U.S. Department of Commerce was prompted by concern that there may be deteriorating economic conditions in the Cartridge Actuated and Propellant Actuated Device (CAD/PAD) industry as a result of major defense expenditure reductions.

The Navy's CAD/PAD Program Office (within NSWC) at Indian Head serves as the lead service for CAD/PAD items for the Department of Defense. The Commerce Department's Office of Strategic Industries and Economic Security in the Bureau of Export Administration conducted a survey of CAD/PAD producers in 1994 to obtain needed information for the assessment. The survey was authorized under Section 705 of the Defense Production Act and related Executive Order 12656.

CAD/PADs are specialized work performing components used in many modern weapon systems. The cartridges use precisely measured propellant and explosive mixtures of varying compositions and burning characteristics that perform a wide variety of jobs within the weapon systems. They range in cost from about $1 to over $10,000 and may be purchased one at a time or by the thousands. The aerospace sector is the major user of CAD/PAD items. Many are used in life saving applications under emergency conditions. Major uses include aircrew ejection seats found on high speed aircraft, chaff and flare ejectors used as countermeasures to anti-aircraft missiles, bomb rack and missile releases, and missile fuel ignitors. Commercial use has increased rapidly, especially with the advent of automotive airbag initiators, which are being phased in as a mandatory Federal safety requirement. Other commercial uses have also increased. These include mining and oil field development devices, emergency cutting tools, and fire extinguisher actuators.

Market Trends

The total market for CAD/PAD products increased from $288 to $425 million between 1991-1995 (up 48%) as commercial shipments expanded rapidly. Commercial shipments rose from a small base of only $78 million in 1991, to $247 million in 1995, surpassing defense shipments by a substantial and growing margin. CAD/PAD defense shipments declined sharply in both total value and in overall market share for CAD/PAD products during the period. Reported defense shipments fell from $210 million in 1991 (based on incomplete data), representing 73 percent of the overall CAD/PAD market, to $178 million in 1995, only 42 percent of the market total.

Despite growth in the overall market, most CAD/PAD firms experienced hardship during this period and did not benefit from the rapidly expanding commercial markets. The industry went through a period of consolidation which saw the number of firms active in the sector drop by one-third. Three major departures from the defense market included DuPont, Dyno Nobel, and the ICI Corporations. Also, several major mergers and acquisitions resulted in the rationalization of operations.

The expansive growth of the automotive airbag market and, to a lesser extent, other commercial markets has not been shared by all firms. Most of the benefit has accrued to several larger firms. This is evidenced by increased market concentration levels of the top four firms in the industry, which rose from 54 to 64 percent of the total market over the five-year survey period (1991-1995). This share will probably continue to grow. Most smaller firms (under $5 million) and some mid-size firms (under $20 million) did not participate in the expanding commercial sector.

Smaller firms typically ship most if not all of their production into defense markets. They usually lack the resources to develop new commercial markets, which can be very risky and may take several years to yield a return. Nearly every smaller CAD/PAD firm reported their major bottleneck to increasing defense production was the subcontracting of raw materials and parts. This is related to a shrinking number of sub-vendors willing or able to supply defense parts, increasingly smaller order quantities, lack of market

power, and the high relative overhead costs associated with finding alternative qualified vendors. The end results are delivery delays and higher costs for defense.

Another market trend related to reduced defense expenditures is increased foreign sourcing. Most of the foreign sourcing is for materials that go into explosive mixtures. These materials were most often imported due to a lack of a domestic source (i.e., foreign dependencies). In addition to materials, selected parts of CAD/PAD assemblies and machinery used to produce CAD/PADs were reported as imported. With a few exceptions, these items were imported because of lower cost, better quality, or quicker delivery considerations. The foreign dependencies for rare items were also cited. These items are generally made in such small quantities that the producer requires a global market to obtain least-cost production levels.

Much of the foreign dependency/sourcing is from NATO allies (UK, Germany, France, Canada) or Japan, which are considered secure sources. While foreign sourcing increases the risk of supply interruption in wartime, in peacetime it may offer an acceptable lower cost option. Some firms have increased inventories of foreign sourced items, at least in one case, for up to a three year supply. The Navy's Indian Head CAD/PAD group reported it was reestablishing capabilities to eliminate some foreign dependencies.

The actual decline in the CAD/PAD defense market is unknown. Estimates were established by reviewing aggregate procurement outlays, which began their fall in the late 1980s, and trends in procurement authorizations for aerospace vehicles. Total Defense procurement authorizations fell by two-thirds from FY1985 to FY1995 ($135-45 billion). Procurement outlays (i.e., actual spending) peaked in FY1987 ($106 billion) and then fell by almost half by FY1995 ($54 billion). Declines in aircraft, helicopters, and missiles procurement authorizations has been even more dramatic. For example, aircraft authorizations fell from 337 in 1990, to only 55 in 1995 (down over 80 percent). Helicopters dropped from 243 to 72 (down over 70 percent). And, missile authorizations were down from 24,000 to 2,500 (nearly 90 percent). These declines perhaps overstate the impact on CAD/PADs because of the ever greater sophistication of new or upgraded

aerospace vehicles. The latest models use much greater numbers of CAD/PADs per air vehicle than their older, but more numerous counterparts.

Based on this aggregate data and statements from industry representatives, in the last decade the CAD/PAD defense market fell an estimated 50 percent. Most of the decline occurred following 1991, during which time overall defense outlays fell most sharply. Defense budget cuts have undoubtedly had a negative impact on the CAD/PAD industry, just as they have on other defense industries. Only three respondents to the CAD/PAD survey reported defense cuts had no adverse impact on their operations, while 26 firms (more than three-fourths of the respondents) reported a significant to major adverse impact.

Industry Performance

While shipments rose 48 percent to $425 million, employment in the CAD/PAD sector increased 8 percent between 1991-1995, up from 3,758 to 4,040, accompanied by significant increases in sales per employee (productivity). The share of production workers to total employment increased from 53 to 61 percent. However, declines occurred in the professional occupations, although small increases were reported in 1995 over 1994 totals. Technicians and technical services personnel fell from 544 to 476, while scientists and engineers fell from 436 to 414.

Capital investment outlays averaged about 4.4 percent of sales for the five years (1991-1995). Total investment for the period was over $78 million. Investment in defense operations was only about 20 percent of total investment outlays. This amounted to only 1.7 percent of (shrinking) defense sales. In contrast, investment in expanding commercial markets was more than 7.6 cents per commercial sales dollar. Most of the investment outlays were to add new capability, upgrade technology, and improve productivity. A large portion was also used to add new capacity for producing airbag initiators.

Research and development (R&D) outlays totaled more than $70 million for the five

years. Of the total, 74 percent ($52 million) was directed into defense related activities. Indian Head contributed $22 million of this total. Of the $48 million in R&D conducted by private firms (2.7 percent of sales), 47 percent was reported as financed by the Federal Government, mostly by the Department of Defense. Additional sums came from the National Aeronautics and Space Administration and Department of Energy. Defense projects represented about 62 percent of privately conducted R&D. The top 3 firms conducted 55 percent of the R&D. Ten firms conducted over $1 million in commercially related R&D.

Profitability, based on the five-year results of 25 firms, averaged an estimated 6.6 percent. This compares favorably with average profits for all manufacturing of 3.7 percent, but was exceeded by the general chemical industrial sector. Industry profits tumbled to their lowest level in 1994 at less than 2 percent, which coincided with the lowest level of defense shipments. Seven firms reported losses that year.

Several factors may be at work to reduce future profit levels. For example, several firms commented that competition in the CAD/PAD sector is sharper now that the industry has consolidated; the remaining firms are leaner and more aggressive. Also, commercial markets in general tend to be stingy. The motor vehicle companies are forcing all of their suppliers to reduce prices and improve quality. This has already affected the airbag companies by driving costs and prices down with increased production volumes. Moreover, the smaller defense market has become more competitive.

Financial analysis of the CAD/PAD sector was made difficult by incomplete data. Only 13 firms provided balance sheet items (total assets, current assets, and current liabilities) for the CAD/PAD portions of their business. For this group the 1993 current ratio (current assets/current liabilities) was 3.44 (all manufacturing was 1.4); the current to total asset ratio was .62; and the asset turnover ratio (sales/total assets) was 1.3 (all manufacturing was 1.1). These ratios indicate the CAD/PAD sector taken as a whole carries large inventories, has relatively high variable costs, and is labor-intensive. The larger CAD/PAD firms exhibit almost the opposite of these characteristics. With higher fixed costs, larger firms are more vulnerable to business fluctuations.

Competitive Considerations

Competition in the CAD/PAD industry has intensified, in many cases driving prices down near or below costs. The shrinking defense market has forced some firms to terminate operations, and nearly all others to consolidate production. The wave of mergers and acquisitions that occurred in the last decade allowed the industry to both rationalize assets and position itself in emerging commercial markets. Stronger firms that acquired or merged with former competitors managed to maintain, and in several cases, actually increase market share.

While the overall number of competitors has been reduced, this is offset by the increased aggressiveness of the remaining businesses. Opportunities for market share are available to the supplier that places emphasis on increased product performance and reduced cost. More than 40 percent of the firms surveyed believe their competitive prospects will improve in the next five years. However, 31 percent are pessimistic about their future prospects.

Foreign competition is not a major problem in defense markets because of the pre-production qualification tests, transportation costs, and specialty nature of the product. As for airbag initiators and other commercial products, U.S. firms have taken the lead and currently export far more than what is imported.

In February of 1995, CAD/PAD survey participants received an information package from BXA to make them aware of export opportunities for current CAD/PAD products. A brochure was enclosed entitled "Export Programs: A Business Directory of U.S. Government Services" as well as an order form for another BXA publication entitled "Pacific Rim Diversification and Defense Market Assessment: A Comprehensive Guide for Entry into Overseas Markets" (a European guide is also available). The letter urged the survey participants to take advantage of the current Government programs designed to assist manufacturers in developing and expanding export market opportunities.

Other Issues

Several non-economic issues also adversely impact the CAD/PAD industry. These predominantly involve government regulations concerning the environment, worker safety, and the transport of hazardous materials, export barriers, and small business set-asides. Another issue is government competition with private industry.

Environmental and safety (OSHA) regulations: About 60 percent of the respondents cited environmental and worker safety regulations as contributing to increased operating costs. Because the market is shrinking, these CAD/PAD firms have difficulty passing on increased operating costs. The most commonly mentioned areas of concern were the disposal of hazardous waste, which now must be off-site, and prohibitions on ozone-depleting substances. As for worker safety, the biggest cost is ventilation systems that remove toxic fumes from the shop floor.

Classification of shipping: Nearly half the respondents described a lengthy and burdensome approval process to transport explosives for non-government contracts. CAD/PAD manufacturers must obtain a recommendation for classification from the American Association of Railroads, Bureau of Explosives (a private industry association), or from the Interior Department's Bureau of Mines. The recommendation is forwarded to the Department of Transportation, Office of Hazardous Materials, which issues a "letter of competent authority" to the manufacturer, who may then ship the product.

CAD/PAD firms reported the Bureau of Explosives lacks the resources to provide this service in a timely fashion. In extreme cases it has taken about a year. The Bureau of Mines typically provides the service in 1-3 months, but the fee is often excessive, ranging up to $450 to over $6,000, and the schedule unpredictable and insensitive to firm's planning. The Office of Hazardous Materials is currently issuing letters of competent authority to shippers in about one week. The Agency 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.

Export Market Issues: Nearly half the respondents also commented on barriers to exports. CAD/PAD products are controlled under authority of the Arms Export Control Act administered by the U.S. Department of State. CAD/PAD manufacturers must register with State and apply for an export license when shipping to foreign destinations. Several CAD/PAD firms mentioned that the license review process is inordinately cumbersome and time consuming, and needs simplification. Licenses typically take 3 months to a year to obtain. Export opportunities have been lost because of delays or denials of export licenses. It was suggested that restrictions should be removed where competitors in NATO member countries can export the same product with few or no restrictions.

Export barriers also come in the form of foreign government subsidies. It was mentioned that Canadian and Israeli competitors receive subsidies on certain items from their governments enabling them to bid below U.S. producers. It was also reported that a Belgian competitor was able to eliminate international shipping expenses by utilizing government supplied military air transports.

The Small Business Set-Asides: All purchases under $25,000 are automatically set aside for small business. Contracts over $25,000 may also be set aside for small firms when two or more bids are likely to be received from responsible small businesses. In addition, section 8(a) of the Small Business Act permits small, socially and economically disadvantaged firms to receive non-competitive Federal contracts.

Problems arise when some small businesses receive a certificate of competency from the Small Business Administration without possessing sufficient capability to fulfill CAD/PAD contracts. Certification allows the firm to compete for and win CAD/PAD bids even if that company is found unqualified by DoD. The concern is greatly magnified because aircraft safety and human lives often depend on the performance of CAD/PAD products. CAD/PAD quality control must be of the highest level. Also, the taxpayer may ultimately be charged up to three times the fair value for these CAD/PAD items, while defense requirements for the items are delayed and sometimes compromised.

Several of the survey participants indicated the set-asides encourage non-competitive

firms to remain in business, thereby stifling competition. Also, due to increased competition for DoD contracts, legitimate companies are forced to bid too low to provide sufficient profit margin. Many former defense suppliers are now focusing on commercial business because they can no longer afford to maintain the high quality standards and reduce profit margins in order to compete for defense contracts. The procurement regulations compel DoD to purchase CAD/PAD items on a lowest bid only basis. Several firms suggested "best value" procurement should be practiced where high quality at a fair market price are the qualifying factors.

Government competition with industry: This issue has become more contentious to the parties involved with the decline in defense requirements. Twenty-five of the 35 CAD/PAD survey respondents reported the Federal Government was competing with them in at least one of three areas. These three areas include production, product acceptance testing, and research and development. Industry claims all three areas could be accomplished faster and less expensively by private firms. Indian Head maintains that a "core" DoD CAD/PAD capability has inherent benefits to the national defense. It ensures: 1) a warm base, 2) retention of skills and the technical knowledge to produce and handle CAD/PAD items, and 3) provides insight into the production processes and technology of CAD/PADs that helps channel scarce research money to where it is needed.

The Government Accounting Office (GAO) investigated claims of unfair government competition in 1993, under Office of Management and Budget (OMB) Circular No. A-76. This circular established Federal policy regarding the performance of commercial activities by government entities. The circular also sets forth conditions where government performance of a commercial activity is authorized. These exceptions include: 1) the manufacture of mission essential items; 2) acceptance testing; 3) depot maintenance; and 4) research and development.

GAO did not find "unfair" competition by the Government. However, GAO recognized that duplication of production facilities is an added cost to the taxpayer. In view of this fact, GAO emphasized the need for ongoing evaluation of the necessity for maintaining core capabilities and the cost of facility duplication.

Between 1991 and 1995 the Government operation at Indian Head reduced CAD/PAD employment from 379 to 276 (down 27%), while production fell steadily from $2.9 million to $1.5 million. Indian Head production in 1995 accounted for less than 1 percent of total defense CAD/PAD production.

In separate conversations with OMB, BXA analysts sought to further clarify the exceptions criteria cited by GAO. An OMB representative reported Circular A-76 is a "policy statement" by the Office of the President of the United States that seeks to achieve the lowest cost for the taxpayer in government procurement. It is not a legal requirement backed by legislation. In brief, the policy refers to products uniquely for

defense that: 1) cannot be contracted to a private firm(s), or 2) that can be produced less expensively in-house by the Government than by a private firm.

Recommendations

The issues of environment, worker safety, small business set-asides, classification of shipping, exporting, and government competition with industry require more discussion and cooperation between various government agencies, and input from private CAD/PAD firms. Indian Head's CAD/PAD program officials have the strongest interest in the long-term health and survival of the CAD/PAD industry; they are the obvious candidate to spearhead initiatives in these areas.

Indian Head should organize regular meetings, perhaps on a quarterly or semi-annual basis, to discuss these and other issues in an open forum. The meetings could also provide an opportunity to provide the CAD/PAD industry with multi-year forecasts of defense requirements, and brief the industry on technical developments, new requirements, and other matters. Representatives from other government agencies could attend these meetings in give and take sessions to educate the industry on new matters, invite industry input, and seek ways to resolve problems.

Indian Head can also do several things unilaterally. For example, it could institute

longer-term procurement commitments that would help induce cost-saving investment, streamline production, improve quality, reduce administrative overburden, and promote on-time delivery. Longer-term contacts would particularly benefit smaller CAD/PAD companies in terms of market strength to bargain with their subvendors, investment, and the retention of skilled employees.

Additionally, Indian Head should consider contracting out a greater portion of R&D to help the CAD/PAD industry retain skilled labor, and further promote dual-use technologies. Lastly, Indian Head could establish commercial transportation classification capability at Indian Head as agreed at a meeting with the Department of Transportation and Department of Interior in 1994. Indian Head already has expertise in CAD/PAD products and could reduce the lengthy process time by offering shippers an alternative testing site.

BXA's Office of Strategic Industries and Economic Security should provide the list of CAD/PAD industry subvendors to Indian Head and send the subvendors the BXA *Competitive Enhancement and Defense Diversification Needs Assessment* survey. To encourage defense diversification efforts, BXA is conducting a needs assessment of the defense sub-contractor base. Firms are being surveyed by BXA to determine what government services will be most useful to them in diversifying their operations. The information collected will be used to direct U.S. Government defense diversification resources. BXA has assembled an interagency team of representatives to respond to requests for assistance. All CAD/PAD survey participants were given the opportunity to request assistance through the BXA Needs Assistance Program. Most firms are unaware of existing government diversification programs.

BXA is continuing to identify and contact defense sub-contractor groups. In July of 1995, BXA met with a representative from the National Institute of Justice/Office of Law Enforcement Technology Commercialization to discuss defense diversification opportunities for CAD/PAD manufacturers in the area of law enforcement product development. The National Law Enforcement Technology Center identified four classes of law enforcement products that could use cartridge-actuated and propellent-actuated devices: launchers, diversionary devices (i.e., smoke signal grenades), large-area

dispensers for chemical incapacitating agents, and inflatable boats. BXA will be contacting CAD/PAD suppliers to inform them of the defense diversification opportunities in the area of law enforcement products. As part of this effort, BXA will be providing a list of law enforcement products currently under development so CAD/PAD manufacturers can make direct contact with potential partners.

The U.S. Department of Transportation could implement a few changes to help alleviate the concerns of the private sector, particularly of smaller companies, about the delays and cost of obtaining a letter of competent authority for shipment of commercial products. BXA makes the following suggestions: 1. Institute a graduated payments system based on manufacturing firm's gross revenues, or allow smaller firms the option to pay later; 2. Computerize record keeping at all levels of the classification process, and expand use of classification by analogy to all classifications on file; 3. Establish education program, possibly on video cassette, that assists applicants, particularly new ones, in determining the required documentation requirements and how to avoid delays in classification processing. An expert system might also be created to assist companies with documentation and legal requirements.

1. Introduction

1.1 Background

This national security assessment was initiated in December 1993, at the request of the Cartridge Actuated Device/Propellant Actuated Device Program Office of the Naval Surface Warfare Center located at Indian Head, Maryland. Cartridge actuated devices (CADs) and propellant actuated devices (PADs) are key military components that use propellant and explosive mixtures as energy sources. The components are used to perform a variety of specialized work functions. Among these functions are the ejection of aircrews from aircraft in emergency situations, initiation of flares or chaff as countermeasures to incoming anti-aircraft missiles, and activation of sonabouys dropped from aircraft into the ocean to conduct anti-submarine warfare.

The Navy's CAD/PAD Program Office serves as the lead service for CAD/PADs for the Department of Defense. The Navy's request to the U.S. Department of Commerce was prompted by deteriorating economic conditions in the CAD/PAD industry that resulted from major defense expenditure reductions. Other factors, such as environmental, safety, and other regulatory issues, were also a concern to the continued health and competitiveness of the industry.

The Commerce Department's Bureau of Export Administration is delegated authority under Section 705 of the Defense Production Act (DPA) of 1950, as amended, 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 Strategic Analysis Division of SIES performed this assessment under the Industrial Capabilities Program. The Navy and the other services have an established history of cooperative study efforts with BXA that resulted in a number of national security assessments. Past assessments included the ball and roller bearing, gears, forgings, and investment castings industries. (A complete list of BXA assessments is included in Appendix F.)

The Navy's CAD/PAD Program at Indian Head operates within the framework of the Joint Ordnance Commanders Group (JOCG). The JOCG was chartered by the Department of Defense, Joint Logistics Commanders to review activities involving development, production and support of ordnance systems, subsystems and components. The JOCG functions are to establish

organizational structures, provide policy direction, approve annual plans, and approve studies and joint ordnance policies and procedures. The JOCG created a CAD/PAD Ad Hoc Subgroup to coordinate the Army, Navy and Air Force CAD/PAD programs to avoid duplication and to exchange technology and development information. The CAD/PAD Ad Hoc Subgroup consists of representatives from six organizations which include:

1) The Indian Head Division of the Naval Surface Warfare Center
2) The Program Executive Officer for Tactical Weapons and Program Manager-Air, Naval Air Systems Command
3) Air Force Materiel Command and Air Logistics Command
4) Ogden Air Logistics Center
5) Army Industrial Operations Command
6) Army Aviation and Troop Command

The goal of this assessment, as expressed by the CAD/PAD group at Indian Head, was to analyze the long-term health and competitiveness of the CAD/PAD industry, identify factors affecting the industry, and develop recommendations to ensure the continued ability of the industry to support defense missions and programs. Based on this overall goal, BXA developed the following objectives:

- Provide an economic profile of the U.S. CAD/PAD industry.

- Identify potential shortfalls in the defense production capability of the industry that resulted from defense budget cutbacks or other causes.

- Evaluate the effects of mergers, acquisitions, and consolidations that have occurred in the sector in the last decade at an unusually high level.

- Determine the influence that emerging commercial markets, such as automotive airbags, could have on military CAD/PAD capabilities.

- Review the impacts of goverment environmental and safety regulations.

- Assess the impact of critical foreign relationships and dependencies.

- Propose specific recommendations and actions to eliminate or reduce potential shortfalls and other problems in this industry.

1.2 Methodology and Scope

At the outset of this national security assessment, analysts obtained written information and conducted interviews with persons in both public and private organizations involved in various aspects of the CAD/PAD industry. After a number of meetings with Navy representatives, a survey questionnaire was designed and field tested 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).

Upon OMB approval, the questionnaire was sent to 60 companies believed to be involved in the manufacture of CAD/PADs in the United States. Of the 60 companies, 35 completed the survey. A partially completed survey was also submitted voluntarily by a foreign firm. A majority of the 25 companies that did not complete the survey had either dropped the product line; gone out of business; were acquired by other firms; or, had not produced any CAD/PAD items since 1990. In addition to these private firms, the survey was also completed by Navy CAD/PAD Program representatives at Indian Head, Maryland, covering their extensive on-site operations.

Information gathered from the survey was aggregated into a data base 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 issues. Analysts from BXA also interviewed various government officials in the Departments of Defense, State, Transportation, Interior, and Labor, plus the Environmental Protection Agency and General Accounting Office. Plant site visits to facilities in Arizona, California, Colorado and Utah, and to the Indian Head facility in Maryland were also undertaken by BXA staff. Additional telephone contacts were made with company officials to clarify survey responses and/or gain further insight into the industry. Many companies provided annual reports, product brochures, and other printed materials that were also useful in this analysis.

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 emerging commercial markets. The next section discusses production capabilities, bottlenecks to ramping-up to production capacity, foreign sourcing, and ongoing defense-to-commercial conversion efforts. Then, shipment trends are reviewed and analyzed with regard to defense, commercial, and international markets during the 1991-1995 period. This is followed by industry performance measures in terms of employment, capital expenditures, research and development, profitability, and financial indicators. Next, the competitiveness of the industry is assessed, which includes a compilation of the company views of their own competitive prospects, industry consolidation, trade issues, and company strategies to compete in the future. Following the competitiveness section, selected factors that affect the CAD/PAD industry are outlined. These factors include defense budget cuts, environmental and safety regulations, Government competition with industry, and small business set-asides. Findings and recommendations are presented at the end of the report.

2. Industry and Product Descriptions

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 the old method (i.e., jumping) extremely hazardous. Designers developed the ejection seat to meet this new problem. The ejection seat made liberal use of precision engineered propellants and explosives that literally blew an aircraft's crew members and their seats away from the aircraft in an emergency and automatically deployed their parachutes. While the ejection seat remained an important use for CAD/PADs, in subsequent years applications of the underlying technology expanded to many other areas as well (e.g., the escape system on space shuttle), mostly in the aerospace sector.

Defense business remained the key driver that stimulated development of a private CAD/PAD industry up until recent years. The expanding military requirement 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 and performance, and begin development of commercial markets. Today, the experience, technology, and know-how of the industry represents a critical asset to the national defense, and is of growing importance in automotive safety (airbags), oil production (well perforating guns), the mining industry (detonating cord), fire and rescue operations (fire extinguisher actuators), and other commercial markets (aircraft evacuation slides).

2.1 Industry Description

2.1.1 The Industry - The U.S. CAD/PAD industry is small. In 1995, annual shipments are predicted to reach $425 million and employment over 4,000. Growth in commercial markets, led by airbag initiators, is expected to accelerate annual sales above $500 million by 1996 or 1997. While as many as 60 firms participated in the industry in the recent past, the industry is currently comprised of about 40 firms located in 19 states. States with the most production include California, Arizona, Colorado, and New York. In 1993, California led all other states in shipments with almost 30 percent of the industry total. The U.S. Navy's Indian Head Naval

Surface Warfare Center, about 35 miles south of Washington, D.C. in Maryland, is also an important player in most aspects of the industry, including the production of CAD/PADs. The Center has capabilities to produce most CAD/PAD items, and has integrated research and development and testing facilities.

CAD/PADs do not fit neatly into the Standard Industrial Classification (SIC) system of the United States. The 4-digit SIC codes, which are used to group all U.S. business establishments into any of about 850 distinct industries, do not provide for CAD/PADs specifically. Of 459 separate codes that apply exclusively to manufacturing industries, CAD/PAD producers can be found in more than a dozen classifications. Moreover, for many survey respondents, CAD/PADs are not the primary product produced at their establishments. For example, several producers make ordnance items that are classified in SIC 3483 - Ammunition, except for Small Arms (3 plants), or SIC 3489 - Ordnance and Accessories (8 plants). Other firms, with strong metal working capabilities, are classified in SIC 3451 - Screw Machine Products (2 plants) and SIC 3463 - Nonferrous Forgings (1 plant). Several are also found in SIC 3728 - Aircraft Parts (4 plants) and SIC 3764 - Missile Parts (2 plants). Two of the airbag initiator companies are classified in SIC 3714 - Automotive Parts. Most CAD/PAD producers blend at least some of their own explosives. A few do this as their primary activity and are classified in SIC 2892 - Explosives (3 plants).

It is debatable whether CAD/PADs are truly ordnance items. The answer, based on specific applications, appears to be sometimes "yes" and sometimes "no." In the classical definition ordnance applied to cannon and artillery and their ammunition. Today, ordnance includes weapon systems of all kinds and their equipment and ammunition. CAD/PADs are often used as subcomponents of safety devices. They are by that account roughly analogous to parachutes or chest protectors, neither of which are ordnance items. They are also manufactured to a higher quality and precision than ammunition because human lives often depend on their performance. However, CAD/PADs are also used to kick-out missile fins and release bombs from racks where they play an integral role in the performance of the weapon system. These applications, on the other hand, are more characteristic of ordnance items.

2.1.2 Structural Characteristics - Historically, the CAD/PAD market has been highly fragmented by an abundance of part numbers (over 3,000) ordered mostly in small volumes. This gave and continues to give smaller firms with specialized talent an opportunity to compete in niche markets. The growth of automotive airbags and other commercial markets coupled with

declines in defense requirements have changed these dynamics. The CAD/PAD industry is now becoming more concentrated, with several major firms (over $20 million in annual sales) gaining an increasing market share of a larger overall market. In 1991, the top four companies accounted for 54 percent of total industry shipments. By 1995, the top four are estimated to account for more than 64 percent of shipments.

The defense market remains less concentrated than the commercial market. In 1993, shipments by the four largest suppliers to defense totaled $85 of $191 million, or about 45 percent. (Indian Head NSWC produced and shipped only about $2 million of the CAD/PAD total in 1993, and was not one of the top four shippers.) The defense business is rounded out by a few mid-size companies and many smaller firms (under $5 million). The lower concentration level in defense is due to the specialized nature of the market. Small firms continue to play an important, if not critical, role in supplying product to defense, usually in small or odd lots. With much less overhead than larger firms, small firms are more competitive in these niches. Smaller firms are also relatively more active in defense markets than in commercial markets. For example, 12 (mostly small) of 34 respondents (one of 35 firms did not report shipments) shipped 100 percent of their production to the military in both 1993 and 1994, and five other firms shipped more than 90 percent. The 12 relying totally on defense markets shipped a total of $57 million in 1993, averaging less than $5 million per firm.

The following table shows the number of CAD/PAD firms by range of total sales. In 1993, the average firm's sales were $9.8 million. This, however, is heavily weighted by larger firms. The median firm had sales of $5 million.

Number of Firms by Range of Total Sales, 1993

Sales Range of CAD/PAD Products	Number of Firms
less than $1 million	9
over $1 to $5 million	8
over $5 to $10 million	7
over $10 to $20 million	5
over $20 million	5

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

Indian Head NSWC manages about 40 percent of total military CAD/PAD requirements, with Hill Air Force Base in Ogden, Utah and prime contractors such as Hughes, Raytheon, and McDonnell Douglas accounting for the majority of the rest. Most of Hill AFB's purchases are for replacement component needs. Other military activities, such as Kelly Air Force Base near San Antonio, Texas also purchase small amounts of CAD/PADs. For CAD/PAD items under its management Indian Head manufactures and reworks about 10 percent; the other 90 percent of CAD/PADs are purchased from private industry.

Indian Head and Hill AFB are exploring further consolidation through a Joint Program Office. Indian Head is focused primarily on man-rated (life-saving) CAD/PADs, particularly aircrew ejection seats, which alone constitute about 80 percent of the value of Indian Head's managed items. Indian Head also maintains significant propellant and explosive capabilities, some of which are provided to private firms for fulfilling defense contracts. The facility also conducts tests and quality evaluation and undertakes development and product improvements. Indian Head determines the Navy's systems requirements. These are communicated to the Navy's Ship Parts Control Center in Mechanicsburg, Pennsylvania, which then contracts with industry (and occasionally with Indian Head) to procure the items. In Fiscal Year 1993, the CAD/PAD program at Indian Head totaled about $70 million.

2.2 Major Products and End Markets

To summarize, the development of explosives reportedly began in China in the 8th or 9th century. In Europe, it began with the use of black powder in the 1200s. In the 1800s, explosives technology expanded rapidly with the nitration of many compounds. Development was intensified in World Wars I and II with many new compositions and military applications. After World War II, greater strides were made in explosives technology, made possible by the advent of electronic instrumentation, high speed photography, computers, and the financial support of governments in military and space research.

Propellants and explosives are chemical compounds or mixtures of compounds that rapidly produce large volumes of hot gases when properly initiated. 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 available energy stored compactly and readily available to perform a variety of work functions. Propellants are used when the energy required is released in milliseconds (in guns), or 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.

2.2.1 CAD/PAD Products - 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 within the weapon systems. They range in cost from about $1 to over $10,000, and may be purchased one at a time or by the many thousands.

The aerospace sector is the main user of CAD/PAD items. Over time the number and sophistication of CAD/PAD devices used in air vehicles has increased. The A-7, which is now out of production, used less than 20 CAD/PADs. The newer F-14 uses over 200 items, and the B-1 bomber, over 600 CAD/PAD items. In the future it appears U.S. defense forces will have far fewer but more sophisticated aircraft and helicopters. Related to this issue, a spokesman at Indian Head predicted that the downtrend in defense procurement has stabilized, and CAD/PADs may even experience moderate growth in the future with newer, more sophisticated, and smarter weapon systems requiring more items.

CAD/PAD items include, but is not limited to, detonators, detonating and thin layer explosive cords, percussion primers, electric ignition elements, laser initiation, pyrotechnic delays, thermal elements, rocket catapults, underseat rocket motors, thrusters, cutters, and water-activated pyrotechnic devices.

Several types and designs of CAD/PADs are used, sometimes alone or with many others to perform a more complex task. CADs are used, for example, to supply power 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; cut cargo parachute reefing lines in airdrop resupply; and provide staging operations for unmanned aerial vehicles, like opening and closing fuel valves, deploying and detaching parachutes, and inflating flotation bags, slides or landing cushions.

The importance of CAD/PADs to the military was demonstrated during Desert Shield/Storm operations in the Persian Gulf in the early 1990s. For example, during operations in the Persian Gulf, the Harrier carrier-based aircraft were grounded for about six days for lack of chaff releasing impulse cartridges. Chaff is used as a countermeasure against radar-directed missiles. With supplies of these CAD items at or near exhaustion, the military canvassed known vendors around the country for available supplies. A producer of the needed items named Technical Ordnance, located in St. Bonifacius, Minnesota, was one of those contacted. As a normal business practice, Technical Ordnance had produced and maintained an extra 15-20,000 of the needed devices for its own inventory. The Defense Department flew a cargo plane from the Persian Gulf area to a nearby airport, loaded the devices and flew them back to the Gulf. Had a new order been necessary, it may have taken as long as three months to replenish the supply of impulse cartridges.

2.2.2 Emerging Commercial Markets - Commercial markets are growing in several areas. These include law enforcement, fire and rescue, mining, oil field development, aerospace, and automotive safety. By far the largest emerging commercial market for cartridge actuators is automotive airbags. This market was given a major boost by passage of the 1991 Intermodal Surface Transportation Efficiency Act. Section 208 of the Act stipulates that by the end of this decade all new passenger vehicles sold in the United States are to be equipped with driver and front seat passenger airbags. The requirement will be phased in rapidly beginning with the 1997 model year, which begins in September 1996. The Act mandates that inflatable restraint systems must be installed in:

- ninety-five percent of the 1997 model passenger vehicles sold in the United States;
- all 1998 model passenger vehicles and 80 percent of the vans and pickups sold in the U.S.
- All 1999 vehicles (passenger cars, vans and pickups)

The market potential in the United States for two frontal airbags may be over $200 million per year. That estimate is based on annual sales of about 15 million vehicles in the United States

with 30 million airbag initiators priced at $6-7 per unit. However, this probably understates the ultimate market potential for these products. For example, airbags set off by minor traffic accidents have generated an expanding replacement market. Also, in addition to frontal airbags, side-impact airbags have proven their effectiveness in providing enhanced passenger and driver safety on American highways. Side impact airbags are now offered as optional equipment on several European luxury imports. American companies are expected to follow. Although side airbags are not (yet) a safety requirement mandated by law, it is believed that consumer demand will make them a popular safety option on automobiles.

According to the National Highway Traffic Safety Administration, side-impact accidents accounted for 60 percent as many fatalities and almost two-thirds as many injuries as frontal accidents in 1993.

Impact Point	Deaths	Injuries
Front	11,594	1,011,000
Left/Right Side	6,922	666,000

Source: Automotive News, March 20, 1995 (page 22)

The Volvo Company, a Swedish automaker, has already made side airbags standard equipment on its most popular sedan for the 1996 model year. Five additional European auto companies along with one Japanese and one American automaker also intend to incorporate this safety feature into their new car production within the next several years.

One CAD/PAD company reported there could be as many as 15-20 airbags and seat-belt tensioners in cars of the future. This may be overly optimistic, but the potential is there. In 1995, 8 of the surveyed companies reported shipments of more than $160 million in airbag initiators. This is up almost six-fold from 1991.

While the automotive safety market is the largest and most important commercial market for CAD/PADs, it may ultimately support only a dozen or so CAD/PAD companies, if that many. Motivation to develop other commercial markets is strong, and as a result other commercial markets are literally being invented one by one, as each firm searches for potential markets. While not all commercial endeavors have been successful, many have met the challenges of the marketplace. These other commercial markets grew from about $50 to $85 million between

1991 and 1995, or about 70 percent.

Two such products are Hi-Shear's "Jaws of Life, " used in emergency rescue operations, and Teledyne McCormick Selph's "Perforating Gun Assembly," used in developing oil fields. Hi-Shear Technology Corporation is developing a new Jaws of Life type rescue device powered by CAD's that it now produces for ejection seats. The new Jaws of Life device could contribute significantly to the company's defense diversification efforts by accounting for up to fifty percent of total sales. Hi-Shear won a $800,000 Federal grant for the project in 1993, under the Department of Defense Technology Reinvestment Program, which will account for half of the developmental costs.

Conventional rescue devices of this nature operate on hydraulic pressure provided by a gasoline powered compressor and require a crew to set up the machinery. The hoses that carry the hydraulic fluid can hamper rescue operations where there is limited access such as in areas devastated by earthquakes.

Hi-Shear's device, which resembles a large pair of scissors, is lighter and less expensive than the hydraulic operated Jaws of Life. Each stroke of the scissors would require the use of a single CAD. Cutting open the roof of a car would require four CADs, so the sale of each unit would ensure repeat business in the re-supply of spent cartridges. This CAD operated rescue device will cost less than half the price of the conventional hydraulic version. The cost savings could enable hundreds of rural and volunteer fire departments to purchase the new systems in lieu of the conventional systems which are too expensive for them to afford.

Teledyne McCormick was approached by a major oil company about 10 years ago to use explosive technology to bring a newly drilled oil well into production. The result was the development of the "perforating gun assembly." When a company drills an oil well, it installs and cements in place a steel casing to prevent collapse of the hole. The company must then somehow break through the steel casing and cement so oil can reach the drill hole and flow to the surface. That is where the gun assembly, using precision explosive technology, comes into play.

The oil company lowers the perforating gun assembly down the inside of the steel casing to the depth of the oil bearing rocks. The perforating gun consists of an ignition source, an energy transfer assembly, and conical shaped charges. When the system is fired, the charges, by their conical shape and position, perforate the steel casing and cement and fracture the oil strata so the oil can run freely. By 1993, McCormick Selph had provided more than 10,000 percussion

primer assemblies for perforating gun use without any reported failures.

The impact of commercial markets on the defense base for CAD/PADs is for the most part positive. A major airbag initiator producer reported defense drives innovations in commercial sectors. However, concerns persist, as some firms have abandoned the defense business in favor of more lucrative commercial opportunities. Others, as they gain commercial experience may also abandon defense markets because the two markets are somewhat incompatible. On the other hand, they may use the commercial experience to leverage reforms in the defense procurement process to make the two more compatible.

The commercial successes to date have been dominated by the larger, better capitalized firms. Most of these firms want to hold on to their defense business, although some have isolated the two markets in consideration of the different production parameters that apply. They value the fact that Defense remains the chief stimulus for technology advancement. Smaller firms have been less successful in finding commercial outlets, chiefly for lack of resources. Most cling to defense in an increasingly competitive market. With options limited, many of these firms are concerned with the rigidities of defense procurement and other government regulations that are making it difficult to conduct operations profitably.

3. Production Capabilities

3.1 CAD/PAD Production Processes

CAD/PADs cover a wide variety 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. For example, Woerner Engineering, Inc., a smaller firm by industry standards, has a 1,200 acre site in Elbert, Colorado, with 300 acres in the interior devoted to CAD/PAD operations. The surrounding 900 acres are being used to raise buffalo.

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. However, the industry practice is to outsource all or most of the fabrication of metal parts to specialized metal workers. 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. Also, a few firms, such

as AMTEC, near Chicago, while making CAD/PADs, actually specialize in metal working. However, CAD/PAD-related work is usually just a small portion of such a firm's overall business.

With several exceptions, device assembly is normally outside the purview of most CAD/PAD producers. Companies such as McDonnell Douglas in Titusville, Florida (ejection seats) and Kilgore in Toone, Tennessee (flares) make devices. The cartridges manufactured by the industry are installed in these "devices." Devices include items such as inflatable life preservers and life rafts, valves that cartridge energy opens or closes, sonobouys, and many others.

The device manufacturers usually work closely with the CAD/PAD producers to ensure the product is properly engineered. Also, some 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. Most 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.

CAD/PADs are normally built in lots or batches using explosive or propellant charges mixed in a single batch and 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 bridgewire is soldered or welded to the pins inside the case. The bridgewire will

eventually be in contact with the primary explosive material. Current through the bridgewire 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. Output from the percussion primer, when struck, will provide the heat source for igniting the primary charge, in place of the bridgewire. 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 bridgewire, 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.

3.2 Product Production

The survey canvassed respondents to find out which CAD/PAD products they make, which they can make on short notice, and which products they can not make. Each product category has at least several manufacturers, and most categories have substantial back-up potential from firms that can make the products. It is important to note that the product categories cover "baskets" of product types, and there may be occasions where only one producer is making a particular part number.

Twenty-two firms were listed as sole sources for the Navy. Additional sole sources may apply to the other services and to prime contractors. A ripple effect can occur when a sole source producer discontinues production of a unique item or product line. Dyno Nobel, a sole source for types of electric primers, impulse cartridges, delay cartridges, and automatic inflators, is preparing to discontinue its CAP/PAD operations. This will have a major impact on other CAD/PAD firms that rely on Dyno Nobel for supplies, and on prime contractors who rely on these firms as well as Dyno Nobel.

In many cases where large numbers of part numbers are involved, sole or single sourcing may be the result of a patent or in scale economies. However, the likelihood of back-up capability is

very high since the item must be reasonably similar to at least some, if not many, other part numbers, given over 3,000 to choose from. A greater concern with sole sourcing may be price. A Navy spokesman at Indian Head estimated that competition between at least two vendors reduces price by an average of 40 percent. Also, most sole sourcing is confined to highly specialized, difficult to make, bigger-ticket items produced in small numbers. Sometimes, the maintenance of single-purpose equipment or overhead for items of this nature may indicate a sole source is the cheaper and more prudent choice. Not many items of this nature fall within the scope of CAD/PADs.

The table on the next page presents the number of firms that make or can make each of the CAD/PAD product categories included in the survey. Shipment data for each category is included in the last two columns. Three of the five "other" products (Codes 9A-9E) were aggregated because of difficulties in clearly identifying them, and to protect company proprietary information.

Automotive airbags were already the largest single category in dollar value by 1993. The average unit price of an airbag initiator in 1993 was $7.76, although it varied greatly among manufacturers. Over time the price has come down, presumably because of higher volume production and the manufacturers' coming up the learning curve. The highest unit volume item in 1993 was (2A) electrically initiated impulse cartridges (EICs). Almost 13.7 million of these items were produced that year by 28 respondents (also the most). EICs sold for an average of $3.17 per unit. Again, prices varied widely among manufacturers, generally moving up or down with production volumes.

Firms sometimes specialized in one or two product categories. No firm produced CAD/PAD products in every category. The production equipment, engineering, and process parameters are somewhat different from one product group to the next, and therefore, do not always carry over.

Approximately half the respondents reported dropping at least one product line or another since 1991. The reason most frequently cited was declining demand. Nearly 40 percent of respondents cited this reason. Several indicated it has become increasingly difficult to produce many CAP/PAD items in small quantities profitably. Roughly 20 percent ceased production of a CAP/PAD item because of firm restructuring. Other reasons include loss of market share to domestic competition, or an inability to comply with environmental regulations.

PRODUCTION CAPABILITY (Number of Firms Producing and 1993 Shipments)					
Codes	Product Type	Number of Firms that:		1993 Shipments	
		Make	Can Make	units (in 000s)	value ($000s)
1	Aircrew Escape Propulsion System	8	8	15.5	$16,025
2	Impulse Cartridges (Other)	3	3	653.4	14,215
2A	Electrically Initiated Impulse Cartridge	28	1	13,652.9	43,219
2B	Percussion Initiated Impulse Cartridge	20	5	2,634.8	9,768
3	Impulse Initiators	15	12	72.7	10,152
4	Delay Cartridge and Delay Initiator	20	11	10,581.8	29,389
5	Aircraft Stores, Flares, Chaff,	12	10	5,163.5	10,302
6	Detonating Cords and Charges	6	1	130.8	44,839
7	Cutters	20	7	103.0	7,820
8	Catapults, Thrusters, Removers	10	10	23.6	19,792
9	Other (9A, 9D, 9E)			215.8	47,464
9A	Automatic Inflators	6	3	*	*
9B	Gas Generators	18	3	119.0	4,218
9C	Airbag Initiators	8	2	9,896.2	76,831
9D	Laser Initiated Cartridges	5	4	*	*
9E	Fire Extinguisher Cartridges	7	3	*	*

* Included in "Other."

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

3.3 Conversion Capabilities

When asked to comment on efforts to convert from defense production to commercial related business, 60 percent of the respondents reported some progress in developing and producing

commercial products. One company reported that it was currently producing 60 percent defense and 40 percent commercial. In this uncommon instance, the firm reported its production lines are designed to be easily converted back and forth from defense to commercial applications when required. A second company has converted to manufacturing ammunition for the law enforcement sector; however, the business is being severely impacted by government restrictions on ammunition and types of markets.

One company has increased efforts to market CAD/PAD products in the oil field pyrotechnic market but reports that export licensing is a limiting factor in marketing to foreign countries. Another company reports that it has been successful in marketing impulse cartridges for rock blasting purposes in the mining industry.

Eight companies report varying success in converting to the production of components for the automotive airbag industry. However, it was noted that while CAD technology is readily applied to airbag related production, manufacturing processes, procedures, and equipment are making the transition costly both in time and in capital investment requirements.

In general, CAD/PAD production operations are not readily convertible to commercial operations. Two problems are high overhead costs associated with automating production and producing in large quantities, and an unfamiliarity with commercial channels of distribution. Several companies reported that unlike the defense market, the commercial market is limited for low volume products with a high degree of reliability and quality. One company reported that the commercial product liability makes conversion impractical. The operations structure of the average CAD/PAD facility is geared toward meeting military specification requirements. Government funding is not available for converting to commercial use. R&D funds are limited for development of commercial products.

The success of conversion efforts by smaller companies with limited capital resources will depend upon the mix of remaining developmental and production funding available from both the public and private sector. As previously mentioned, Hi-Shear Technology Corporation has been successful in developing an emergency cutter for use by fire department rescue squads. Hi-Shear received a Technology Reinvestment Program award which assisted in funding half the developmental costs needed to place this new commercial product on the market.

3.4 Production Bottlenecks

The survey asked the CAD/PAD companies to list the first three production bottlenecks they would encounter in ramping up to full capacity production. Thirty-one company responses were used in the analysis. Four additional reports were not used because of problems with the information. Of the 31 responses, three firms, each with over $10 million (1993) in defense shipments, indicated they would experience no bottlenecks.

The most commonly identified bottleneck, cited 13 times as the top bottleneck, was materials availability. Materials availability was cited an additional seven times as the second or third level bottleneck for a total of 20 mentions, or almost two-thirds of the 31 respondents. This includes raw materials and subcontracting for parts and components. Of the 20 firms, one was a large firm that has subsequently left the business. The remaining 19 are all small firms with a substantial portion of their business with Defense. The 19 firms' total shipments in 1993 were $52.4 million ($2.8 million average), of which $41.6 million (80%) went to defense. Fourteen of the firms sold more than 90 percent of their total sales to Defense.

Production bottlenecks are clearly concentrated in the small defense contractor area and appear to have been aggravated by the declines in defense requirements in recent years. A manifestation of the problem reported by several producers is the trend toward increasingly smaller order quantities on CAD/PAD contracts. This trend is tied to the reduced number of aircraft and missiles now being procured, and the retirement of older air vehicles from the defense arsenal. Small orders add to the difficulty of finding subcomponent vendors, and add to the cost and lead time of purchased items. For example, fewer suppliers are willing to supply items like precision metal parts because the quantities are so small that it simply is not cost effective to produce. Two companies reported a shortage of zirconium powder which is produced in different particle sizes to control burning rates. These companies report the lack of available zirconium stems from the fact if are required in small quantities. Moreover, small scale production is not cost effective in large part due to the high product liability costs associated with manufacturing explosive powders.

Another reason that materials availability is a common bottleneck for CAP/PAD firms is that some of the energetic materials required to produce these items are no longer produced at all and a substitute must be found. For example, lead azide manufacturer DuPont stopped producing the product due to falling demand. Further, lead-based powders are currently being phased out of use as a result of tighter environmental regulations. CAP/PAD firms are developing and

searching for alternative materials to be used in existing CAP/PAD designs.

Delays also result after a substitute material is identified because firms may then have to submit a request for a waiver or deviation from the technical data package supplied by the end user. One firm cited a delay of six months to receive approval from the Navy to use an alternative material.

Summary of CAD/PAD Industry Bottlenecks				
Bottleneck Description	Bottleneck			Total
	#1	#2	#3	
Materials Availability	13	2	5	20
Component Testing and Inspection	4	1	0	5
Raw Materials Handling	3	4	1	8
Assembly and Testing	2	4	3	7
Labor Costs and Training	2	3	1	6
Engineering (Design & Production)	2	2	4	8
Other (Manu. Space and Equipment)	2	2	1	5
Production Scheduling		3	4	7
Packaging and Delivery			1	1
None				3

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

Correction of the 13 materials availability top bottlenecks would cost in total only about $1.8 million, but may take half a year for the average respondent. Some firms approached the problem by suggesting the work be brought in-house and doing it themselves. For example, one firm reported that the installation of glass/metal seal processing equipment would cost about $50,000. Other CAD/PAD firms listed costs for new vendor finder's fees and certification, or to pay more to existing vendors to make it profitable for them.

<u>Component testing and inspection</u>, as shown on the table, was a distant second, mentioned as the top bottleneck four times. However, component testing created a bottleneck for CAP/PAD

manufacturers for both commercial and U.S. military contracts. Testing required for lot acceptance, particularly for Navy contracts, takes roughly two months. During this period a firm may opt not to produce any similar CADs or PADs while awaiting the results of the test. Further delays result if the sample fails the lot acceptance test, and requires a failure analysis.

Three of the four firms selecting component testing and inspection as their number one bottleneck reported it would cost $1.1 million to reconcile the problem and take an average of three-quarters of a year. One firm reported it would cost about a $1 million to purchase the necessary equipment, and half a year to install it.

<u>Assembly and testing</u>, which overlapped somewhat with component testing and inspection, was cited twice as the top bottleneck. Each case involved a large establishment that had on-site testing facilities. The respondents claimed that lot acceptance testing at Indian Head NSWC was the bottleneck, and could be corrected by allowing them to do the testing on site. Hill AFB normally allows testing at private facilities, which it considers more efficient.

<u>Labor costs and training</u> and <u>engineering (design and production)</u> were reported as bottlenecks by several companies that layed off skilled personnel in the recent declining market. Most of the burden of this training falls on the companies. Replacement costs of many of these occupations are often prohibitively high. Also, it is apparent, particularly among larger firms, that the output of their most skilled employees is being channelled into the commercial markets.

Several companies offered general comments to supplement their bottleneck reports. One of these firms said that in today's business environment "ramping-up," particularly if capital were required, would be heavily dependent on the business potential after the ramp-up crisis dissipated. This statement alludes to the increasing importance of commercial markets in maintaining a warm defense base. Another company reported that the handling and disposal of hazardous waste is becoming a major bottleneck. The firm added that elimination across the board of ozone depleting chemicals is also creating problems; as is the ability to obtain Department of Transportation shipping classifications in a timely manner.

Additionally, a firm stated that it is no longer easy to find purchased parts and raw materials in stock because of the international emphasis on just-in-time manufacturing, which attempts to minimize inventories. The firm's production could not reach maximum levels until raw materials (aluminum and steel tubing) and purchased parts (springs, cotter pins, primers) are manufactured. However, another firm said that such bottlenecks would be a problem for only for a short period

of time. Vendors would need time to ramp up production of hardware, but once up and running parts would flow in sufficient quantities to satisfy production. These constraints would be only short term, until parts flow was established.

3.5 Foreign Sourcing and Dependencies

Foreign sourcing by CAD/PAD companies of materials, components, and capital equipment has increased over the survey period. A few countries, primarily England, Germany, France, and Canada dominate as sources for most of the imported items. While these are generally considered secure sources, foreign sourcing is inherently more risky in wartime, increasing the vulnerability of U.S. firms to supply interruptions just when their production is most needed.

Most of the materials and a few of the imported components are simply not available in the United States because of insufficient market size to justify domestic production. This situation is in part related to the large number of variations and small order lots common in the CAD/PAD sector. Declines in defense requirements have aggravated the issue. In some cases, environmental or other regulations also contributed to increased foreign sourcing.

Firms were asked to identify sources and types of goods imported from foreign countries. These imported items are described on Tables 1-3 in Appendix D. The survey respondents reported 45 instances where foreign items are used in their domestic CAD/PAD production. Most of the foreign suppliers of materials and components are located in NATO member countries, although other countries were also identified.

The types of goods imported vary from raw materials such as zirconium to capital equipment such as milling machines. The most frequently cited reasons for importing goods were the following:

MOST FREQUENTLY CITED REASONS FOR IMPORTING			
Reasons For Importing	Materials	Components	Machinery and Equipment
No Known Domestic Source	16	2	4
Lower Cost	3	4	9
Better Quality/Reliability	1	3	6
Quicker Delivery	1	2	5

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

One firm reported purchasing PVX explosive (a material) from the Government of the Peoples Republic of China. The respondent reported that no domestic source was available. Imports from Japan and Slovenia were also reported; however, these were for economic reasons (i.e., lower cost or better quality), not for lack of a domestic alternative. Imports of capital equipment were frequently reported from Japan, the world's leading machine tool builder. Japanese companies sell general purpose CNC lathes and mills. More specialized machines are reported as imported from Germany, such as ultrasonic welders and plasma etching machines. While Japan's machines were typically imported because of lower cost, the German machines are so specialized, there may be only one producer that supplies the entire world market.

Future foreign dependencies were also anticipated by some respondents. One firm said that Hexanitrolstilbene powder will continue to be imported from Sweden. The company added that no domestic source is available. As a contingency, the company has incurred the costs of maintaining a 3-year supply. Another firm expressed concern about the continued availability of zirconium metal powder and zirconium nickel alloy. Ventron, the supplier of these materials, was sold to a German firm, CM Chemical Products, a member of the Chemetall group.

Survey participants were also asked to indicate any shortages of materials or supply interruptions that have had a negative effect on domestic manufacturing operations. Forty-five percent of the firms responding experienced production delays or shortages for various reasons. Several firms indicated that their supplier closed operations or ceased producing the needed materials. Other firms mentioned environmental concerns with lead content and the elimination of certain chemical compounds from the manufacturing process as causing delays. Two respondents mentioned shortages of zirconium as a cause of delivery delays that lasted up to one year.

To find solutions to the problem of shortages, firms increased the size of their vendor base domestically and in some instances looked to foreign suppliers. Another solution was to develop in-house capability to produce critical components or to re-design products to be less dependent on scarce raw materials. One firm reported that the U.S. Government was the only manufacturer of NOSOL-318 Flake Propellant used in 6 different ignition cartridges for CADs. Non-availability of this propellant has caused a loss of defense related contracts from foreign customers. It was suggested that the U.S. Government should consider selling the propellant to a commercial distributor to ensure adequate availability in the future.

4. Industry Performance, 1991-1995

A cursory review of the 1991-1995 statistical trends in the CAD/PAD industry as reported in our survey revealed that the data were understated. The understatement applied to all statistical indicators - shipments, employment, capital investment, research and development expenditures, and financial statistics. Statistical tables of each of these aggregate measures are on Tables 4-7 in Appendix D.

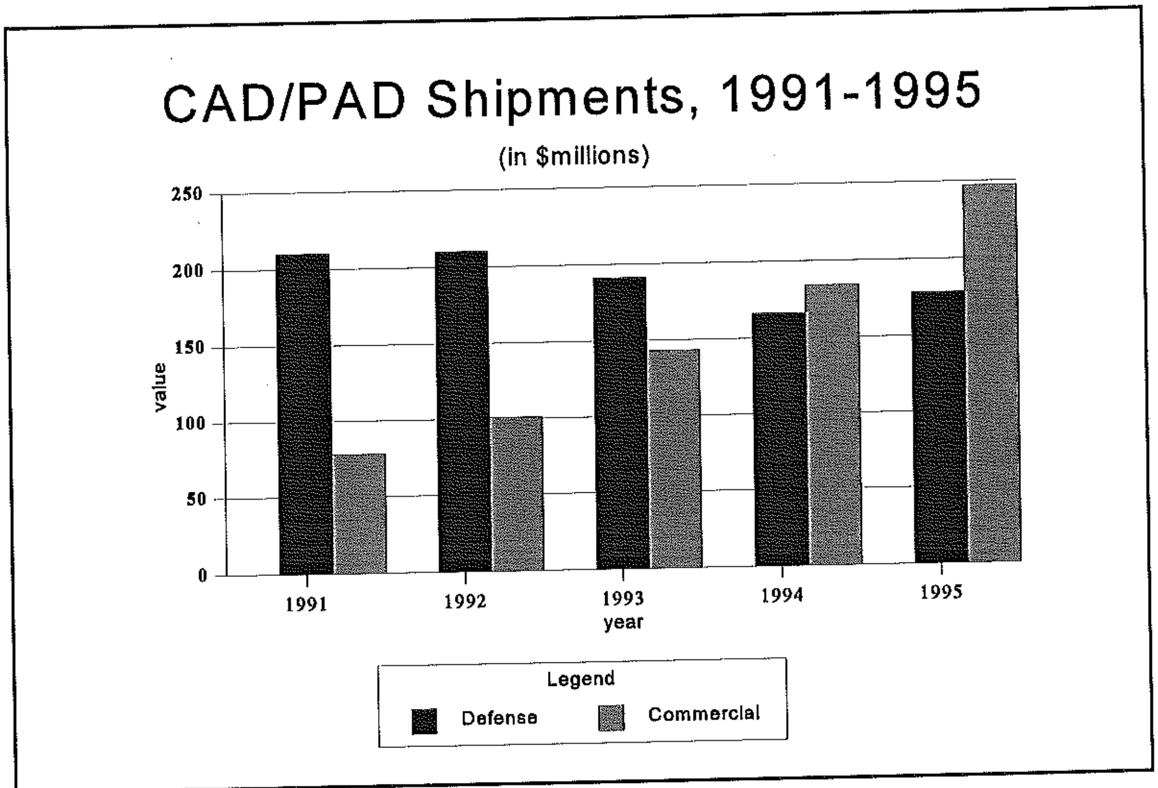
The large number of mergers, acquisitions, consolidations, and bankruptcies by firms in the industry during this period contributed to this understatement by our inability to obtain survey responses from now defunct firms. However, the resulting gaps in the data apply mostly to 1991, and less so to 1992, while the data for 1993 and subsequent years appear to be more reliable. The 1991 statistical totals are probably at least 10-15 percent understated. In dollar terms, the understatement of shipments ranges from $30-45 million and applies almost totally to the defense market. Of this amount, the Commerce Department was able to identify about $20 million in unreported shipments based on conversations with industry representatives of recently consolidated firms. Investment and measures other than shipments were totally unretrievable.

The data itself showed inconsistencies which made the 1991 totals suspect. For example, available statistics report almost no decline in defense shipments from 1991 ($210.1 million) to 1992 ($209.9 million), despite significant drops in aggregate defense procurement outlays that year. In contrast, the decline from 1992 to 1993 ($191.3 million) was almost 9 percent, and that between 1993 and 1994 ($165.7 million), another 13.4 percent. An expected decline from 1991 to 1992 of at least similar magnitude to the subsequent years is simply not reflected in the available numbers.

While the data set may be incomplete, the actual trends in shipments, employment, and the other measures over this period are still discernable. Therefore, rather than attempt to estimate these numbers and risk possibly greater errors, the reader is alerted to this understatement. All graphs, most discussions of trends, and the tables in Appendix D reflect numbers taken directly from available survey responses.

4.1 Shipment Trends

The period 1991-1995 saw defense shipments decline from commanding a major and dominant share of the CAD/PAD market to a much lesser share, with diminishing importance to the long-range business prospects of many firms. In 1991, defense shipments of $210 million represented 73 percent of the industry's total shipments of $288 million. The large defense share dropped rapidly as commercial shipments, led by an enormous surge in shipments of airbag initiators, expanded by an average of almost 35 percent a year. Also, defense shipments declined, falling over 21 percent to $166 million by 1994. The year 1994 marked the first time commercial shipments exceeded defense shipments in the industry's almost 50 year history. In 1995, defense shipments rose by 7 percent to $178 million, but lost another 5 percentage points in overall market share (to 42 percent) as commercial shipments continued to surge. The following chart shows these trends.



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

The great increase in commercial shipments from $78 to $247 million between 1991 and 1995 was accompanied by an increase in the market shares held by the industry's leading firms. The top four companies in terms of shipment value increased their market share from 54 percent in 1991 to 64 percent of the industry total in 1995. This occurred as the high volume production and total value of airbag initiators displaced the more specialized batch type production characteristic of defense production, which had offered greater opportunities to smaller firms.

Over the same period, the market share of the top four firms in the defense market stayed nearly the same, at about 43 percent of defense shipments, based on available data. However, if the 1991 defense data were fully stated, the market share of the top four firms probably would show a small increase as well. Over the 1991-1995 period, many smaller firms and a few larger ones exited the defense business. Survivors consolidated operations and increased productivity. Some survivors maintained or actually increased their defense shipments by absorbing the business of exiting firms. Others merged or were acquired by former competitors. This also contributed to the greater concentration taking place in the industry. Three of the four largest defense suppliers are included among the top four for the overall market.

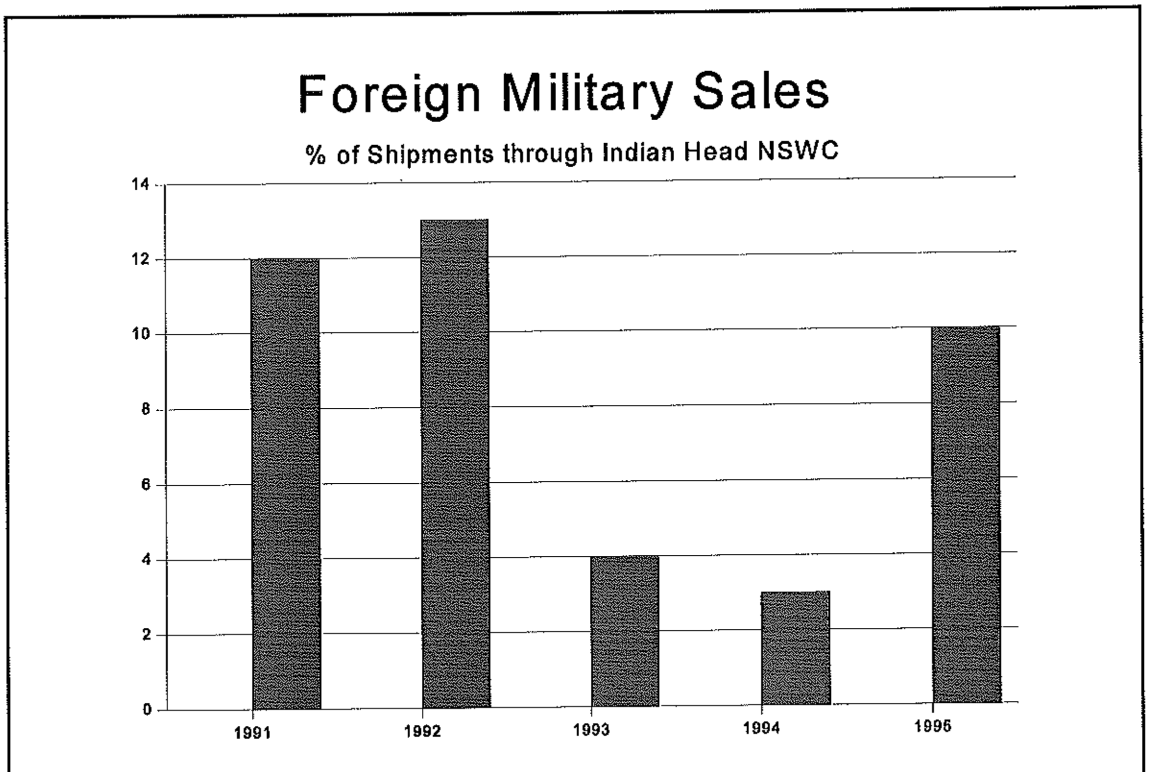
As might be expected in a declining and increasingly competitive defense market, many firms focused their efforts on developing and entering commercial markets. Those most successful in this effort appear to be the larger better capitalized firms such as OEA and Special Devices (both in airbag initiators) or Teledyne McCormick Selph (oil field equipment, seatbelt tensioners, and side-airbag initiators). Some of these firms are maintaining a strong presence in the defense market, if for no other reason, that it still represents a significant amount of business. Moreover, Defense is the major financier for the development of new products and technology, which appeals to these firms in that spin-offs offer expanded possibilities in commercial markets.

An important exception here may be Dyno Nobel, a Norwegian owned company. Dyno Nobel, located in Port Ewen, New York, and a long time mainstay and major player in the defense CAD/PAD market, announced in 1994 that it was exiting the defense business altogether in favor of commercial business. At least in part, the firm is hinging its future hopes on blasting caps for the mining industry. Dyno's defense business is being sold.

Another exception is ICI Industries, a British company. ICI is selling the defense end of its business, located in Valley Forge, Pennsylvania, to Eagle-Picher Corporation. ICI's large 2,700 acre explosives operation in Tamaqua, Pennsylvania, will be retained, as ICI plans to continue building its automotive airbag initiator business. Still another exception is DuPont. DuPont was

a long time supplier of explosive products to the CAD/PAD industry. The firm discontinued operations of its explosives operations at Falling Waters, West Virginia, and Pompton Lakes, New Jersey, in early 1994, citing the volume declines of detonators, squibs, and other explosives in recent years.

CAD/PAD firms exported about 8 percent of total shipments on their own accounts over the five-year period. Total exports, while important to some firms, play a secondary role for the CAD/PAD industry as a whole. Also, the drop in defense budgets worldwide appears to have affected the international markets for CAD/PAD products. However, information regarding trends in defense exports is mixed. Some firms report a decline of up to fifty percent in defense exports since 1985, others cite a fractional annual increase, while others report a large increase in overseas market share because a competitor has gone out of business.



Source: Indian Head NSWC

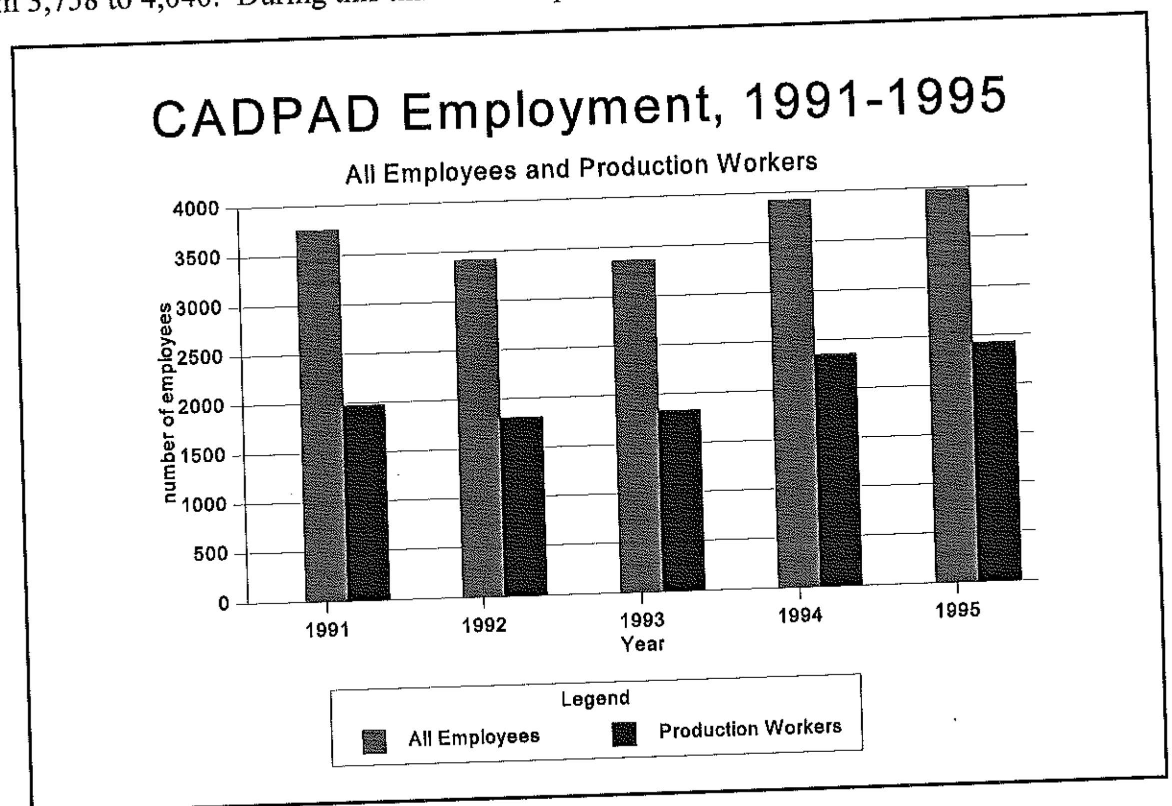
Major customers of U.S. CAD/PAD firms are foreign governments in Europe, Japan, and Israel. Replacement parts for aircrew escape systems are commonly exported to these countries. These items are replaced periodically according to an established shelf and installed life. Twenty-two reporting firms are involved in the export of CAD/PADs. Fourteen of the 22 are involved in

commercial activities to varying degrees, and a few export to commercial markets. Commercial exports are expected to increase with the growth of the automotive safety industry. Currently U.S. firms have captured over fifty percent of the European market for airbag initiators and inflators. However, most are exported to Europe by Morton International or TRW and other bag makers that buy initiators from U.S. CAD/PAD companies.

Foreign military sales (FMS) through the Naval Surface Warfare Center made up between 5 and 10 percent of CAD/PAD items acquired under their management. These figures do not include FMS sales through the Air Force at Hill AFB, or indirect FMS shipments through prime contractors such as McDonnell Douglas and others. Indian Head officials report that FMS sales are holding, and they have expectations they may actually increase somewhat in future years.

4.2 Employment Trends

Overall employment in the CAD/PAD industry rose between 1991 and 1995 by almost 8 percent, from 3,758 to 4,040. During this time the composition of the labor force shifted somewhat



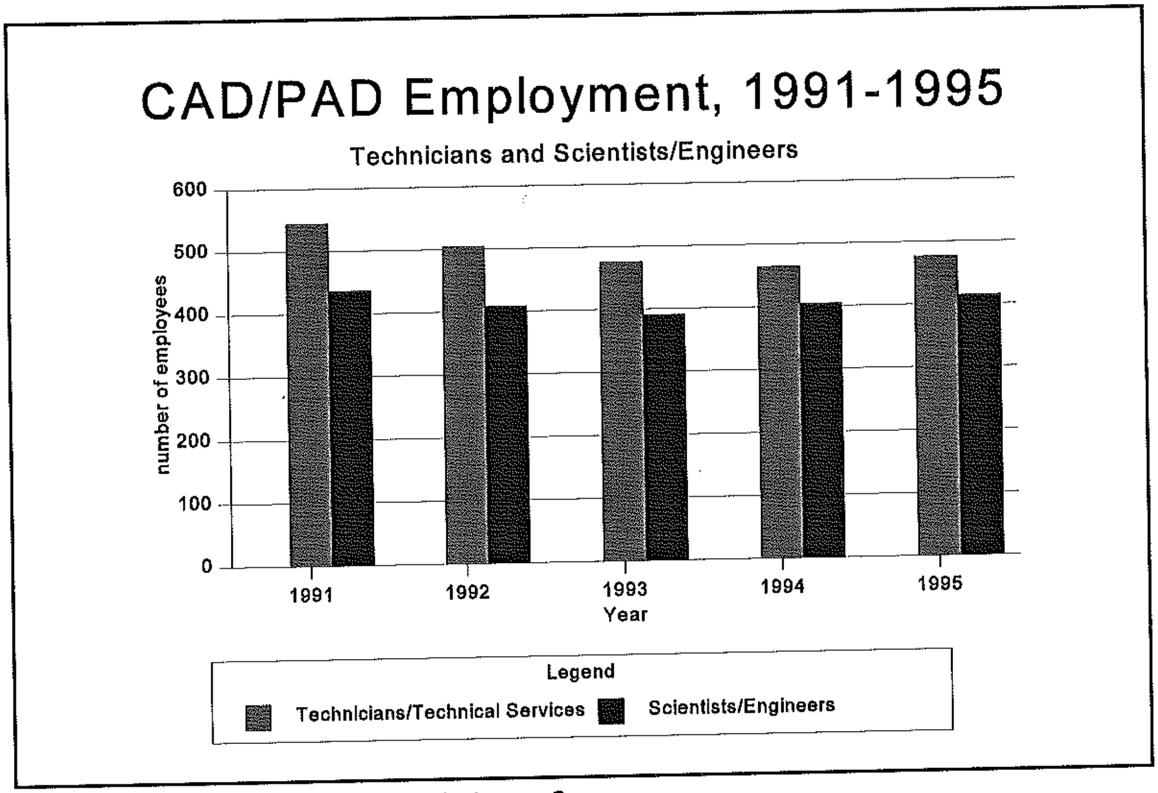
Source: U.S. DOC/BXA CAD/PAD Industry Survey

from the technical and engineering occupations toward a greater relative share of production workers. Employment dropped from its 1991 level to 3,364 in 1993, its low point, only to rise sharply in the following two years because of active commercial markets. From its 1993 low, the rise in total employment was over 20 percent.

The number of production workers rose by almost one-third during the latter two years, adding nearly 600 people, while other occupations declined slightly or showed negligible or small increases. As a result, the percent of the work force comprised of production workers rose from about 53 percent in 1991, to 61 percent in 1995. The shift toward more production workers is accounted for in its entirety by a few companies expanding into the production of airbag initiators. For these firms, the engineering content of the CAD item is amortized over a much greater volume of units while the additional units require added production shifts composed predominantly of production workers.

Declines in the number of technicians, scientists, and engineers bottomed out in 1994, and since, each has shown a slight increase. The decline in technicians and technical services personnel was about 15 percent, from 544 to 464, before increasing about 2.5 percent in 1995 to 476. Scientists and engineers fell only 7.3 percent over the same period from 436 to 404, and then also rose about 2.5 percent in 1995 to 414. The trends in professional occupations are presented on the chart on the next page.

While a few firms reported labor problems during the past five years, more firms expressed concern about an uncertain future. Concern about hiring and holding onto trained people in professional occupations was a common theme. For example, one firm reported problems hiring college educated technical staff at competitive salaries. The company pointed out that colleges and universities do not produce pyrotechnic CAD/PAD engineers. And, typically, it takes 5-10 years of work experience after graduation to produce knowledgeable people. Many technicians have left the industry in recent years. Once they establish themselves elsewhere, they are not expected to return. Other firms mentioned that candidates for specific occupations, such as powder blenders, design engineers, test technicians, and R&D scientists, are becoming increasingly difficult to find. Also, two companies noted that workmens compensation insurance has become excessive and now threatens their business.



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

The downsizing and consolidation over the last five years have been traumatic on people at all levels of these organizations, leading in some cases to morale problems and worker defections. Four companies reported experiencing excessive turnover of their work force due primarily to reduced or sporadic defense sales. One of these firms pointed out that ordnance personnel are retiring at all levels, especially engineers and senior line workers.

4.3 Investment in Plant and Equipment

Capital investment outlays for 1991-1995 were requested of the companies on the industry survey. The reported investment numbers were provided for all operations of the respondents, including their CAD/PAD operations. An estimate of the CAD/PAD capital investment was made for each firm based on the proportion of their CAD/PAD sales (or shipments if sales were not reported) to their total company sales of all products, and applying that proportion to total capital investment outlays. This was done for each year for 33 respondents.

Based on our calculations, one-third of the 33 respondents reported over 85 percent of their business and investment was dedicated to CAD/PAD. These 11 firms accounted for 70 percent of total CAD/PAD investment expenditures, while contributing just under 58 percent to total CAD/PAD sales. Their capital outlays as a percent of sales for the period amounted to 5.3 percent, which is considerably higher than that for all CAD/PAD (4.4%), and far above investment on total sales of everything each firm sold (2.9%). This disparity reflects several CAD/PAD firms' strong move into the automotive airbag initiator market, which called for major investment outlays in both plant and equipment.

The CAD/PAD business represented less than one-third (29%) of the total business reported by survey respondents. This is misleading in terms of industry specialization. A couple of larger firms reported total sales in the hundreds of millions, which brought the CAD/PAD share down. However, the straight percentage of CAD/PAD sales to total sales averaged for all firms was over 50 percent; or simply stated, the typical firm was more than half CAD/PAD oriented. Also, the CAD/PAD portion grew over the period, beginning the period at 26 percent and finishing at 33 percent. This again is attributable to the rapidly growing automotive CAD/PAD markets, and the stagnation or shrinkage (for many firms) of their non-CAD/PAD business, which frequently involved defense.

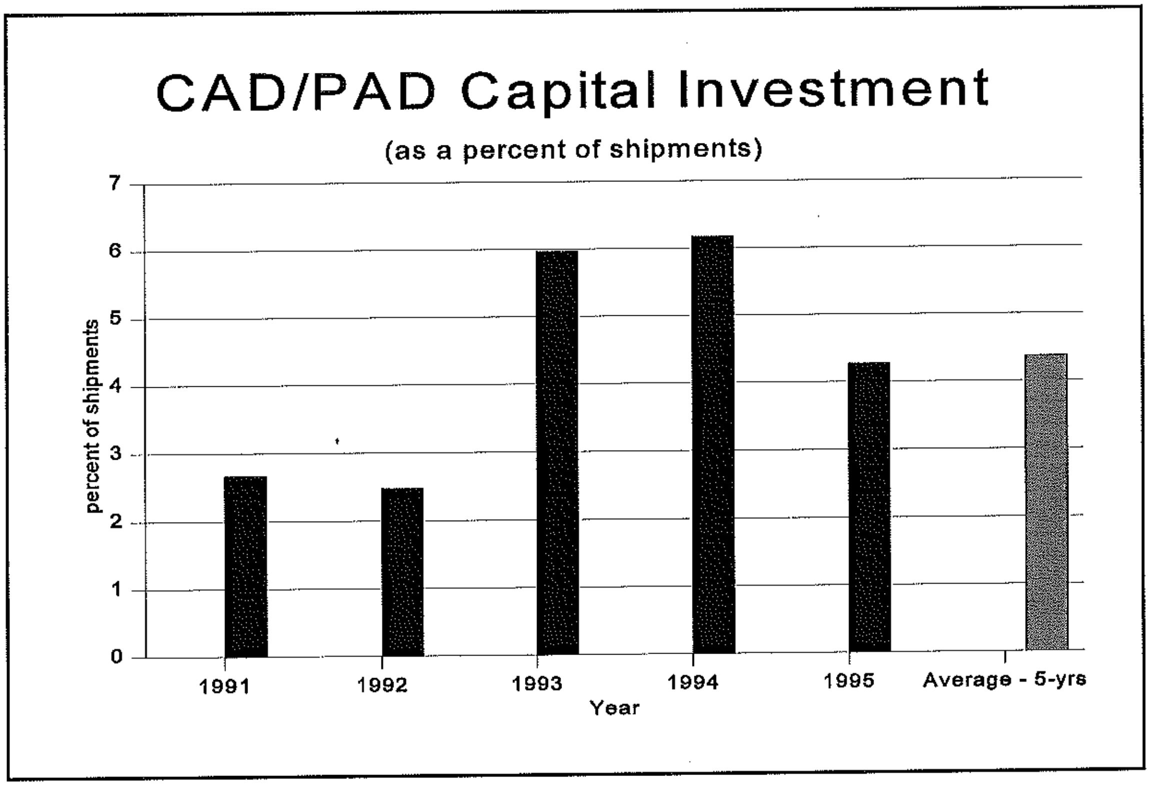
The table below presents estimated capital investment in CAD/PAD operations from 1991-1995. The high amounts beginning in 1993 are mostly accounted for by three or four firms focused on the emerging commercial markets. An analysis of investment in defense operations based on reports by 11 firms dedicated to the defense market showed that only small amounts have been invested in the defense area.

CAD/PAD CAPITAL INVESTMENT (in thousands of dollars)						
	1991	1992	1993	1994	1995	five-year total
CAD/PAD Sales	$305,952	$335,768	$343,770	$360,825	$440,425	$1,768,740
Investment	$8,173	$8,330	$20,531	$22,286	$18,821	$78,141
% of Sales	2.67%	2.48%	5.97%	6.18%	4.27%	4.37%
Investment in Plant vs. Machinery and Equipment						
Plant	$1,539	$2,504	$8,930	$7,453	$4,984	$25,409
Mach. & Eqmt.	$6,635	$5,826	$11,601	$14,833	$13,837	$52,733

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

The 11 firms invested only $7.5 million on total defense sales of $441 million for the five years. This is only 1.7 percent of sales. If this 1.7 percent standard holds true for all defense sales for the period ($955 million), then investment in defense operations amounted to only $16.2 million, or about 20 percent of total CAD/PAD capital outlays. Comparatively, the U.S. Navy's Indian Head NSWC invested over $8 million in CAD/PAD operations (not included on table), which is almost half the private sector's defense total. In contrast, the remaining capital outlays ($62 million) amount to more than 7.6 percent of commercial CAD/PAD sales ($814 million) for the same period.

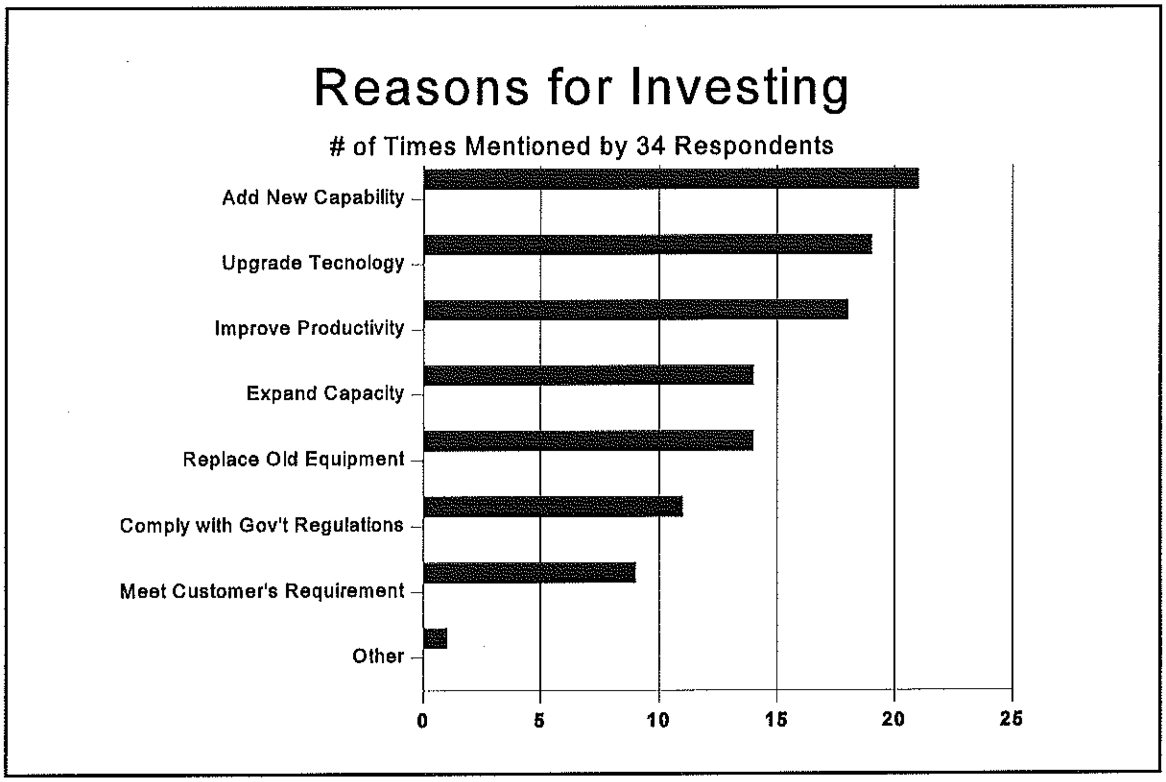
The average combined defense and commercially generated investment of 4.37 percent of sales over five years is higher than that of all manufacturing industries (3.4%) and Industry 2892 - Explosives (3.6%), and much higher than Industry 3483 - Ammunition, Except for Small Arms (1.4%) and Industry 3489 - Ordnance and Accessories (1.15%). The latter two industries are more indicative of defense industries and add support for our arguments that CAD/PAD defense investment is also on the low side. The five-year investment period used for these other industries was 1988-1992; later years were not available at the time of this writing. However, this only marginally diminishes their usefulness for comparison. The following chart shows annual CAD/PAD capital outlays as a percent of sales.



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

The CAD/PAD investment percentage is high by historical standards, and should be lower in the future. While many factors influence capital investment (i.e., capital intensity, new technologies, and new products), yearly changes in investment almost certainly flow with the expected expansion or contraction of markets. The CAD/PAD sector experienced both of these conditions simultaneously. The shrinking defense market inhibited investment, thus weakening the overall capabilities of the industry's defense oriented operations. On the other hand, the rapid growth in the commercial market led to an inordinate amount of investment, which can be expected to subside to a lower level once the new capacity is in place.

Thirty-four respondents provided reasons they invested for each year from a list of options posted in the survey. Many firms selected multiple reasons from this list, especially those dealing with expanded capabilities and productivity. The chart that follows presents the results of the firms' responses for just one year, 1993. At the time of the survey this year was the most recent complete year for which the firms had actual data.



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

The results are not surprising. The most common answer, given 21 times (62% of firms), was to add new capability. This answer also was the most common for the five years (89 mentions), and supports the contention that many firms made an effort to move into, and sometimes invent, commercial markets. Other important telling responses included upgrading technology (19), improving productivity (18), and replacing old equipment (14). Many firms cited all three of these which are interrelated to a large degree. Several defense suppliers among this group made the decision to stay the course and remain strong competitors in that market. It also underscores the drive toward increased competitiveness that pervades survivors in the industry. In 1994, improve productivity was mentioned 20 times, leading all others, and upgrade technology was given 19 times.

Capacity expansion (14 mentions) was also high on the 1993 list, and to an extent is related to add new capability. If weighted by investment dollar, capacity expansion would appear much more significant. It would apply primarily to the commercial market. Investment outlays for comply with gov't regulations (11 mentions) were less significant, but remain an important consideration. The least mentioned investment generator was meet customer's requirement. This was mentioned 9 times in 1993.

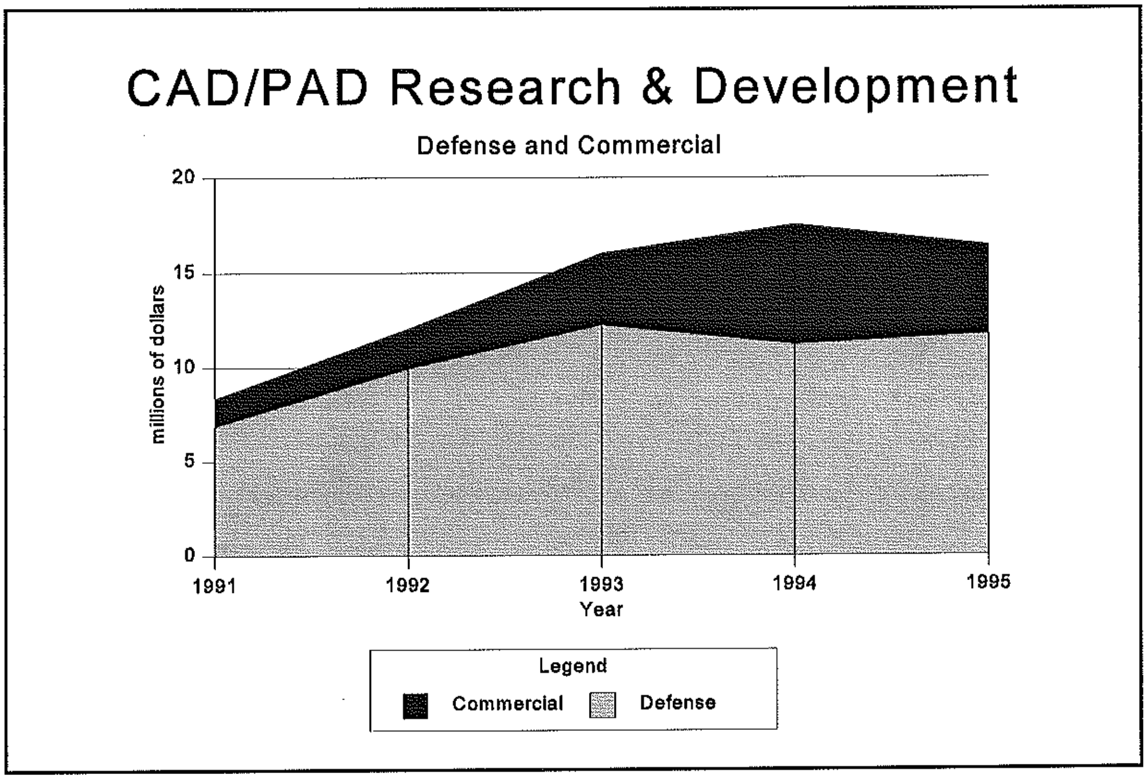
4.4 Research and Development

Twenty-two survey respondents, including Indian Head NSWC, provided information regarding R&D spending on CAD/PAD related activities. Total funding for the five-year period 1991-1995 was $70.4 million. Of this total, $52 million (74%) was directed into defense related activities, and $18.4 million was commercial. Eleven of 19 firms, plus Indian Head, were involved solely in defense projects, reporting no commercial spending. Two firms reported spending solely on commercial applications. Indian Head NSWC contributed $22.2 million of the total funding. This constituted almost 43 percent of total defense related R&D, and almost one-third of total R&D.

CAD/PAD R&D conducted by private firms averaged about 2.7 percent of sales from 1991-1995. For the five-year period, about 47 percent of the R&D funding used by private firms was received directly from the Federal Government, mostly the Department of Defense and Service Branches. Other Federal agencies funding R&D included the National Aeronautics and Space Administration (NASA) and the Department of Energy. One firm mentioned it received a Technology Reinvestment Award for slightly less than $1 million through NASA. Another 47 percent of the funding came from internal sources of the firms, and 6 percent was paid for by customers.

Some of the customer generated R&D originated with the Federal Government. Also, an unknown portion of internally sourced funding was generated by a matching grant or contractual arrangement with Defense. Internal funds generated privately averaged 1.4 percent of sales for the five years. Most was earmarked for commercial R&D. Total R&D conducted by private firms (from all sources) was just over $48 million for the five years, with a high mark in 1994 of $13.5 million. Defense R&D projects represented almost 62 percent of privately conducted R&D.

The following chart shows the large defense share of R&D. Commercial R&D has increased its share from less than 20 percent of the total in 1991, to almost 30 percent in 1995. The commercial share peaked in 1994 at just over 36 percent.



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

Most of the R&D was conducted by larger firms, although a few small ones also participated. The top three firms represented over 55 percent of privately conducted R&D. The top three in the commercial area accounted for 64 percent of the total, while a different top three accounted for 55 percent of the defense related R&D. Ten firms conducted over $1 million in defense related R&D for the five years. Seven firms conducted over $1 million in commercially related R&D.

The aggregate statistics do not show a slowdown in CAD/PAD R&D expenditures, although some firms cut R&D during the period. On the contrary, R&D increased over the period, falling slightly in 1995 from peak levels in 1994. However, one firm reported ending an "insensitive propellant" development project for the Army Missile Command in 1993, because the contract was terminated. Another firm reported a "laser firing unit" and "laser initiated ordnance" development project was terminated due to lack of market potential. Other firms reported ceasing R&D on particular projects because the development item went into production, the project was finished, or funds were redirected. One company stated it designed an improved impulse cartridge, but dropped the project when it learned the performance requirements were

being changed.

Survey participants were asked to what extent defense related R&D is transferrable to commercial operations and vice versa. Seventeen firms responded to the question. Generally, the firms reported little direct transfer in either direction is feasible. Several put the percentage at about 5-10 percent. It's evident that most private R&D is weighted toward "product development" with specific objectives in mind. This normally precludes transferability. Private firms reported that two-thirds of their commercial CAD/PAD R&D dollars, and over three-fourths of their defense dollars, were for "product development." By comparison, Indian Head NSWC's spending on product development was 58 percent of its total expenditures. The assessment did not gather information on basic science or applied research.

One firm reported automotive airbags, a totally commercial application, resulted from a series of defense projects. The firm also noted that Defense has financed R&D into advanced materials, which is now being applied in the commercial arena. In contrast, another firm stated that commercial and defense requirements for energetic materials are quite different. Few common applications for product-specific knowledge exist between the two. However, knowledge and experience gained in new production and testing techniques, equipment, and improved skills carry over. Still another firm with significant defense and commercial business stated that wherever possible R&D projects are designed to support both areas. For example, factors such as environmental safety, improved performance and reliability, and cost are considered.

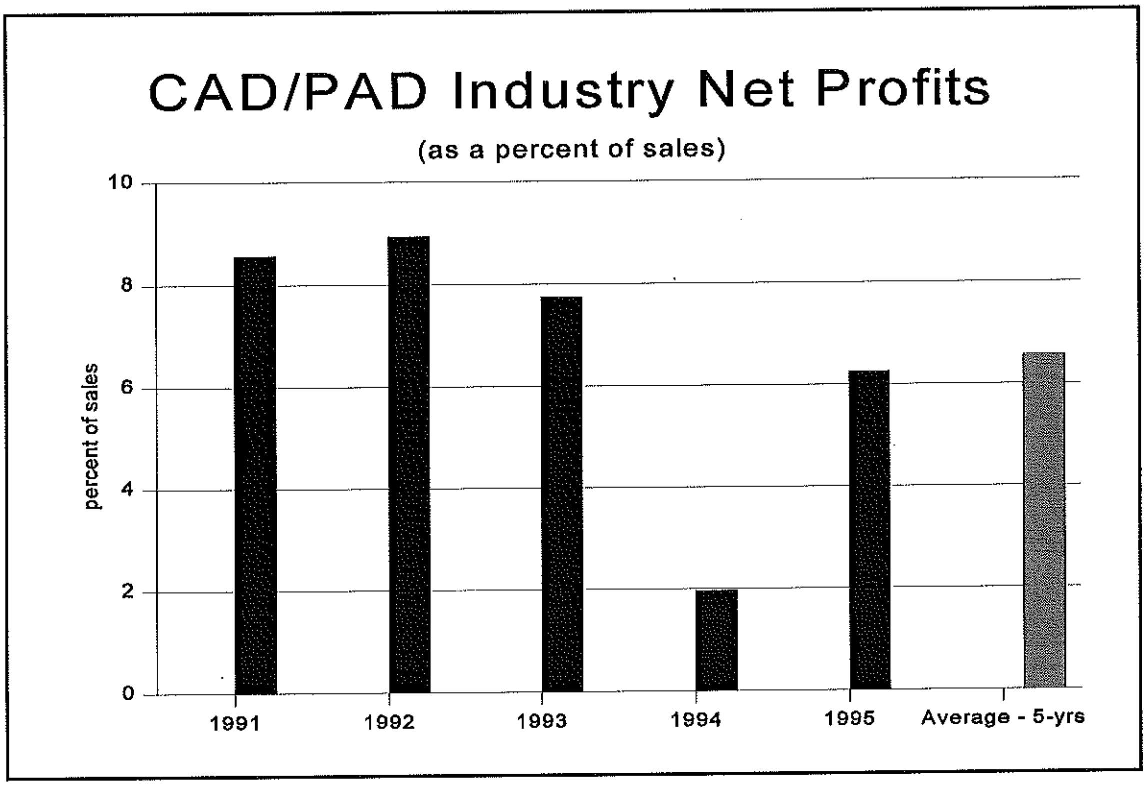
Some markets in the commercial sector are very similar to certain markets in the defense sector. These areas, while limited in scope, have nearly a 1-to-1 correlation. One firm mentioned that law enforcement and defense have close ties. Another mentioned that fire suppression system development for military aircraft is expected to lead to commercial systems in the future. Also, commercial airbag development has provided solid-propellant "production processing" advances. These are applicable to some military system applications, including aircraft fire suppression.

4.5 Profitability

Based on the results of about 25 firms that provided usable survey responses, the five-year (1991-1995) average net profit on sales for the CAD/PAD industry was estimated at about 6.6 percent. This compares favorably with average profit levels in all manufacturing industries (3.7%), but was exceeded by the general chemical sector (7.9%), which includes explosives.

These two broader aggregates are based on 15 quarterly averages from 1991 to the third quarter of 1994.

As shown on the chart below, profits were higher in the beginning of the period than at the end. The opposite occurred for the broader aggregates as the economy struggled through a mild recession in 1991-1992. The CAD/PAD sector was at this time still somewhat immune from the

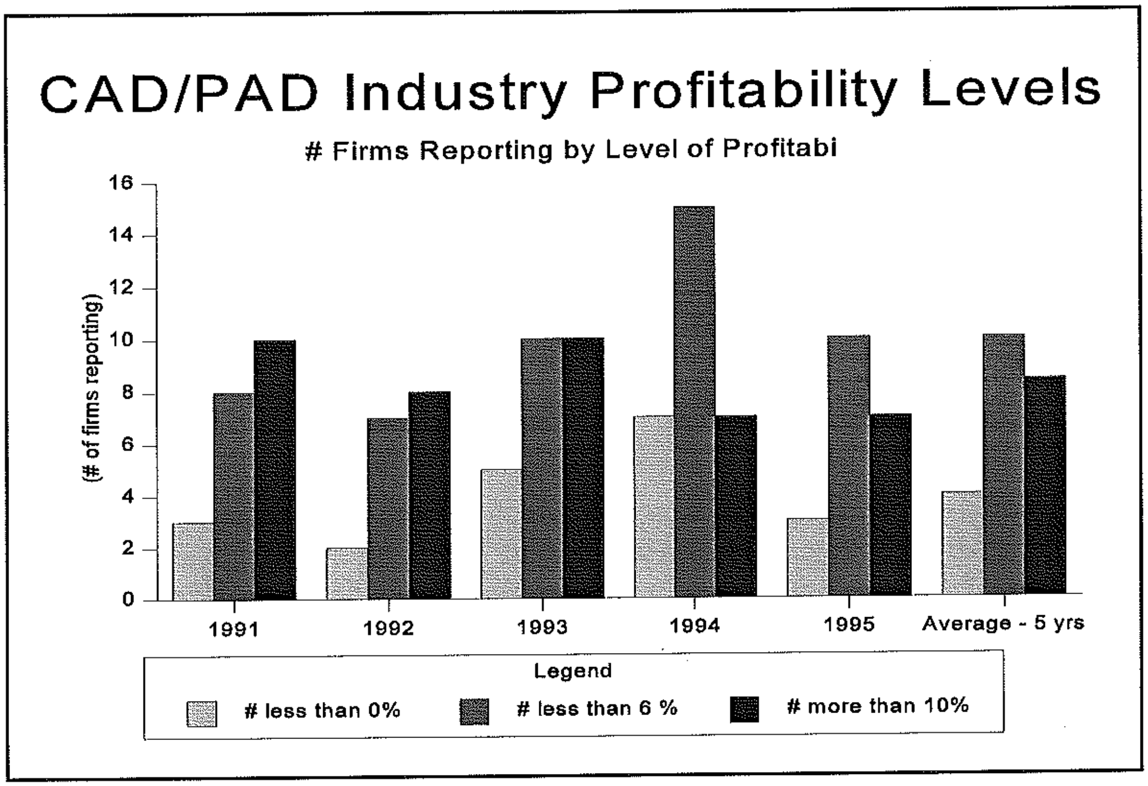


Source: U.S. DOC/BXA CAD/PAD Industry Survey

vicissitudes of the general economy as outlays for defense procurement remained high through 1991 and into 1992, and constituted the major portion of the CAD/PAD market. However, the rapid drop off in CAD/PAD defense shipments after 1992 left a surplus of capacity in the industry and less revenue to cover fixed costs and overhead. During this time, some unit prices reportedly rose as less business forced unit costs higher. Profits tumbled to their lowest levels in 1994, as seven of 25 firms (28%) reported losses. This was also the same year that defense shipments fell to their lowest level.

Future profits may not be as high because of stronger competition. For example, while at present three firms dominate the automotive airbag initiator niche, several others are entering this sector. The move toward economies of high volume production in this market is placing downward pressure on both per-unit costs and prices of initiators. This will tend to moderate future profits in this sector. Moreover, the motor vehicle companies are putting pressure on all parts and components suppliers to improve quality and lower costs.

Several firms commented that competition in the CAD/PAD marketplace has become sharper as surviving firms compete in a smaller defense market and place greater emphasis on



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

developing commercial products. Greater and more intense competition would also moderate profits.

The more intense competition taking place in the CAD/PAD industry can be illustrated by comparing the trend in the number of firms reporting above or below a given profit level. For

example, if the number of firms reporting less than 6 percent profit margins is growing over time, this could be interpreted to indicate greater competition. Other explanations may also apply. The trend could be a transitory reflection of cyclical business and not be permanent at all.

To evaluate these theories, the trend from 1991-1995 in the number of CAD/PAD firms reporting profits was measured at three levels: 1) less than 0%, 2) less than 6%, and 3) more than 10%. The first two measures increased somewhat on trend, but this is inconclusive because of shrinking defense markets. The downward trend in the number of firms making more than 10 percent in profits, however, supports the contention. One would expect this measure to change "directly" with changes in overall profits. Instead, the opposite occurred on two occasions and no change was recorded on a third. Also, the total number of firms reporting greater than 10% declined, reducing overall industry profit levels. And finally, the percent of firms over 10 percent dropped from about 48 percent of all the firms in 1991, to about 30 percent in 1995.

4.6 Financial Indicators

Twenty-six of 35 survey respondents provided financial balance sheet information on total operations for their 1993 corporate year. Only 13 of these posted the CAD/PAD portion of their business, and much of this was incomplete. Three balance sheet items - total assets, current assets, and current liabilities - were extracted from these reports for analysis.

The 13 CAD/PAD firms' aggregate current ratio (current assets divided by current liabilities) was 3.44, which is much higher than the all manufacturing average of about 1.4, and the chemical sector of about 1.27. The current ratio indicates the ability of firms to meet debts and money due within one year (short term or current liabilities). A higher ratio normally means a healthy situation. However, among other things the ratio is heavily influenced by inventories, which can inflate current assets if in-process production, testing or other delays slow shipments of finished products. Thus, a high ratio can also be a sign of inefficiency.

The standard deviation of the current ratio for the CAD/PAD group was 3.11, which is very high. The ratio ranged from about .62 to over ten. The small sample size and presence of anomalies greatly effected the overall average, making the results suspect. However, one way to make use of this ratio is to compare it for firms over and under $10 million in annual sales. Smaller firms generally are expected to have a higher ratio. The straight average value of the current ratio is 4.72. This is derived by simply adding up each firm's ratio and dividing by 13. Since this is

higher than the weighted average of 3.44, it indicates larger companies in the group do in fact have lower ratios than smaller companies, and may therefore, operate somewhat more efficiently.

A rough measure of fixed vs. variable costs can be obtained by calculating the current asset to total asset ratio. This ratio for the CAD/PAD group was .62: for each 62 cents of current assets, total assets were $1. Here, the straight average was .70, indicating that smaller firms are also more current asset intensive. Conversely, larger firms have relatively more property, plant, and equipment (fixed assets). This is a normal and expected pattern for industrial organization. Thus, smaller firms have relatively higher variable costs (wages, salaries, inventories, purchased materials, etc.) and larger firms have relatively higher fixed costs (long term debt, capital depreciation, overhead, etc.). With higher fixed costs the large firm is less flexible and more vulnerable to business fluctuations.

A close parallel to the current/total asset ratio is the asset turnover ratio. The asset turnover ratio (sales divided by total assets) for the CAD/PAD group was 1.30. The ratio for all manufacturing (1.1) and the chemical sector (.9) are both lower. This roughly indicates a sector's or industry's capital intensity. By this standard the CAD/PAD industry is not as capital intensive as most other industries.

The straight average asset turnover ratio for the industry was 1.71. Comparing this to the 1.3 weighted average indicates once again that asset heavier larger firms are more capital intensive. This is not to say that large firms are preferable (or less desirable) than small firms. The two are quite different and the two styles of production are not interchangeable. The craftsman can make the first unit cheaper than a machine and may, in fact, be able to make the first 100 units cheaper. However, at some point the machine becomes cheaper, and will generally continue getting cheaper as volume is increased. Thus, a large firm of craftsmen could not compete with a machine-laden large firm making large volumes, and a small machine-laden firm could not compete with a small firm of craftsmen making odd lots.

5. Competitive Assessment

As previously noted, competitive conditions in the CAD/PAD industry have changed dramatically in the last ten years, due to major reductions in defense spending and new business opportunities in certain commercial markets. In the mid-1980s, the defense market represented as much as 90 percent of the total business. Today, defense represents less than 45 percent. In the future the relative defense portion of the total market will decline further as commercial markets, led by automotive airbag initiators, gain greater market share.

Competition in the industry has been intense, in many instances driving prices down near or below costs. The shrinking defense market forced some firms to terminate operations, and nearly all others to consolidate production. The wave of mergers and acquisitions that occurred in the last decade allowed the industry to both rationalize assets and position itself in emerging commercial markets. Stronger firms that acquired or merged with former competitors managed to maintain and in several cases actually increase market share.

Some companies also invested heavily in state-of-the-art equipment and facilities to expand their capabilities and product lines. These firms improved productivity and now compete more effectively in both defense and emerging commercial markets. While this adjustment continues, an increase in the average size and market share of firms in the industry is evident.

5.1 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, as shown on the table on the next page.

Competitive Prospect	Number of Firms Reporting	Percent Distribution
Improve Greatly	3	8.6%
Improve Somewhat	12	34.3%
Stay the Same	9	25.7%
Decline Somewhat	6	17.1%
Decline Greatly	5	14.3%

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

Of the thirty-five companies surveyed, only three anticipated that competitive prospects for their production operations would **improve greatly**. Of this group, two companies planned to invest in state-of-the-art plant and equipment to reduce labor costs and increase output. The third company forecasted a larger sales volume from new product lines in commercial markets, which included cartridge actuated rescue equipment and airbag initiators.

Twelve manufacturers predicted that their competitiveness will **improve somewhat** over the next five years. Four of these companies reported that reduced defense spending will result in fewer competitors. This will mean greater relative market share for those companies that remain. Another company expects to increase sales by developing a new fire suppression system, again in the commercial market. Six of the companies in this group expected an improvement in competitiveness by reducing overhead costs, thereby increasing production efficiencies and cost competitiveness. One company cited the use of advanced design techniques to simplify designs, which in turn will reduce hardware and labor costs.

Nine of the thirty-five companies responding expect their competitive outlook to **stay the same**. One company cited a significant program about which it felt uncertain in securing the contract award. The firm added that no increases in CAD/PAD sales are anticipated as the size of the U.S. Air Force and Navy aircraft fleets continue to decline. Other companies reacted differently. For example, one vendor projects that the increase in commercial automotive and space products will offset the decreases it has experienced in defense sales. Another reported it reacts to market fluctuations by adjusting personnel levels and R&D and investment up or down to maintain its

competitive position. Another firm did not anticipate any new entrants into the field in light of reductions in quantity and types of products being purchased by the government. Yet another respondent anticipated maintaining a competitive position by the acquisition of firms producing similar products. The same respondent also noted that increased vertical integration has helped it maintain its competitive position.

Six companies predicted that their competitiveness would **decline somewhat** over the next five years. Several companies in this group reported that reductions in their work force due to declining demand for their products adversely affected their engineering and design capabilities. Conversely, one firm reported retaining the most qualified people, who typically have the higher salaries. The firm noted that this increased overall production costs. Also, companies reported that fewer sales resulted in less funds available to reinvest in new equipment. One company in this group also stated that costs are increasing, especially in the area of insurance, noting that it varies from state to state.

Lastly, the remaining five companies reported that their competitive prospects would **decline greatly**. As defense procurement declined, these firms were forced to lower their bidding prices on fewer available jobs. As a consequence, the vendors were forced into unprofitable positions in order to keep their plants operating. One firm indicated that the manufacturing infrastructure (i.e., tooling, equipment, and facilities) has remained high relative to reduced defense procurement. This has increased costs to the military and lowered profitability in the industry.

5.2 Industry Consolidation

Declines in the defense market have forced a major restructuring in the CAD/PAD industry. The restructuring has also weakened the supporting subcontractor sector. However, its effects are a leaner, more competitive industry, that is also somewhat less able and less inclined to meet defense requirements. Today, there are about 20 fewer businesses than there were 10 years ago. That is nearly a one-third drop. Many firms went out of business or exited the business. Others were absorbed into the operations of acquiring firms. Major exiting players like Dyno Nobel, ICI, and Dupont were mentioned previously, but many others were also impacted.

Major acquisitions included Universal Propulsion's purchase of Stencil (Ashville, NC) in 1986. This put Universal into the ejection seat business. Stencil's assets were moved to Universal's main facilities in Phoenix. In 1990, Universal also purchased Space Ordnance Systems

Company. In a more recent deal, Pacific Scientific acquired Unidynamics (Goodyear, AZ) in April 1993, and consolidated assets and people in its nearby plant in Chandler, Arizona. Unidynamics reportedly had sales near $20 million in the mid-to-late 1980s, but this apparently dropped rapidly after 1990. The combined firm is very strong in both defense and commercial markets. In July 1993, Special Devices purchased Scot, Inc. (Downers Grove, IL) for about $5.3 million. Special Devices specialized primarily in CAD/PAD missile applications and automotive airbags, while Scot specialized principally on CAD/PAD aircraft applications. Both firms are strong in design and engineering, and together they will be a broad line producer.

Other companies consolidated internally. The largest CAD/PAD firm, OEA, completed consolidation of its aerospace/defense operations at its subsidiary (ET, Inc.), in Fairfield, California, in early 1995. OEA's Denver plant is now dedicated to automotive airbag initiator production. Also, Teledyne McCormick Selph was consolidated with Teledyne Ryan Aeronautical in 1993. While maintaining its defense business, Teledyne is a strong technology company actively pursuing and developing commercial markets. In another action, Quantic purchased Whitaker 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. The firm greatly boosted productivity in the process.

In other actions, Maryland Assemblies in Florida shut down. 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. 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.

Many smaller firms were also affected, sometimes indirectly. For example, during this period a few firms reportedly started up new 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, 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.

The survey participants were asked to comment on the effects of mergers, acquisitions and

takeovers in their present business activities. Approximately half of the respondents indicated that there has been no appreciable effect, while the remaining companies provided written comments to indicate that changes are occurring and the number of companies is being reduced due to the reduction in the size of the market.

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 they are purchased by other companies. The company reported it was forced to develop a new electronic component when the takeover of a former vendor pushed the product lead time to fifty weeks.

While the overall number of competitors has been reduced, this is offset by the increased aggressiveness of the remaining businesses. Opportunities for market share are available for the supplier that places emphasis on improved product performance and reduced cost. Customers have become competitors by buying up competition and through vertical integration. The sales volumes increased for companies that remained as a result of 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.

5.3 Trade Related Effects

When asked about sales or markets lost to imports, only four firms reported foreign competition as a concern. One firm reported that two orders totaling $700,000 were lost to a company located in Israel. Another respondent reported sales lost to an Israeli company for linear shaped charge and mild-detonating cords. The two remaining companies reported CAD/PAD sales lost when prime contractors selected the Martin Baker ejection seat, made in the United Kingdom, in lieu of the U.S. manufactured product. Foreign competition is not a major problem because CADs and PADs are specialty products which require qualification tests or pre-production tests prior to being accepted for purchase. In addition, many CAD/PAD items are proprietary devices, where a U.S. firm has sold its design to the U.S. Government making it difficult for foreign competitors to obtain the specifications.

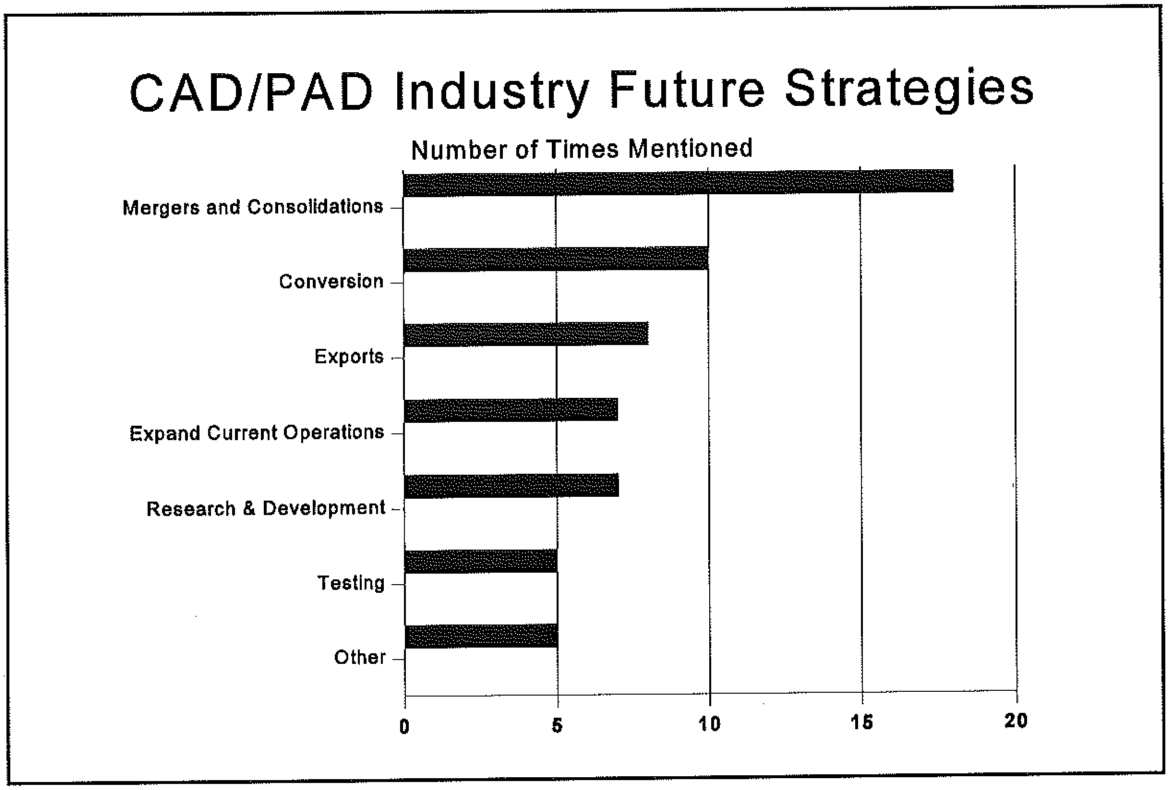
5.4 Future Strategies

The survey respondents were asked to comment on any strategies implemented by their firm that would ensure long-term participation and competition in the CAD/PAD industry. The most frequently mentioned strategies were mergers and consolidations followed by defense conversion efforts. One firm reported that it was consolidating DoD related production and centralizing corporate administrative functions in an effort to become more efficient and cost effective. Other companies plan to convert their current defense technologies to commercial applications in an effort to counter the forecasted decline in defense business. Some are considering acquisitions of companies with similar technological expertise. It is predicted that expansion into markets such as automobile airbags will provide a solid basis for maintaining a technology base in propellant devices. One firm mentioned that through an anticipated expansion in commercial business they will be in a better position to retain the optimum manufacturing base required to sustain a defense capability.

Eight companies report that exporting is becoming more critical to their expansion efforts. One firm has reacted to the unpredictable volume of defense business by establishing joint ventures, purchasing agreements, and licensing agreements in several European countries. Another firm is placing emphasis on increasing foreign military and space related sales.

In February of 1995, CAD/PAD survey participants received an information package from BXA to make them aware of export opportunities for current CAD/PAD products. A brochure was enclosed entitled "Export Programs: A Business Directory of U.S. Government Services" as well as an order form for another BXA publication entitled "Pacific Rim Diversification and Defense Market Assessment: A Comprehensive Guide for Entry into Overseas Markets" (a European guide is also available). The letter urged the survey participants to take advantage of the current Government programs designed to assist manufacturers in developing and expanding export market opportunities.

Seven CAD/PAD manufacturers report that R&D is a significant factor in their future plans for expanding and developing commercial product applications. One company reports that their ability to compete in the global market place will depend on their ability to win U.S. Government sponsored R&D programs as well as R&D funding available through private sources. The chart on the following page summarizes the frequency and type of strategy being followed by the participants.

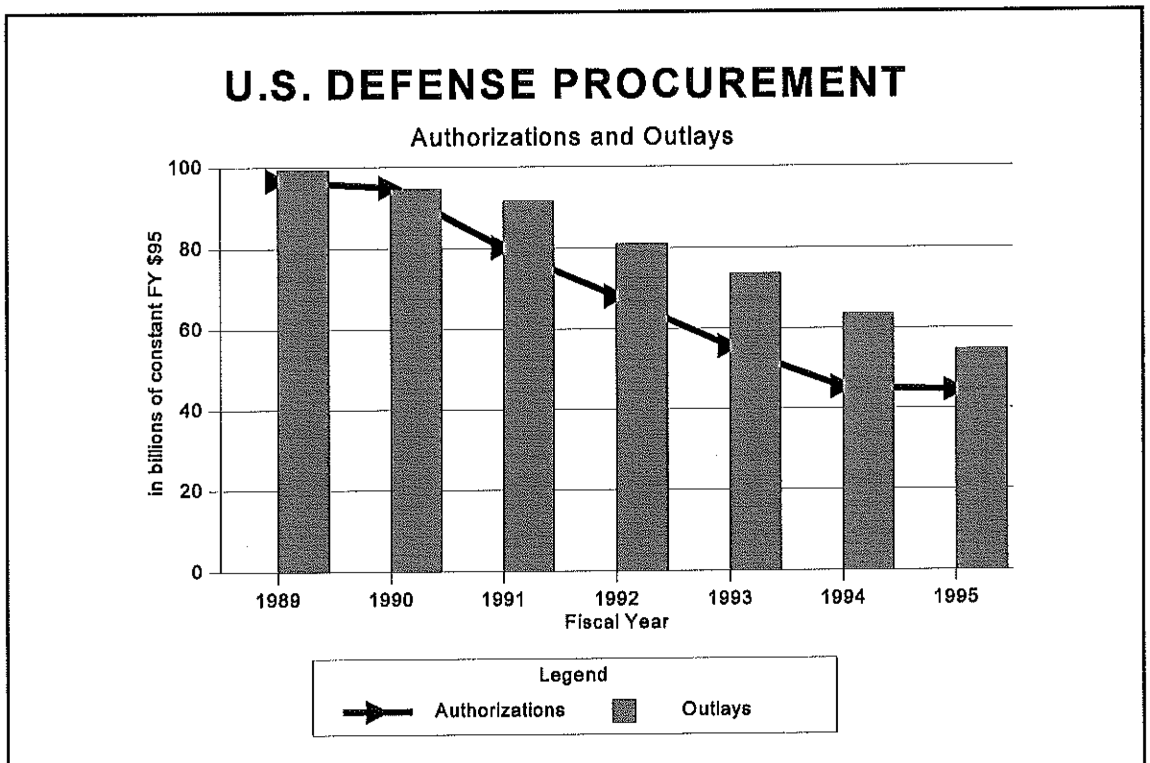


Source: U.S. DOC/BXA CAD/PAD Industry Survey

6. Factors Impacting CAD/PAD Industry

6.1 Defense Budget Cuts

Defense budget cuts have undoubtedly had a negative effect on the CAD/PAD industry. The magnitude of the cuts may have reduced defense requirements for CAD/PAD items by half (or even more) from their peak in the 1980s. This cannot be demonstrated directly because actual statistics on total defense requirements for CAD/PAD items are not available. However, aggregate defense procurement dropped sharply over this period as evidenced by both procurement authorizations and actual outlays. The chart below shows authorizations and outlays 1989-1995.



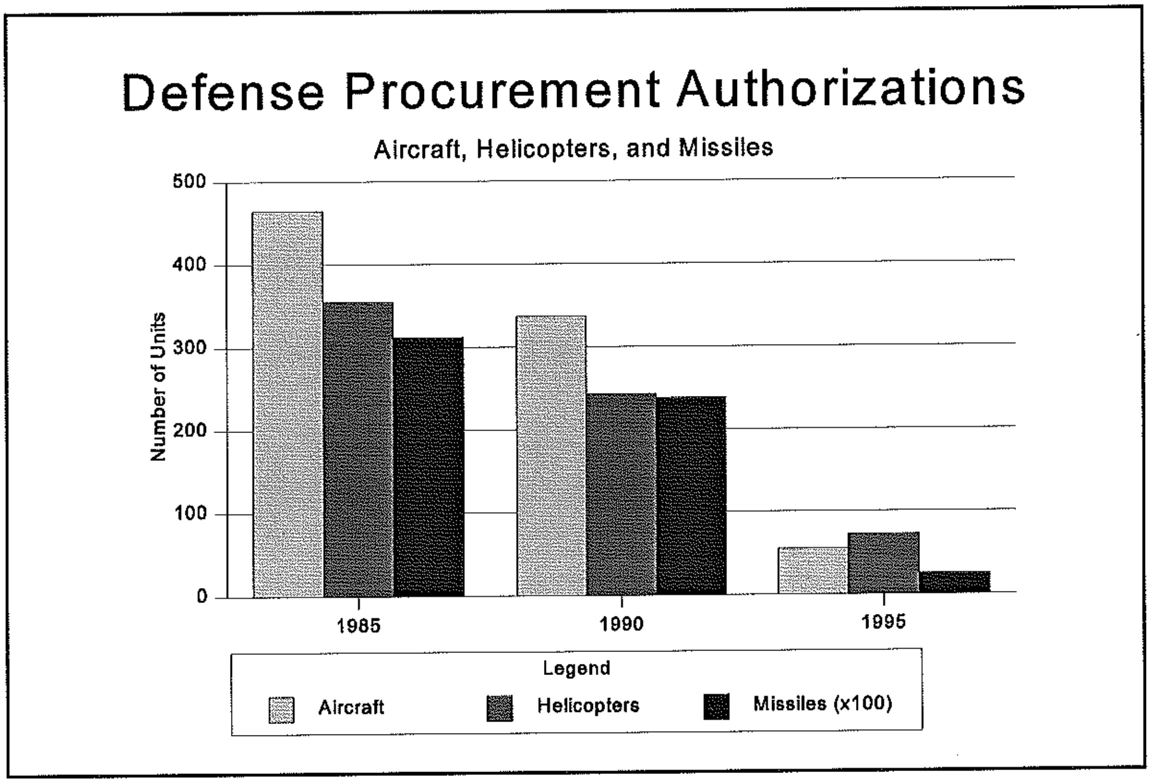
Source: Budget 1996, U.S. Office of Management and Budget

Total procurement authorizations fell by two-thirds from their highest level ($135 billion in FY1985) during the defense build-up, to only $45 billion in FY1995. Procurement outlays,

perhaps a better indicator of impacts on industry because they reflect actual spending, peaked in 1987 at $106 billion. By 1995, outlays were down almost 50 percent to $54 billion.

The years covered by the CAD/PAD industry survey (1991-1995) show major declines in defense procurement for each year. While total procurement outlays still exceeded $90 billion (almost $92 billion) in 1991, outlays dropped 12 percent in 1992, nine percent in 1993, and 14 percent in both 1994 and 1995. Further declines in outlays are projected through 1998, when they are projected to bottom out at $41 billion.

Another indicator of declining CAD/PAD requirements is the tremendous decline in the procurement of aircraft, helicopters, and missiles. Aircraft procurement authorizations fell from 465 in 1985, to 337 in 1990, and to only 55 planes in 1995. The decline from 1990 to 1995 was



Source: McDonnell Douglas Corporation

over 80 percent. This perhaps overstates the impact on CAD/PADs; increasingly sophisticated aircraft that tend to have many more CAD/PADs per plane than older models. Procurement authorizations for helicopters and missiles also fell sharply. The number of helicopters fell about 70 percent from 1990 to 1995 (243 to 72), while missiles, shown in 100s of units, fell nearly 90 percent (24,000 missiles to 2,500) during the same time frame. These numbers are authorizations. Actual purchases may be spread over several years.

The survey participants were asked to indicate what impacts defense spending reductions had or will have on their CAD/PAD operations and to indicate what steps are being considered to offset any negative impact that these reductions had on business with respect to closed plants, reduced employment, consolidated product lines, and new lines of business. Respondent's impressions of the impact of defense cuts are presented on the following table.

Magnitude of Adverse Impact	Number of Firms Reporting	Percent Distribution
None	3	8.8%
Moderate	5	14.7%
Significant	12	35.3%
Major	14	41.2%

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

Of the 35 companies that participated in this assessment, only three reported no adverse impact from defense budget cuts. The balance of the respondents, however, indicated that defense spending cuts caused declines in the volume of business. To compensate for this decrease in revenue, these companies reduced overhead expenses through plant consolidations, reduced employment, and purchased other firms. Reductions in technical and manufacturing personnel leads to the loss of skills and technological expertise that will be difficult to replace if demand returns to previous levels. Less business also reduced cash flow and investment capital, which is vital to maintaining a strong commitment to advanced technology.

Thirteen of the respondents reported that plant consolidations were a part of their plans to cope with reduced defense contracts. These firms have reduced overhead costs by consolidating product lines, closing buildings and merging departments through reorganizations. One company reported that it has maintained its industrial base without any loss of skill or technology

by consolidating its production facilities with a corporate affiliate. Another company reported that defense budget cuts have eliminated their defense business at present. However, they will maintain their status as a "planned mobilization producer" for the military. This entails reserving capacity for government contracts in time of national emergency.

Eighteen of the survey participants reported that reduced government spending has resulted in a reduction in overall employment. Personnel are either reassigned to commercial operations or laid off as government business fluctuates. One company reported that support staffs have been reduced and consolidated through a merger with an affiliate. Another company indicated that it reduced employment by 35 percent and that management had taken a 20 percent reduction in salary. A third company reported that even with payroll cuts of between $1.5 and $2 million, the profit available from existing sales is not sufficient to support the critical number of employees needed to maintain the business. Yet another firm developed the capability of adjusting the number of shifts worked from one to three per day in order to meet fluctuating production demands.

Fourteen of the companies surveyed reported that reduced defense contract size and frequency has led them to focus on converting their defense technology to commercial product lines. Two companies reported that they are entering the automotive airbag manufacturing business. Two other companies reported that they were considering the manufacture of fire protection products such as fire suppression cartridges. Other firms indicated that they would offset the reduction in defense spending by finding new opportunities in composite materials and commercial space and by expanding export marketing efforts. As the defense market shrinks, CAD/PAD firms must diversify product lines and adopt new marketing strategies in order to survive.

6.2 Government Regulatory Issues

6.2.1 Environmental and Worker Safety Regulations - Sixty percent of the survey participants cited environmental and safety (OSHA) regulations as contributing to increased operating costs and reduced competitiveness in the international marketplace. Because the market is shrinking, CAD/PAD firms have difficulty passing through increased operating costs. Pressure to lower bid prices for fewer defense contracts has compounded the problem.

Several firms stated that they have hired one to two employees whose sole responsibility is to ensure the company's adherence to environmental regulations. One firm stated that the cost of

environmental compliance has risen from $250,000 annually to $1.2 million. Of that $1.2 million, 33 percent was attributed to administrative costs.

The most commonly cited reasons for increased costs were hazardous waste disposal and the prohibition of ozone depleting substances. Finding suitable alternatives for certain types of solvents used in operations has become more expensive because of waste stream modifications which often require a complete change in handling, storage, and disposal methods. Hazardous waste disposal costs have increased significantly due to the elimination of on-site open detonation as a means of disposing of the explosive waste stream. Firms are now required to process lead bearing explosive waste off site and are paying up to $250 per 55 gallon drum to comply with waste disposal regulations.

CAD/PAD firms are also subject to a new regulation prohibiting the use of ozone depleting cleaners. These cleaners were used to remove the grease from precision machined metal parts. Cleaning these parts without ozone depleting solutions is less effective, more labor intensive and therefore more costly.

The majority of firms have accepted OSHA regulations as a cost of doing business. OSHA's main area of concern with this industry is the safety of workers who come into contact with hazardous materials. The major costs associated with occupational safety are the ventilation systems that keep toxic fumes from operators on the shop floor. Operators working with lead based propellants must periodically have their blood levels checked. One firm reported that increased costs and permit fees have necessitated a reduction of product lines that contain lead.

6.2.2 Classification for Shipping - 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. In addition, a hidden cost of delays of this nature is an occasional lost sale. For instance, four CAD/PAD firms reported the loss of an export sale due to the protracted review process. The companies' concern applied to non-defense shipments, since DoD classifys its own shipments. With the increased emphasis on commercial market development among CAD/PAD firms, the difficulties associated with obtaining this approval present an additional obstacle to diversification efforts. Also, the process imposes a relatively greater hardship on smaller CAD/PAD firms with limited financial resources. Part of the difficulty, again impacting smaller firms the most, stems from a lack of experience and familiarity with the documentation and procedures needed to obtain transport approval.

The DOT regulations that apply to new explosives shipments are codified in Title 49, Section 173.56 of the Code of Federal Regulations (see Appendix C). The DOT 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 letter of recommendation, as specified in the regulations (49 CFR 173.56(b)1) may be obtained from one of two organizations: the American Association of Railroads, Bureau of Explosives (BOE), a private association located in Short Hills, New Jersey; or the U.S. Department of Interior, Bureau of Mines (BOM), located in Bruceton, Pennsylvania.

These two organizations prepare letters of recommendation 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 or BOM official, or at BOM's testing facilities, or at a testing site designated by BOE such as Universal Tech 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 take acception to certain judgements, or require further clarification that causes additional delays to private shippers.

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 or BOM 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 product. 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.

In January 1995, DOT entered into an 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.

Also, in a 1994 meeting arranged by Commerce's BXA that included representatives from DOT, Interior, and Indian Head CAD/PAD Program officials, Indian Head agreed to apply for approval as an additional testing site. In a separate action, the Energetic Materials and Research Center of New Mexico Tech in Albuquerque, New Mexico is under consideration. Both entities require DOT authorization before they can write letters of recommendation.

CAD/PAD firms reported the longest review periods were by BOE. At BOE, the review takes from six months to a year, and sometimes longer because of a lack of resources. BOE became a one-man operation after a 1985 accident and high rates of insurance forced a permanant closure of its testing facilities. BOE now often uses Universal Tech's testing facility in Riverton, Kansas for testing new explosives. Dr. Chang, the examiner at BOE, has over 20 years experience, and his recommendations are highly respected.

The BOM provides this service in a more timely manner (4-12 weeks), but more expensively than BOE. Many firms reported reluctance to use the Bureau of Mines because it is more expensive. The Bureau of Mines charges a minimum of $450 (for classification by analogy) to over $6,000. However, the average cost, heavily weighted by analogy classifications, is about $1000. In contrast, the BOE charges a minimum of $275 and testing fees reportedly roughly half those of BOM.

The BOM cost includes an unspecified sum for compliance with the Pennsylvania Department of Environmental Resources regulations. The agency inspects BOM's facilities regularly. Also, BOM's management puts a premium on the safety of employees, emphasizing education, correct equipment usage, and proper operating procedures. They also require strict adherence to environmental rules such as hazardous material disposal and limits on contamination of air and water. This adds to costs at Bruceton and BOM's Lake Lynn, Pennsylvania testing site, which is about 70 miles to the west. Four full time environmental health and safety personnel are employed at BOM.

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.

6.2.3 Export Market Issues - Survey respondents were asked to comment on barriers to trade which restrict their ability to export CAD/PAD products to foreign markets. Sixteen (46 percent) of the 35 participants cited export controls or the export licensing process as a major barrier to exports. The U.S. Department of State controls the export of munitions under the authority of the Arms Export Control Act. A list of controlled munitions items found under the International Traffic in Arms Regulations requires CAD/PAD manufacturers to register with the State Department and to apply for an export license when shipping to foreign destinations.

Several respondents noted that the export license review process should be simplified because it is inordinately cumbersome and time consuming. It was reported that the lead time required to obtain a license is typically 3 months to 1 year and that foreign bid opportunities have been lost due to delays or denials of export licenses. Three firms suggested that the U.S. Government should remove restrictions on the export of certain technologies and products when those source technologies and products are available from competitors in NATO member countries with few or no restrictions. Some examples given were mini-smoke propellants for anti-tank and air defense applications and insensitive explosives for warheads that are readily exportable from France, Germany and the United Kingdom. Three other firms suggested that the State Department should remove munitions control requirements from life saving items such as ejection seat systems. Another firm requested that a distribution license be made available which would allow "blanket" export of certain CAD/PAD items to country destinations of lesser concern from a national security and foreign policy standpoint.

According to the U.S. Department of State/Office of Defense Trade Control, there are several areas where improvement can be made by the exporter to ensure that license determinations are issued in a timely manner. The exporter must first submit required company information to

register with the State Department. Once the formal registration is completed, license requests for the export of munitions items will be reviewed.

Export license applications must be thoroughly reviewed by the applicant prior to submission to the State Department to ensure that all proper supporting documentation has been submitted which is pertinent to the transaction such as import certificates and contract documents. The supporting documentation must also contain a full product description of each item to be exported along with product literature which outlines the technical parameters of the product. An end use statement must outline specifically the intended end use of the product and the full name and street address of the ultimate end user. All end use statements must be specific and not general in nature. For example, if the intended end use of the exported item is for scientific research, a full description of the ultimate end user's facility is required as well as information concerning the type of research, name of the project, and nature of expected results, is required.

Export applications received for country destinations embargoed under the ITAR will be reviewed with a presumption of denial. The exporter should be aware of the embargoed list of countries before submitting an export application and corporate market planning should be guided accordingly. If the above guidelines are followed, the total processing time for export license requests to unembargoed country destinations is approximately three to four weeks.

Another source of export barriers cited by the survey participants is foreign government subsidies. It was mentioned that Canadian and Israeli competitors receive subsidies on certain items from their governments which enable them to bid far below the prices of U.S. producers. Another firm reported that a Belgian competitor was able to eliminate costly international shipping expenses by utilizing government supplied military air transports.

6.3 Government Competition with Industry

The survey respondents were asked to comment on the issue of government competition in the CAD/PAD industry. This issue has become more contentious among the various interests involved with the decline in defense requirements. One the one hand, 25 of the 35 firms surveyed (71%) thought the Federal Government was competing with private firms in at least one of the following CAD/PAD areas: manufacturing, testing, or R&D. On the other hand, the Indian Head NSWC points to a 1993 Government Accounting Office investigation that reported the small degree of competition and that the nature of Indian Head's activities were within

acceptable bounds under the Officc of Management and Budget Policy Circular No. A-76.

6.3.1 The Industry Position - In brief, the industry claims that: 1) production and rework done at the Indian Head facility can be done more cheaply by private firms; 2) many firms perform lot acceptance testing at their own facilities both more quickly and less expensively than does Indian Head; and 3) R&D could be contracted to private industry more cheaply and with quicker results than is done by the government.

A summary of the company views is presented on the following table. Note that several firms reported competition in more than one area. Also, nine firms did not answer or stated they did not compete with the government.

Company Views Regarding Government Competition with Private Industry	
Area of Competition	**# of Firms Reporting "Yes"**
Manufacturing	16
R&D	7
Testing	11
None or Not Applicable	9

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

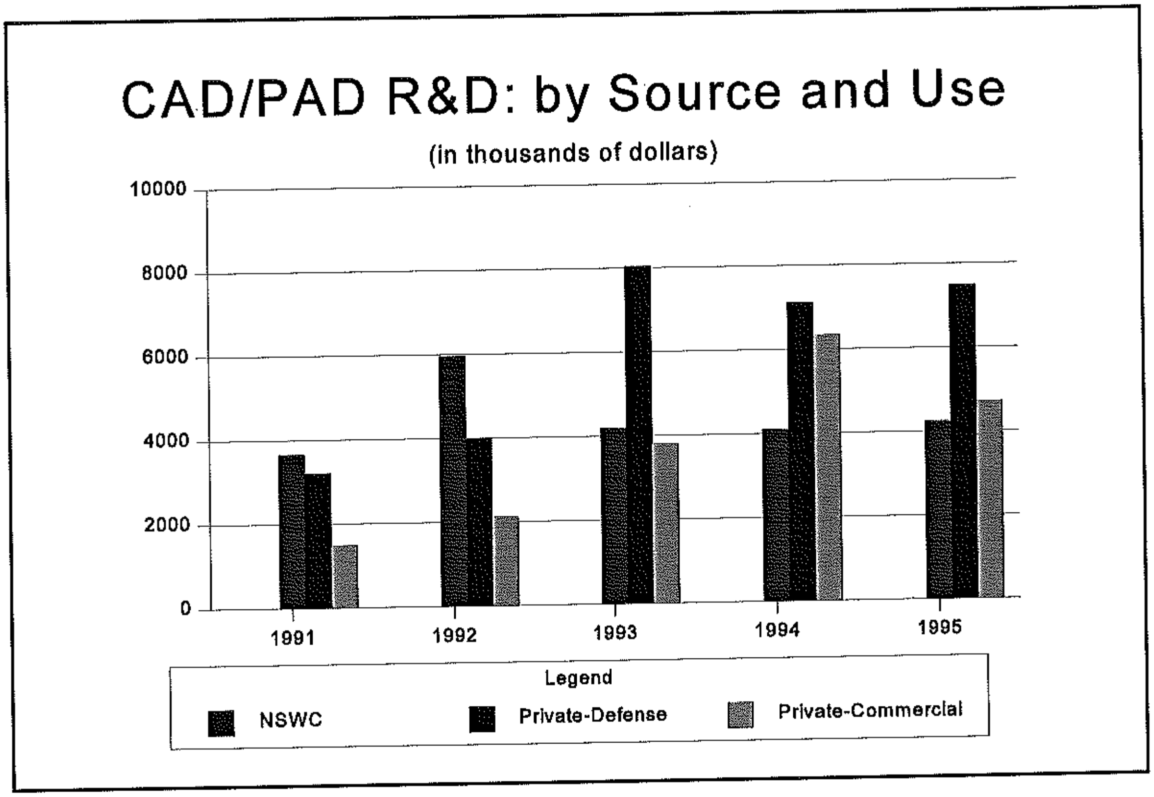
Comments by individual firms covered additional aspects of the competition. For example, one firm reported that the Federal Government controls materials for cartridges; thus preventing private firms from selling directly to foreign markets. Eight of the respondents referred to the Navy facility at Indian Head as being both a supplier and a competitor with private industry. It was mentioned that the Indian Head facility 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.

In support of the industry's testing argument, several comments focused on the fact that the cost 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 their 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.

As for R&D, companies reported concern over the lack of coordination between Indian Head and private industry. Firms engaged in the development of new products want to maintain intellectual property rights over these products to ensure that they will become the sole or primary supplier. However, it was reported that Indian Head freely disseminates new developments to the industry, and contracts will often go to the low bidder rather than the company that made the new product. This can discourage companies from working with the government, and tends to undermine private initiative. Also, in some cases, duplication of R&D projects by Indian Head and private firms was noted. This also discourages private initiative and wastes scarce resources.

R&D funding from private and public sources totaled $70.4 million between 1991 and 1995. Indian Head conducted or sponsored about $22.4 million in R&D for the five-year period. Private industry used 62 percent of its total R&D ($48 million) in defense related projects. Of this $48 million, about 47 percent of the R&D expenditures were privately funded, another 47 percent was Federally funded, and 6 percent came from private contractors. About 74 percent of the total ($70.4 million) was spent on defense related projects. These percentages are shown on the following chart.

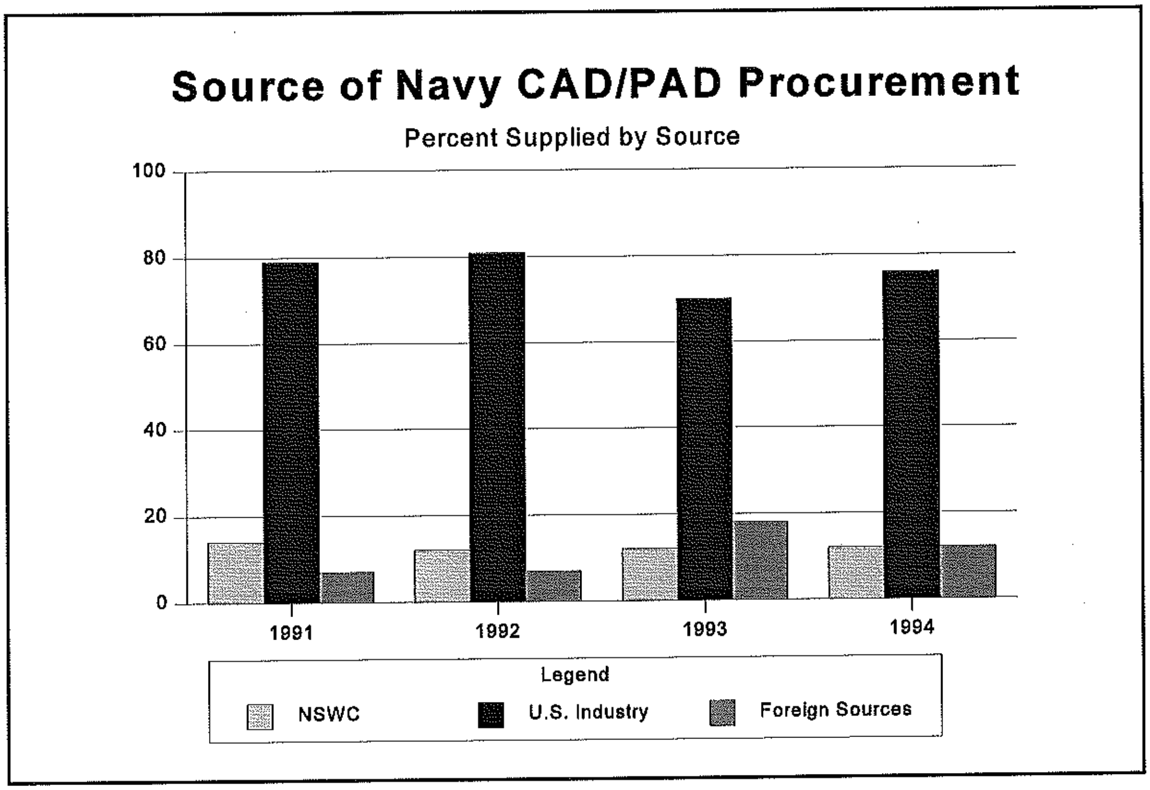


Source: U.S. DOC/BXA CAD/PAD Industry Survey

6.3.2 The Government Position - In October of 1993, the General Accounting Office (GAO) released the outcome of an investigation into claims of unfair government competition involving Indian Head and the CAD/PAD industry. The legal basis for the investigation centered around the Office of Management and Budget (OMB) Circular No. A-76. This circular established Federal policy regarding the 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 results of the GAO findings revealed that the concerns regarding Indian Head competing with private industry were in areas exempt under the A-76 policy.

The GAO also found that 11 percent of total Indian Head procurement was produced in-house and 89 percent was produced by private industry. The Indian Head CAD/PAD program supplies roughly 12 percent of the contract dollars procured by the Navy. The chart below illustrates the

division of shipments procured through Indian Head as a percentage of the totals for 1991-1995.



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

The average value of shipments for the 35 firms surveyed was roughly $10 million per year for 1991 through 1995. The average value of yearly shipments for Indian Head was $2.1 million for the same period. According to figures supplied to the GAO, Indian Head manufacturers only 3 percent of the unit total procured by the Navy and this is done to maintain core capability in this mission essential area.

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.

Between 1991 and 1995, the Indian Head CAD/PAD operation reduced employment from 379 to 276 (down 27%). Production workers dropped even more sharply, from 93-58 (down 38%).

Scientists and engineers fell 18 percent from 122 to 100. Also, production of CAD/PADs dropped steadily at Indian Head facilities over the period, from $2.9 million in 1991 to $1.5 million in 1995. This is actually only about 1 percent of total defense shipments reported by the industry.

6.3.3 Conclusions - The GAO report also revealed that the A-76 policy document provides a contractor with a legal basis for a challenge to Government competition only when a comparison of the cost of contracting and the cost of in-house performance is effected.

In its findings, the GAO also recognized that because the same work is being performed both by private industry and Indian Head, there is duplication of production facilities and that this is eventually paid for by Government. In view of this fact, the GAO recommendations emphasized the need for an ongoing analysis of the duplication of costs as well as an analysis on the necessity of keeping core capabilities.

It is recognized that reduced DoD spending coupled with a downsizing of the industrial base increases competition between the public and private sector. Therefore, the proper procurement balance must be maintained between public and private industry in accordance with the A-76 Circular.

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.

6.4 Small Business Set-Asides

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.

The SBA's 8(a) Contracting Program 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).

SBA set-asides are not to be authorized unless there is a reasonable expectation that the agreed upon terms and conditions of the contract will be performed. Unfortunately, some small businesses receive a certificate of competency from the SBA without possessing sufficient capability to fulfill CAD/PAD contracts. Certification by SBA allows the firm to compete for and win CAD/PAD bids even if that company is found to be unqualified by the Defense Department after a pre-award contract meeting has been held.

CAD/PAD items procured by the Navy under the SBA Set-Aside Program are primarily life saving devices that are essential to air crew escape systems and other end items. Because aircraft safety and human lives are involved, quality control must be of the highest level. For this reason CAD/PADs should not be placed in the same commodity classification with other ordnance items such as bombs and artillery shells where a low failure rate is acceptable. A zero percent failure rate is the only level tolerable for devices that are critical to pilot and air crew safety.

Several of the survey participants indicated that small business contracts encourage non-competitive firms to remain in business, thereby stifling competition. Another respondent believes that government laws and regulations should be more in favor of qualified contractors and that it would not be a disadvantage to other firms if awards were based on performance rather than price. Yet another respondent added that they are frequently underbid by firms that are undercapitalized and cannot qualify to win contract awards.

Due to the increased competition for DoD contracts, many small companies are forced to submit bid prices that are too low to provide a sufficient profit margin. In many instances the Indian Head Division has found that the contractor has lowered the product quality in order to become price competitive. If the overall quality is poor and therefore unacceptable, a high percentage of

the unit output will be returned which will cause the company to default on the contract. In many cases the manufacturer will declare bankruptcy only to continue its substandard business practices at a later time under a different name.

When a low bidding company fails to fulfill a contract agreement the ultimate loser is the American taxpayer. According to an official at Indian Head, when a suitable firm is finally found the cost per item can exceed the original price by a factor of three.

These contract performance problems also cause time delays that can bring military defense activities to a virtual standstill until the critical items can be procured. One such instance occurred when a small contractor that benefitted from the set-aside failed to provide the U.S. Navy with the JAB-22/B Initiator, a pressure generating device used to eject sonobouys from aircraft into the ocean. Sonobouys are critical to anti-submarine warfare efforts. With the JAB-22/B inventory exhausted, Navy personnel were forced to manually launch sonobouys creating potential safety hazards in order to maintain national security mission requirements. It was calculated that the Navy would have 300,000 initiators on back order before final delivery could be effected.

Many former defense suppliers are now focusing on commercial business because they can no longer afford to maintain the high quality standards and reduce profit margins in order to compete for defense contracts. The Competition in Contracting Act often forces the U.S. Government to accept the lowest contract offer. As previously discussed, the low price bidder is not always the best value, but the procurement system makes it very difficult to decide otherwise.

7. Findings and Recommendations

7.1 Findings

o **The CAD/PAD industry's economic health and strength has improved.**

The industry is leaner and more competitive after numerous consolidations. The decline in Defense spending has stabilized, and requirements may now actually rise somewhat because of the greater CAD/PAD usage in newer weapon systems. Expanding commercial markets have greatly improved the prospects for some firms. Compared with most manufacturing industries, profits have been high and debt burdens low. Although defense shipments declined from 1991 to 1995, overall shipments increased 48 percent during the same period, and employment rose 8 percent.

o **Competing in the defense market is less attractive today than it was in past years, although Defense funded R&D continues attracting private interest.**

Many of the larger companies' increased orientation toward commercial markets has refocused their technical personnel and capital. This is evidenced by very low levels of new investment in the defense sector. Commercial markets are now driving private investment. Commercial investment ($62 million) for the five years averaged 7.6 percent of commercial shipments, while defense investment ($16 million) averaged only 1.7 percent of defense shipments. Also, the defense market is seen as a non-growth area.

However, most companies plan to maintain a core defense capability to take advantage of the research and development opportunities Defense offers. Defense continues to drive most research and development expenditures, which is mostly funded by the government. Total privately conducted R&D was $48 million, 62 percent ($30 million) of which was

for defense. The government supplied about half of the R&D financing to private firms. Indian Head added $22 million to bring the total R&D funding for CAD/PAD to about $70 million.

- **The CAD/PAD industry structure is becoming more concentrated.**

  The CAD/PAD industry grew more concentrated and dominated by large firms between 1991 and 1995. The market share of the four largest firms increased from 54 to 64 percent of the total market during this period. This change was driven by rapidly expanding commercial markets, where larger, better capitalized firms have been more successful. The defense market remains less concentrated as the top four suppliers accounted for less than 50 percent of total defense shipments throughout the period. The lower concentration level in defense is due to the specialized nature of the market, and the preponderance of small or odd lot orders.

- **The commercial market is now larger than the defense market.**

  Commercial markets surpassed defense in value of shipments in 1994, and continue growing at high rates. In 1995, commercial shipments will be about 58 percent of total CAD/PAD shipments. By far the leading commercial sector is the automotive safety market, which grew almost six-fold from 1991, to over $160 million in 1995. This market was given a major boost by the 1991 Intermodal Surface Transportation Efficiency Act, which mandates that airbags be used in all cars, vans and pick-ups sold in the United States by 1998. Other commercial markets such as mining, emergency rescue, and petroleum, are also growing, increasing 70 percent from $50 to $85 million between 1991 and 1995.

- **The major production bottleneck, concentrated almost exclusively with smaller firms, is subcontracting for CAD/PAD materials and parts.**

  This bottleneck was identified by 20 firms, 13 of whom saw it as their major bottleneck. This problem is highly concentrated among smaller companies, who often lack the sales volume to attract subcontractors. Small orders add to the difficulty of finding subcomponent vendors able to

supply items such as precision metal parts in a cost effective way. The average shipments of these firms in 1993 was $2.8 million, of which about 80 percent was for defense applications. Other bottlenecks were far less significant, although several firms reported problems finding and training skilled personnel. Smaller companies remain oriented toward defense and continue to play an important role in supplying small and odd lot orders to the military.

o **While many larger firms are actively pursuing commercial markets, conversion from defense to commercial markets is proving to be very difficult for smaller firms.**

About 60 percent of the CAD/PAD firms reported some progress in developing and producing commercial products. In general, CAD/PAD production operations are not readily convertible to commercial operations. Two problems are high overhead costs associated with automating production to produce larger quantities, and an unfamiliarity with commercial channels of distribution. Several companies reported that unlike the defense market, the commercial market has limited opportunities for low volume products with a high degree of reliability and quality. Smaller companies that focus on low volume/high quality are at a disadvantage. The commercial product liability costs also make conversion less practical.

o **While a few firms reported labor problems during the past five years, more firms expressed concern about an uncertain future.**

Concern about hiring and holding onto trained people in professional occupations was a common theme. One firm reported problems hiring college educated technical staff at competitive salaries. The company pointed out that colleges and universities do not produce pyrotechnic CAD/PAD engineers. And typically, it takes 5-10 years of work experience after graduation to produce knowledgeable people. Many technicians have left the industry in recent years. Once they establish

themselves elsewhere, they are not expected to return. Other firms mentioned specific occupations, such as powder blenders, design engineers, test technicians, and R&D scientists where candidates are increasingly difficult to find. Also, two companies noted that workmen's compensation insurance has become excessive and now threatens their business.

o **The most immediate problems now facing the CAD/PAD industry are a number of legal, regulatory, and administrative issues. These include the following:**

Environmental and safety (OSHA) regulations: About 60 percent of the respondents cited environmental and worker safety regulations as contributing to increased operating costs. Because the market was shrinking, these CAD/PAD firms had difficulty passing through increased operating costs. The most commonly mentioned areas of concern were the disposal of hazardous waste, which now must be off-site, and prohibitions on ozone depleting substances. As for worker safety, the biggest cost is ventilation systems that remove toxic fumes from the shop floor.

Classification of shipping: Nearly half of the respondents described a lengthy and burdensome approval process to transport explosives for non-government contracts. CAD/PAD firms reported the Bureau of Explosives lacks the resources to provide this service in a timely fashion. In extreme cases it has taken as long as a year. The Bureau of Mines typically provides the service in 1-3 months, but the fee is thought to be excessive, ranging from $450 to more than $6,000, and the schedule somewhat unpredictable and unresponsive to firms' planning. The Department of Transportation's Office of Hazardous Materials then reviews the Lab results from the Bureau of Explosives or Bureau of Mines and issues a "Letter of Competent Authority" to the shipping firm in about seven days. 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.

Export Issues: Nearly half of the respondents commented on barriers to exports. CAD/PAD products are controlled under authority of the Arms

Export Control Act administered by the U.S. Department of State. CAD/PAD manufacturers must register with State and apply for an export license when shipping to foreign destinations. Several CAD/PAD firms mentioned that the license review process is inordinately cumbersome and time consuming, and needs simplification. Licenses typically take 3 months to a year to obtain. Export opportunities have been lost because of delays or denials of export licenses. It was suggested that restrictions should be removed where competitors in NATO member countries can export the same product with little or no restrictions.

Export barriers also come in the form of foreign government subsidies. It was mentioned that Canadian and Israeli competitors receive subsidies on certain items from their governments which enables them to bid below U.S. producers. It was also reported that a Belgian competitor was able to eliminate international shipping expenses by utilizing government supplied military air transports.

Small Business Set-Asides: Several of the survey participants indicated the set-asides encourage non-competitive firms to remain in business, thereby stifling competition. Also, due to increased competition for DoD contracts, legitimate companies are forced to bid too low to provide sufficient profit margin. Many former defense suppliers are now focusing on commercial business because they can no longer afford to maintain the high quality standards and reduce profit margins in order to compete for defense contracts. The legal environment should not force DoD to procure CAD/PAD items on a lowest bid only basis. Several firms suggested "best value" procurement should be practiced where high quality at a fair market price are the qualifying factors.

A corollary problem arises when some small businesses receive a certificate of competency from the SBA without possessing sufficient capability to fulfill CAD/PAD contracts. Certification allows the firm to compete for and win CAD/PAD bids even if that company is found unqualified by DoD. The taxpayer may ultimately be charged up to three times the fair value for these CAD/PAD items, while Defense requirements for the items are delayed and sometimes compromised.

- **Government competition with industry has become more contentious with the decline in defense requirements.**

Twenty-five of the 35 CAD/PAD survey respondents reported the Federal Government was competing with them in at least one of three areas. These three areas include production/rework, product acceptance testing, and research and development. Industry claims all three areas could be accomplished less expensively and faster by private firms. Indian Head maintains that a "core" CAD/PAD capability has inherent benefits to the national defense. It ensures a warm base, retention of skills, and the technical knowledge to produce and handle CAD/PAD items. It also provides insight into the production processes and technology of CAD/PADs that helps channel scarce research money to where it is needed.

The Office of Management and Budget Circular No. A-76 sets forth a "broad based policy" statement from the Office of the President that seeks to achieve the lowest cost for the taxpayer in government procurement. However, it is not a legal requirement backed by legislation. Its implementation is left to local procurement jurisdictions. The circular sets forth conditions where government performance of a commercial activity is considered appropriate. Here, government performance applies to items uniquely made for the government (i.e., Defense in this case). The criteria are: 1) the item or service cannot be contracted to a private firm(s), or 2) it can be produced more cheaply in-house by the government than by a private firm.

GAO did not find "unfair" competition by the Government in its 1993 investigation. However, GAO recognized that duplication of production facilities is an added cost paid for by the taxpayer. In view of this fact, GAO emphasized the need for ongoing evaluation of duplication costs and the necessity of keeping core capabilities.

Based on information provided by Indian Head, between 1991-1995 the Government operation at Indian Head reduced CAD/PAD employment from 379 to 276 (down 27 percent), while production fell steadily from

$2.9 million to $1.5 million. Indian Head production in 1995 accounted for less than 1 percent of total defense CAD/PAD production.

7.2 Recommendations

Recommendations for Indian Head NSWC

- **Improve communications between the public and private sectors.** Indian Head NSWC should take the lead.

  Establish and regularize formal annual meetings between Indian Head NWSC and private industry to:

  1. promote greater cooperation and goodwill between the public and private sectors;
  2. provide industry with latest six-year budget forecast;
  3. brief industry on technical developments and new requirements;
  4. discuss industry grievances (followed by individual meetings as requested on a company by company basis); and
  5. schedule the occasional attendence of other agencies such as the Labor Department's Office of Safety and Health Administration, the Environmental Protection Agency, or the State Department's Export Control Branch that impact the CAD/PAD industry to enhance communication and promote workable policies.

- **Wherever possible, establish longer-term procurement commitments.**

  Longer-term contracts would induce cost-saving investment, streamline production, improve quality, reduce administrative overburden, and promote on-time delivery. Longer-term contacts would particularly benefit smaller companies in terms of market

strength to bargain with their subvendors, investment, and the retention of skilled employees.

- **Explore other acquisition methods to improve CAD/PAD quality and help ensure a viable industrial base.**

  CAD/PAD acquisition managers and contracting officers should investigate innovative contracting methods, with industry input, such as "best value" contracting, qualified bidders lists, split buys, etc. This could promote quality products, on-time deliveries, and a viable industrial base.

- **Establish commercial transportation classification capability at Indian Head.**

  This was agreed to at a meeting with the Department of Transportation and Department of Interior in 1994. Indian Head already has expertise in CAD/PAD products and could reduce the lengthy process time by offering shippers an alternative testing site.

- **Arrange a meeting between Indian Head personnel cognizant of the non-performing small business set-aside contracts and the Small Business Administration.**

  Greater inter-agency communication is needed. An airing of views on both sides of this issue would be a useful first step. Indian Head should provide SBA documentation of problem small business cases and suggestions as to how future instances can be avoided.

- **Indian Head should consider contracting out a greater portion of R&D to help the CAD/PAD industry retain skilled labor, and further promote dual use technologies.**

- **Indian Head CAD/PAD management should conduct an ongoing evaluation of duplication costs and the necessity of keeping core capabilities.**

<u>Recommendations for BXA's Office of Strategic Industries and Economic Security</u>

- **Provide list of CAD/PAD industry subvendors to Indian Head NSWC; send subvendors the BXA *Competitive Enhancement and Defense Diversification Needs Assessment* survey.**

To encourage defense diversification efforts, BXA is conducting a needs assessment of the defense sub-contractor base. Firms are being surveyed by BXA to determine what government services will be most useful to them in diversifying their operations. The information collected will be used to direct U.S. Government defense diversification resources. BXA has assembled an interagency team of representatives to respond to requests for assistance. All CAD/PAD survey participants were given the opportunity to request assistance through the BXA Needs Assistance Program. Most firms are unaware of existing government diversification programs.

BXA is continuing to identify and contact defense sub-contractor groups. In July of 1995, BXA met with a representative from the National Institute of Justice/Office of Law Enforcement Technology Commercialization to discuss defense diversification opportunities for CAD/PAD manufacturers in the area of law enforcement product development. The National Law Enforcement Technology Center identified four classes of law enforcement products that could use cartridge-actuated and propellent-actuated devices: launchers, diversionary devices (i.e., smoke signal grenades), large-area dispensers for chemical incapacitating agents, and inflatable boats. BXA will be contacting CAD/PAD suppliers to inform them of the defense diversification opportunities in the area of law enforcement products. As part of this effort, BXA will be providing a list of law enforcement products currently under development so CAD/PAD manufacturers can make direct contact with potential partners.

<u>**Recommendations for U.S. Department of Transportation**</u>

o **The U.S. Department of Transportation could implement a few changes to help alleviate the concerns of the private sector, particularly of smaller companies, about the delays and cost of obtaining a letter of competent authority.**

The following suggestions:

1. Have graduated payments system based on manufacturing firm's gross revenues

2. Allow smaller firms the option to pay later.

3. Computerize record keeping at all levels of the classification process.

4. Expand use of classification by analogy to all classifications on file.

5. Establish education program, possibly on video cassette, that assists applicants, particularly new ones, in determining the required documentation requirements and how to avoid delays in classification processing.

6. Create an expert or knowledge-based system software program that assists companies in completing documentation and meeting legal requirements, and that makes the analyst's job at the Bureau of Explosives or Bureau of Mines easier. This technology is greatly underutilized in government, where it can potentially save time and money, and increase productivity several fold.

7. Expedite Indian Head's authorization to become a commercial transportation classification testing site.

<u>**Recommendations for Small Business Administration**</u>

o **The Small Business Administration should consider input and advice from the U.S. Navy prior to issuing a letter of competency.**

Because human life often depends on the performance of CAD/PAD products, the SBA may want to increase or formalize the advice received from Indian Head's CAD/PAD personnel before issuing a letter of competency to a new small business. In light of a number of non-performing U.S. Navy CAD/PAD contracts issued under the small business set-aside program, this issue should be considered carefully to avoid recurrence in the future.

Appendix A

* * *

Letter Requesting Study

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

8900
Ser 50C1/41
19 APR 1993

Mr. Robert Kugelman
Acting Under Secretary for Export Administration
Bureau of Export Administration
U. S. Department of Commerce
Room 3889
Washington, DC 20230

Dear Mr. Kugelman:

The Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland, is the lead service for Cartridge and Propellant Actuated Devices (CAD/PAD). We are interested in the continued ability of our suppliers to meet national security requirements for CAD/PAD in light of defense budget and procurement cutbacks and other factors. We request the assistance of your Office of Industrial Resource Administration in conducting an in-depth assessment of this industry.

Specifically, we would like the Bureau of Export Administration to assist us by developing and conducting a survey of CAD/PAD producers and analyzing factors affecting the industry's ability to meet national security needs. These factors would include production capabilities, financial health, defense conversion potential, regulatory environment particularly safety and environmental compliance, and others. The attached Project Overview provides more details on the scope and goals of the assessment. We are prepared to cover certain Bureau of Export Administration expenses associated with this assessment on a cost reimbursable basis through a Military Interdepartmental Purchase Request (MIPR), also attached.

Preliminary discussions on this cooperative project have been held between Brad Botwin, Director, Strategic Analysis Division of your Office of Industrial Resource Administration and myself as CAD/PAD Program Manager. Questions can be addressed to either of us. My number is 301-753-9913.

8900
Ser 50C1/41

I look forward to launching this cooperative project in the near future.

Sincerely,

D. P. CHAPPELL
Program Manager
By direction of
the Commander

Encl:
(1) Project Overview
(2) MIPR

Copy to:
U. S. Department of Commerce
Office of Budget and Financial Mgmt (Karen Smith)
Strategic Analysis Division (Brad Botwin)

Appendix B

* * *

Product Descriptions and Illustrations

APPENDIX B: Product Descriptions and Illustrations

Product descriptions and illustrations of several types and varieties of CAD/PAD products used by the military are presented here to give the reader a better appreciation of the nature and complexity of the items and how they perform their intended functions. Written product descriptions are given first; illustrations are shown at the end of the appendix. As described in the body of the report, CAD/PADs are used by the military for many aircraft applications from aircraft engine fire extinguishers and aircrew emergency escape systems, to aircraft anti-missile counter measures and many other uses.

* * * * *

Impulse Cartridges have numerous applications. For example, in the event of fire, the aircraft fire extinguisher is activated by an impulse cartridge **(figure 1),** which releases a fire extinguishing agent into the area surrounding the aircraft engine. The fire extinguisher cartridge is electrically initiated. Pressure from the main propelling charge (initiator), forces the puncture device into motion. The contents of the fire extinguisher are retained by disc type plugs at the valve opening. Upon operation of the unit, the cartridge fires a slug which breaks the disk, permitting the fire retardant charge to be expelled through the valve.

Detonating Cords and Charges are used in aircraft canopy removal and include shielded mild detonating cords, linear shape charges, flexible near shape charges, mild detonating fuses, and thin layered explosive lines. Emergency jettisoning of the aircraft canopy can be accomplished internally by the aircrew or externally by rescue personnel. The canopy jettison system is also initiated automatically during the ejection sequence to provide a clear path for seat ejection. The ejection seats typically use impulse cartridges and delay initiators to position the occupant for ejection, initiating seat propulsion and stabilization devices, and to accomplish seat/occupant separation.

Flexible Confined Detonating Cord assemblies **(figure 2)** are used in the escape system of the aircraft to provide an explosive train linking the canopy hook removal subsystems in the cockpit. Shielded Mild Detonating Cord (SMDC) assemblies **(figure 3)** are explosive transmission lines, consisting of a metal sheathed explosive core, covered with a teflon coating, all contained within a thin wall stainless steel tube. SMDC is available in various lengths and bend configurations. SMDC's are also used in the emergency canopy removal system to provide an interconnecting

explosive path to the window cutting assembly.

Impulse Initiators are 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 SMDC. The cartridge actuated initiator **(figure 4)** is a lanyard operated device used in the aircrew escape system. Seat ejection is initiated by pulling a seat-firing handle which actuates the initiator(s). When the lanyard operated initiator assembly handle is pulled, the firing pins are released igniting the initiator.

Percussion initiated impulse cartridges use percussion primers to initiate energetic material. The percussion initiated impulse cartridge **(figure 5)** is the power source that actuates the pilot's canopy unlatch thruster which unlocks the canopy before canopy jettison, and supplies gas pressure to actuate two propellant actuated initiators which initiate SMDC to the canopy jettison rocket motors. When the cartridge is fired by a SMDC, pressure builds up against the firing disc to push both firing pins into the primers, which ignites the ignition charge. The igniter charge then fires the propellant charge, which produces gas pressure. The gas pressure is routed through the canopy unlatch thruster, moving the canopy to the rear of the aircraft.

Catapults, Thrusters, and Removers use energetic materials and employ telescoping-type tubes to perform functions such as separation, ejection, thrusting, or movement.

The rocket catapult **(figure 6)** is designed to remove ejection seat and aircrew member from the aircraft and propel aircrew/seat to a height necessary for safe parachute deployment. The catapult is a gas actuated, solid propellant booster rocket, which provides the initial power for the ejection of the seat. The catapult consists of an outer barrel and an inner telescopic piston. The rocket catapult is a self-contained, mechanically initiated, two stage, solid propellant booster rocket. The nozzle is positioned to provide rocket thrust through the center of gravity of the aircrew/seat combination during ejection.

As the seat travels up the guide rails, the auxiliary cartridges in the catapult are fired; the emergency oxygen supply is mechanically activated; the leg restraint lines are drawn tight; and, the rocket motor initiator is fired. The impulse cartridge in the rocket motor initiator fires the underseat rocket to provide sustaining thrust for the ejection seat. The underseat rocket is fired as the catapult reaches the end of its stroke and sustains the thrust of the catapult to carry the seat to a height sufficient to enable the seat to deploy. Timing of all events after rocket motor initiation are controlled by the electronic sequencer, which utilizes altitude and airspeed

information to select the correct mode of operation.

Pullers and thrusters are basically the same, except they work in reverse. The motion of the puller is inward while the thruster is outward. Power derived from a ballistic cartridge moves a piston in the desired direction. Pullers are used primarily for releasing attached components (e.g., retaining rings, pins, etc.) while thrusters, working in reverse, are moving mechanisms. The cartridge actuated thruster **(figure 7)** is used to force the integrated control system tray in an upward position, providing a clear ejection path during the aircraft emergency escape sequence. It is triggered by gas pressure provided by a remote initiator.

The illustrated underseat rocket motor **(figure 8)** is used on F-14 aircraft; it is a self-contained, mechanically initiated, solid propellant rocket. The rocket motor contains 13 propellant tubes, six nozzles, and one firing unit tube. The six rocket nozzles are fitted underneath the center body and are angled outward to give maximum thrust at the center of gravity. When the seat is ejected from the aircraft, the static line, attached to the aircraft floor becomes taught and activates the firing mechanism to initiate the ignitor. The rocket motor provides thrust for approximately a half-second to propel the aircrew and seat to an altitude sufficient for safe parachute decent, even if ejection is initiated from the ground.

Delay Cartridges and Delay Initiators are items that incorporate pyrotechnic delay material to regulate the timing of the output charge initiation. These include electrically and percussion primed delay cartridges and delay initiators. The explosive actuated delay initiator **(figure 9)** is designed to provide a three second delay in the interseat sequencing system of the aircraft. The explosive energy from the SMDC forces the initiator firing pin to ignite a primer charge. The primer charge ignites an explosive mix which fires a fuse. The fuse provides a three-tenths second time delay before an explosive mix and booster charge is ignited. The explosive energy from the booster then fires an SMDC attached to the outlet port of the initiator.

The delay cartridge **(figure 10)** is used to actuate an automatic parachute release after a three-fourths second delay from the time it is actuated during the ejection sequence from an aircraft. As the seat is ejected from the cockpit, the firing cable is pulled, withdrawing a sear pin from the release mechanism. This action releases the firing pin which strikes the primer, igniting the delay column in sequence to the main charge. The gases generated actuate the parachute release actuator.

The parachute container is fitted with canopy breakers to enable the seat to eject through the

cockpit canopy should the automatic canopy ejection system fail. After ejection, drogue deployment, aircrew/seat separation, and parachute deployment are automatically controlled by an on-board, electronic sequencer. A barostatic release unit provides backup in case of partial or total failure of the electronic sequencer, and a manual override system provides a further backup in the event of failure of the barostatic release.

Gas pressure from impulse cartridges extract the drogue chute to stabilize the aircrew seat. A time release mechanism then provides a several second delay prior to seat-occupant separation. Time delay may vary depending on altitude and airspeed conditions. At the appropriate time an impulse cartridge then releases the drogue chute from the seat. The drogue chute then deploys the parachute to separate the occupant from the seat.

Cutters are devices which employ energetic materials and a cutting blade to sever objects such as a bolt, wire, or cable suspension lines. There are basically two types of cutters, guillotine type and punch type. A guillotine cutter is an axe or blade knife propelled internally by an energetic material. They are used where there is a need for rapid, remote cutting of cable, wire rope, hose, or fuel line. They are designed for mechanical or electrical triggering of the cartridge. A cartridge actuated cutter **(figure 11)**, with a cartridge sealed-in, is used to sever nylon reefing line attached to a recovery parachute. This cutter consists of an aluminum tubular body containing a spring-loaded firing pin and a six second delay cartridge. Once the cartridge is fired the resulting expanding gases force the cutter blade forward, severing the reefing line, which permits full deployment of the recovery parachute.

Ejector Cartridges employ propellants and explosives to eject sonobouys, and to release bombs and missiles from aircraft. This category also includes cartridges that launch aircraft flares or chaff for anti-aircraft missile countermeasures. An aircraft flare ejection cartridge **(figure 12)** is designed to provide a power source for the ejection of aircraft flares and chaff. This cartridge is electrically initiated. When fired, the resulting pressure operates the dispenser or pod.

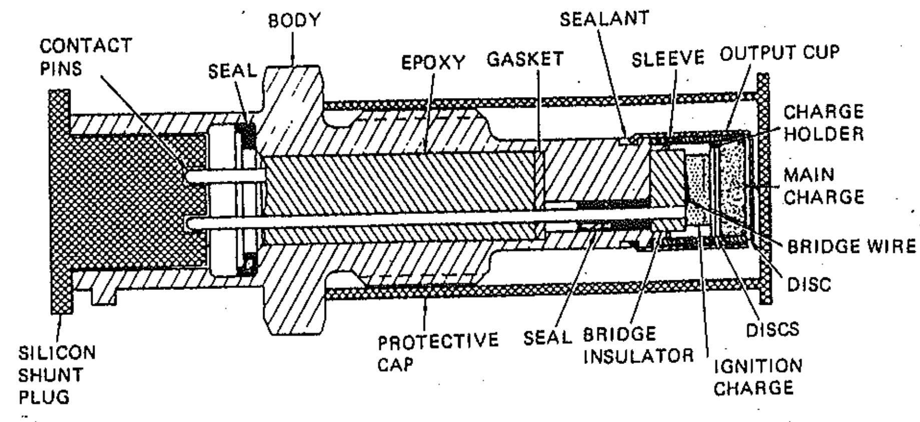


Figure 1. Electrically Initiated Impulse (Fire Extinguisher) Cartridge

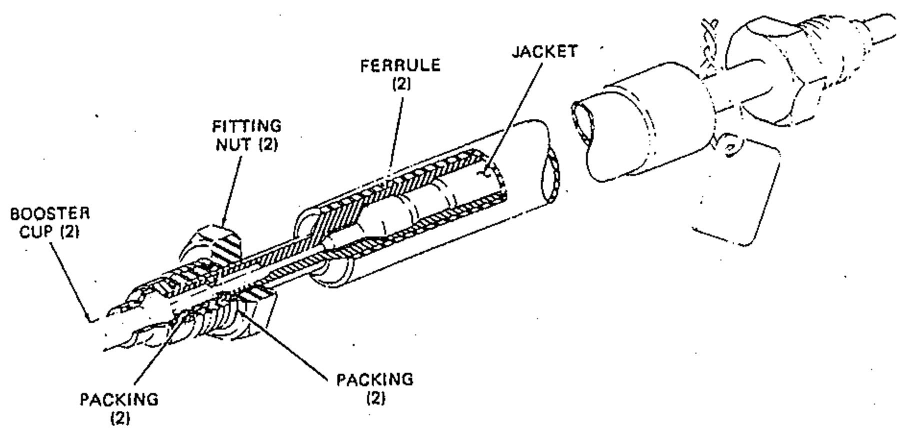


Figure 2. Flexible Confined Detonating Cord Assembly

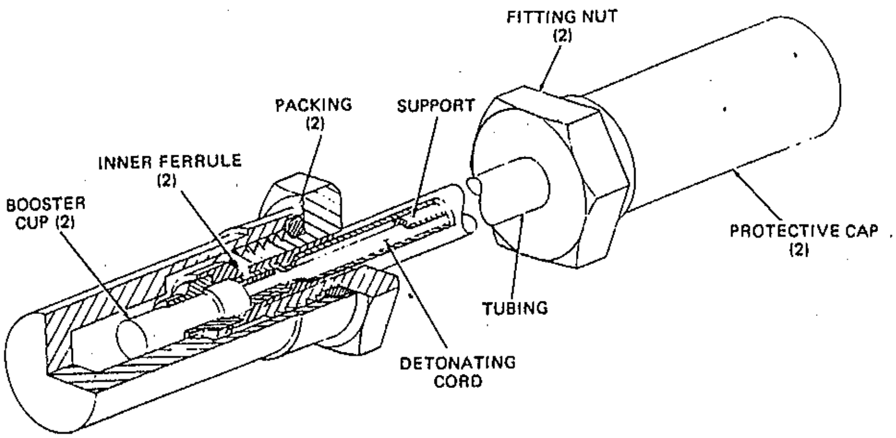


Figure 3. Shielded Mild Detonating Cord

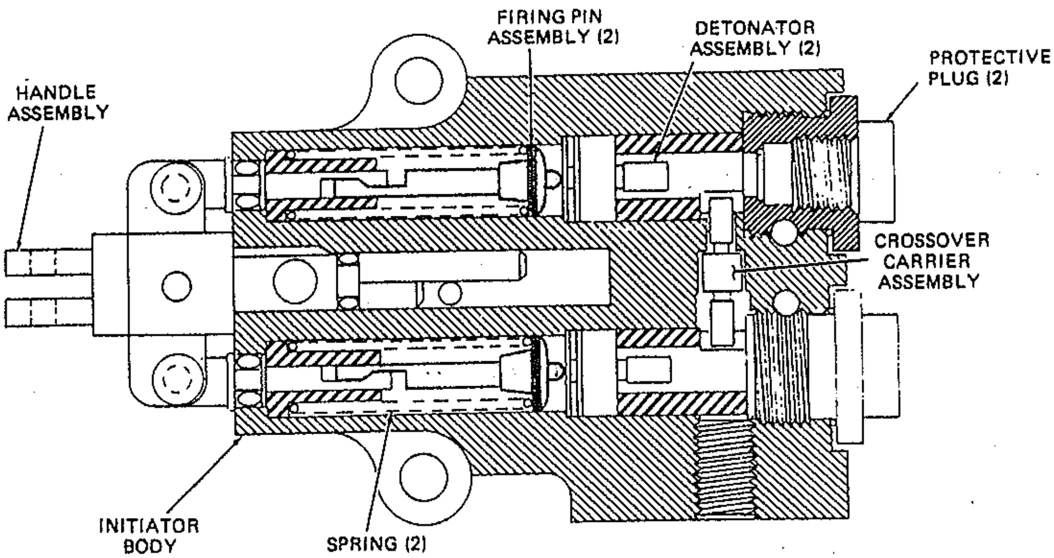


Figure 4. Impulse Initiator

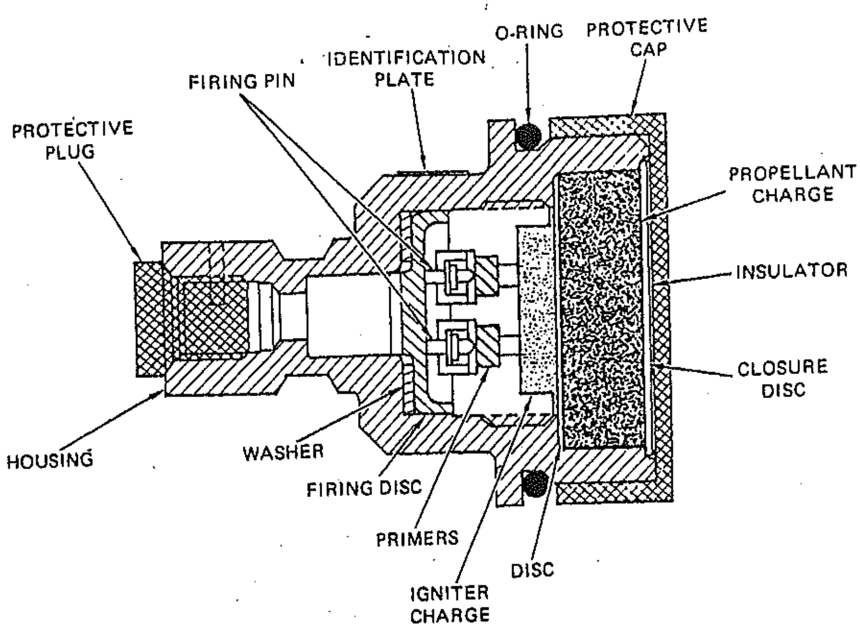


Figure 5. Percussion Initiated Impulse Cartridge

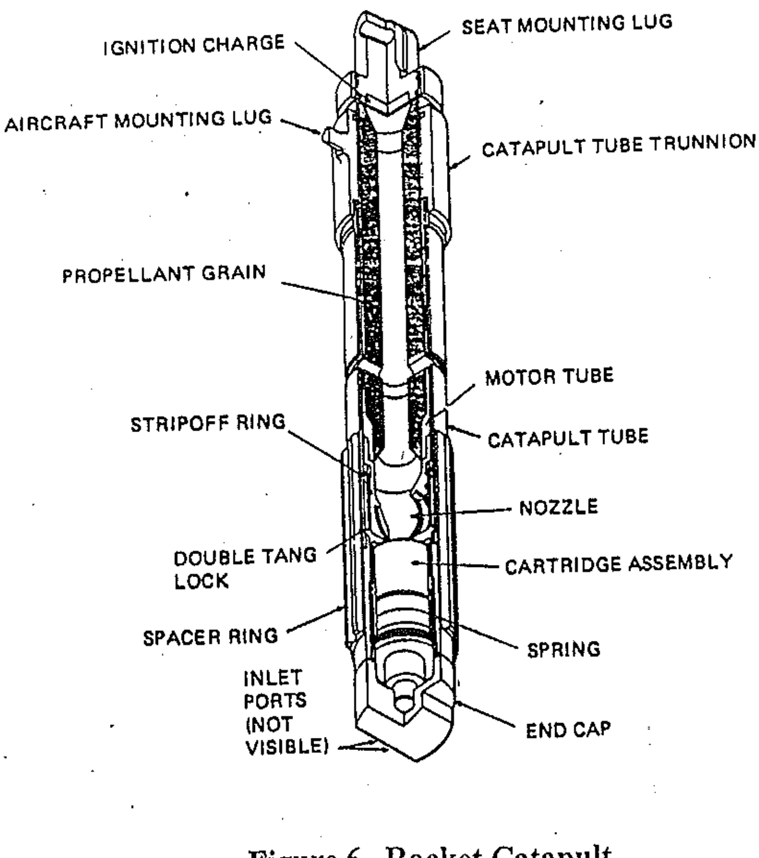


Figure 6. Rocket Catapult

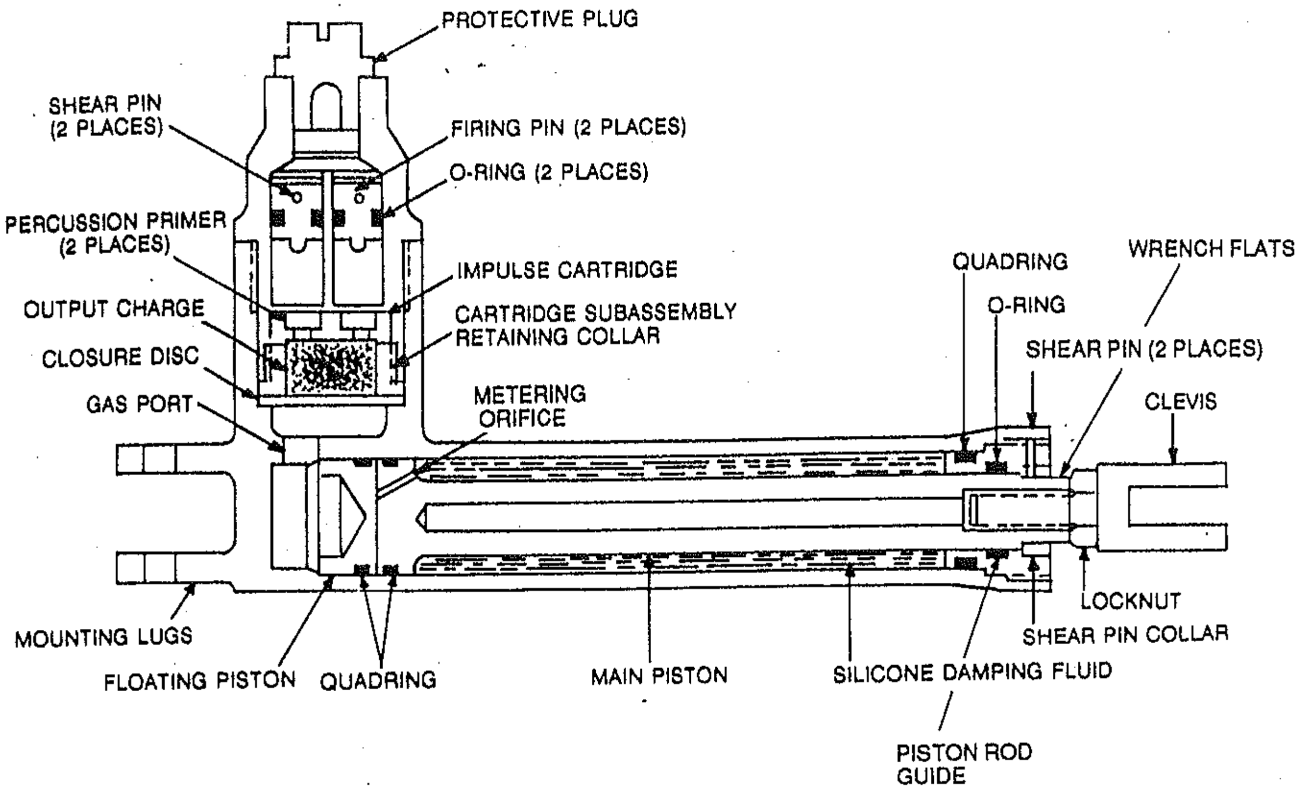


Figure 7. Thruster

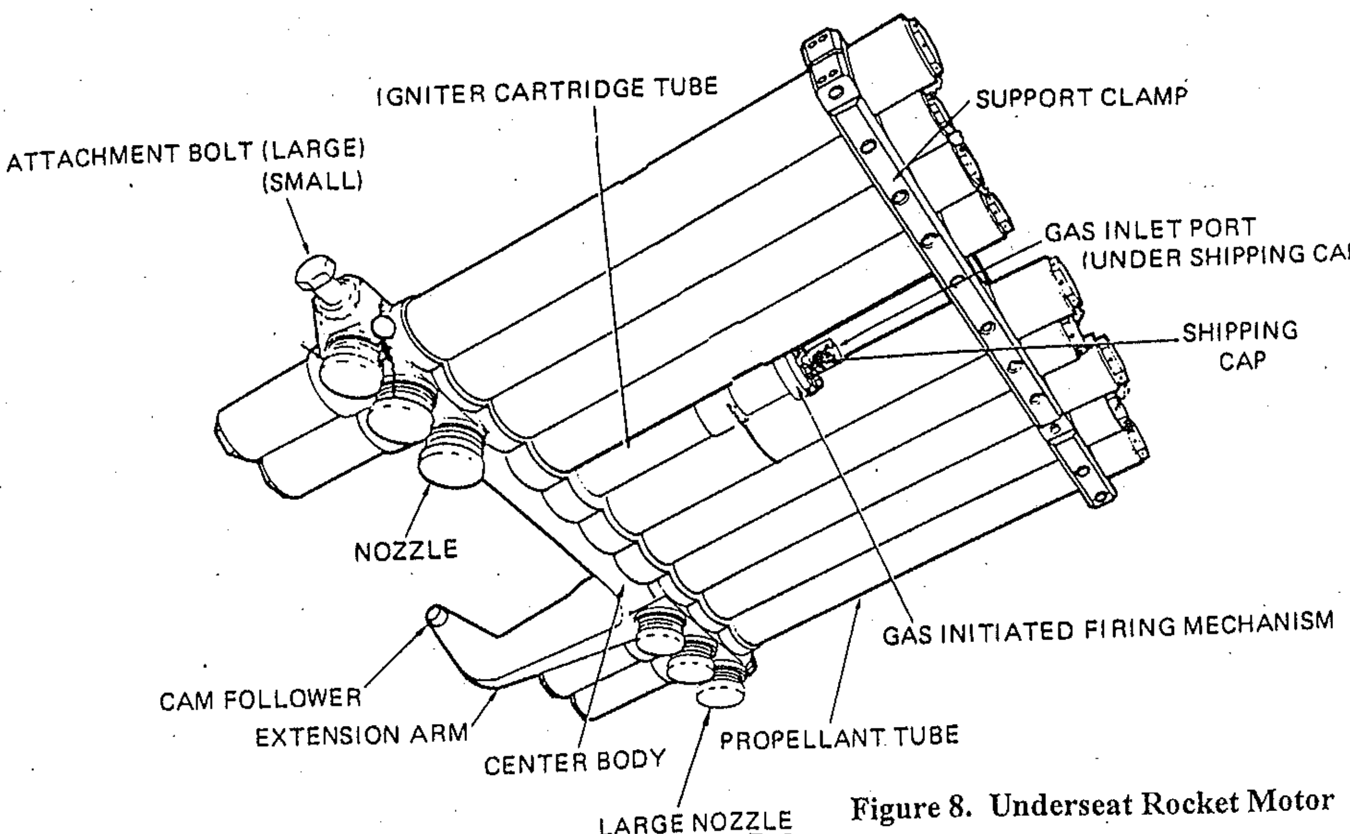


Figure 8. Underseat Rocket Motor

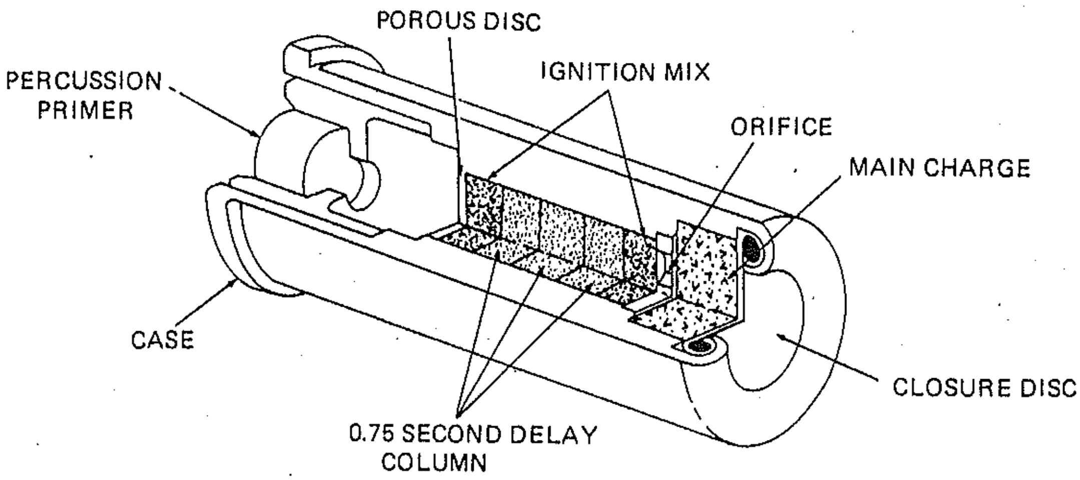


Figure 9. Delay Initiator

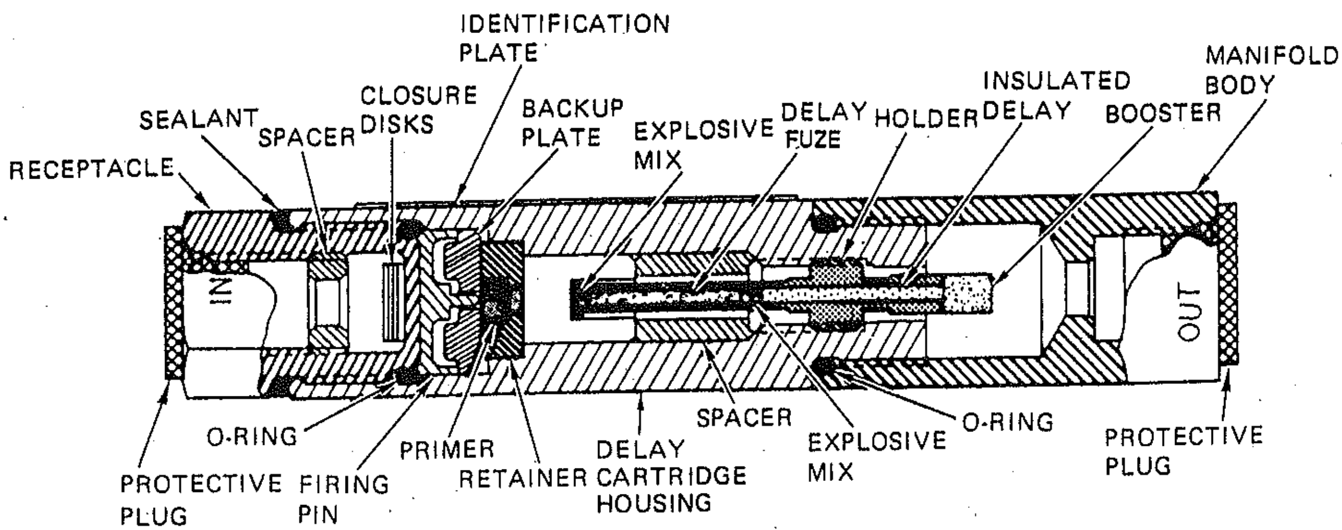


Figure 10. Delay Cartridge

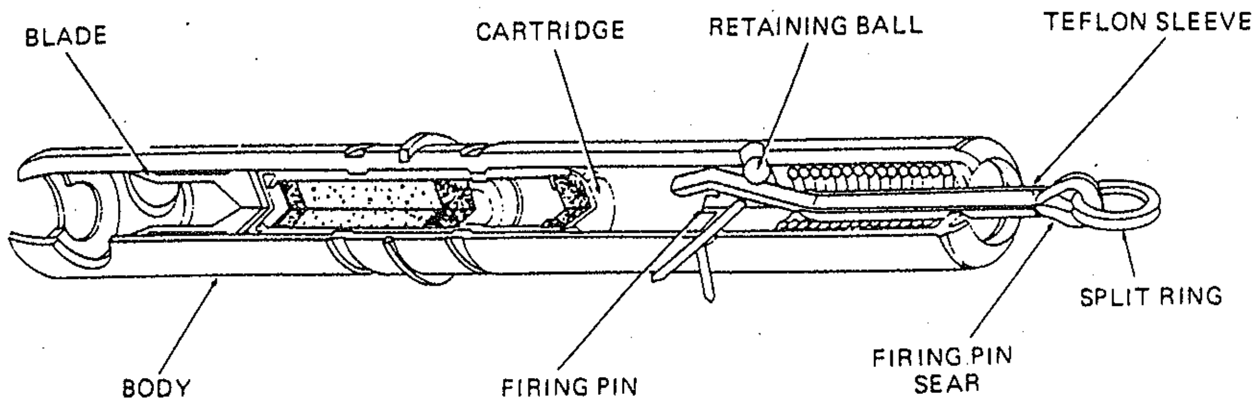


Figure 11. Cutter

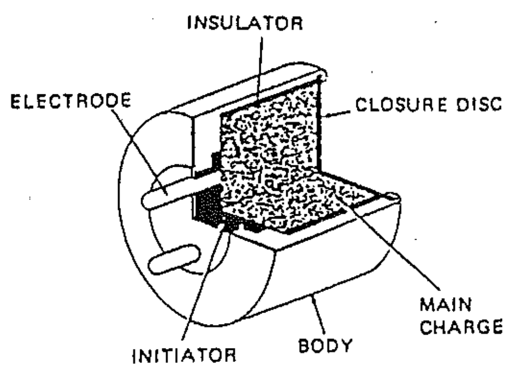


Figure 12. Aircraft Flare Ejection Cartridge

Appendix C

* * *

Transportation Classification Regulations

(b) An explosive mixture or device containing a chlorate and also containing:

(1) An ammonium salt, including a substituted ammonium or quaternary ammonium salt; or

(2) An acidic substance, including a salt of a weak base and a strong acid.

(c) A leaking or damaged package of explosives.

(d) Propellants that are unstable, condemned or deteriorated.

(e) Nitroglycerin, diethylene glycol dinitrate, or any other liquid explosives not specifically authorized by this subchapter.

(f) A loaded firearm (except as provided in 14 CFR 108.11).

(g) Fireworks that combine an explosive and a detonator.

(h) Fireworks containing yellow or white phosphorus.

(i) A toy torpedo, the maximum outside dimension of which exceeds 23 mm (0.906 inch), or a toy torpedo containing a mixture of potassium chlorate, black antimony (antimony sulfide), and sulfur, if the weight of the explosive material in the device exceeds 0.26 g (0.01 ounce).

(j) Explosives specifically forbidden in the § 172.101 Table of this subchapter.

(k) Explosives not meeting the acceptance criteria specified in § 173.57 of this subchapter.

(l) An explosive article with its means of initiation or ignition installed, unless approved in accordance with § 173.56.

[Amdt. 173-224, 55 FR 52617 Dec. 21, 1990, as amended at 56 FR 66267, Dec. 20, 1991; Amdt. 173-236, 58 FR 50236, Sept. 24, 1993]

§ 173.55 [Reserved]

§ 173.56 New explosives—definition and procedures for classification and approval.

(a) Definition of new explosive. For the purposes of this subchapter a *new explosive* means an explosive produced by a person who:

(1) Has not previously produced that explosive; or

(2) Has previously produced that explosive but has made a change in the formulation, design or process so as to alter any of the properties of the explosive. An explosive will not be considered a "new explosive" if an agency listed in paragraph (b) of this section has determined, and confirmed in writing to the Associate Administrator for Hazardous Materials Safety, that there are no significant differences in hazard characteristics from the explosive previously approved.

(b) Examination, classing and approval. Except as provided in paragraph (j) of this section, no person may offer a new explosive for transportation unless that person has specified to the examining agency the ranges of composition of ingredients and compounds, showing the intended manufacturing tolerances in the composition of substances or design of articles which will be allowed in that material or device, and unless it has been examined, classed and approved as follows:

(1) A new explosive must be examined and assigned a recommended shipping description, class, and classification code by the Bureau of Explosives (BOE) or the Bureau of Mines, U.S Department of Interior (BOM). The recommendation of class and classification code must be based on the tests and criteria prescribed in §§ 173.52, 173.57 and 173.58 of this subchapter. Each person requesting approval of a new explosive must submit a copy of the report of examination and assignment of recommended shipping description, class and classification code to the Associate Administrator for Hazardous Materials Safety for approval and must receive written approval and an EX-number from the Associate Administrator for Hazardous Materials Safety before offering that explosive for transportation.

(2) A new explosive made by or under the direction or supervision of a component of the DOD may be examined, classed, and concurred in by:

(i) U.S. Army Technical Center for Explosives Safety (SMCAC-EST), Naval Sea Systems Command (SEA-9934), or Air Force Safety Agency (SEW), when approved by the Chairman, DOD Explosives Board, in accordance with the Department of Defense Explosives Hazard Classification Procedures (TB 700-2, dated December 1989); or

(ii) The agencies and procedures specified in paragraph (b)(1) of this section.

(3) A new explosive made by or under the direction or supervision of the Department of Energy (DOE) may be—

(i) Examined by the DOE in accordance with the Explosives Hazard Classification Procedures (TB 700–2, dated December, 1989), and must be classed and approved by DOE; or

(ii) Examined, classed, and approved in accordance with paragraph (b)(1) of this section.

(4) For a material shipped under the description of "ammonium nitrate-fuel oil mixture (ANFO)", the only test required for classification purposes is the Cap Sensitivity Test (Test Method 5(a), prescribed in the Explosive Test Manual). The test must be performed by an agency listed in paragraph (b)(1), (b)(2), or (b)(3) of this section, the manufacturer, or the shipper. A copy of the test report must be submitted to the Associate Administrator for Hazardous Materials Safety before the material is offered for transportation, and a copy of the test report must be retained by the shipper for as long as that material is shipped. At a minimum, the test report must contain the name and address of the person or organization conducting the test, date of the test, quantitative description of the mixture, including prill size and porosity, and a description of the test results.

(c) Filing DOD or DOE approval report. DOD or DOE must file a copy of each approval, accompanied by supporting laboratory data, with the Associate Administrator for Hazardous Materials Safety and receive acknowledgement in writing before offering the new explosive for transportation, unless the new explosive is:

(1) Being transported under paragraph (d) or (e) of this section; or

(2) Covered by a national security classification currently in effect.

(d) Transportation of explosive samples for examination. Notwithstanding the requirements of paragraph (b) of this section with regard to the transportation of a new explosive that has not been approved, a person may offer a sample of a new explosive for transportation, by railroad, highway, or vessel from the place where it was produced to an agency identified in paragraph (b) of this section, for examination if—

(1) The new explosive has been assigned a tentative shipping description and class in writing by the testing agency;

(2) The new explosive is packaged as required by this part according to the tentative description and class assigned, unless otherwise specified in writing by the testing agency; and,

(3) The package is labeled as required by this subchapter and the following is marked on the package:

(i) The words "SAMPLE FOR LABORATORY EXAMINATION";

(ii) The net weight of the new explosive; and

(iii) The tentative shipping name and identification number.

(e) Transportation of unapproved explosives for developmental testing. Notwithstanding the requirements of paragraph (b) of this section, the owner of a new explosive that has not been examined or approved may transport that new explosive from the place where it was produced to an explosives testing range if—

(1) It is not a primary (a 1.1A initiating) explosive or a forbidden explosive according to this subchapter;

(2) It is described as a Division 1.1 explosive (substance or article) and is packed, marked, labeled, described on shipping papers and is otherwise offered for transportation in conformance with the requirements of this subchapter applicable to Division 1.1;

(3) It is transported in a motor vehicle operated by the owner of the explosive; and

(4) It is accompanied by a person, in addition to the operator of the motor vehicle, who is qualified by training and experience to handle the explosive.

(f) Notwithstanding the requirements of paragraphs (b) and (d) of this section, the Associate Administrator for Hazardous Materials Safety may approve a new explosive on the basis of an approval issued for the explosive by the competent authority of a foreign government, or when examination of the explosive by the Bureau of Explosives or the Bureau of Mines is impracticable, on the basis of reports of tests conducted by disinterested third parties, or may approve the transportation of an explosives sample for the

purpose of examination by the BOE, the BOM, or other government agency.

(g) Notwithstanding the requirements of paragraph (b) of this section, an explosive may be transported under §§ 171.11, 171.12, 171.12a or § 176.11 of this subchapter without the approval of the Associate Administrator for Hazardous Materials Safety if the Associate Administrator for Hazardous Materials Safety has acknowledged, in writing, the acceptability of an approval issued by the competent authority of a foreign government pursuant to the provisions of the UN Recommendations, the ICAO Technical Instructions, the IMDG Code, or other national or international regulations based on the UN Recommendations. In such a case, a copy of the foreign competent authority approval, and a copy of the written acknowledgement of its acceptance must accompany each shipment of that explosive.

(h) The requirements of this section do not apply to cartridges, small arms which are:

(1) Not a forbidden explosive under § 173.54 of this subchapter;

(2) Ammunition for rifle, pistol, or shotgun;

(3) Ammunition with inert projectile or blank ammunition; and

(4) Ammunition not exceeding 50 caliber for rifle or pistol cartridges or 8 gauge for shotgun shells.

Cartridges, small arms meeting the criteria of this paragraph (h) may be assigned a classification code of 1.4S by the manufacturer.

(i) If experience or other data indicate that the hazard of a material or a device containing an explosive composition is greater or less than indicated according to the definition and criteria specified in §§ 173.50, 173.56, and 173.58 of this subchapter, the Associate Administrator for Hazardous Materials Safety may, following examination in accordance with paragraph (b) of this section, revise its classification or except the material or device from the requirements of this subchapter.

(j) Fireworks. Notwithstanding the requirements of paragraph (b) of this section, Division 1.3 and 1.4 fireworks may be classed and approved by the Associate Administrator for Hazardous Materials Safety without prior examination and offered for transportation if the following conditions are met:

(1) The fireworks are manufactured in accordance with the applicable requirements in APA Standard 87-1;

(2) A thermal stability test is conducted on the device by the BOE, the BOM, or the manufacturer. The test must be performed by maintaining the device, or a representative prototype of a large device such as a display shell, at a temperature of 75 °C (167 °F) for 48 consecutive hours. When a device contains more than one component, those components which could be in physical contact with each other in the finished device must be placed in contact with each other during the thermal stability test; and

(3) The manufacturer applies in writing to the Associate Administrator for Hazardous Materials Safety following the applicable requirements in APA Standard 87-1, and is notified in writing by the Associate Administrator for Hazardous Materials Safety that the fireworks have been classed, approved, and assigned an EX-number. Each application must be complete, including all relevant background data and copies of all applicable drawings, test results, and any other pertinent information on each device for which approval is being requested. The manufacturer must sign the application and certify that the device for which approval is requested conforms to APA Standard 87-1 and that the descriptions and technical information contained in the application are complete and accurate. If the application is denied, the manufacturer will be notified in writing of the reasons for the denial. The Associate Administrator for Hazardous Materials Safety may require that the fireworks be examined by an agency listed in paragraph (b)(1) of this section.

[Amdt. 173-224, 55 FR 52617 Dec. 21, 1990, as amended at 56 FR 66267, Dec. 20, 1991; Amdt. 173-234, 58 FR 51532, Oct. 1, 1993]

§ 173.57 Acceptance criteria for new explosives.

(a) Unless otherwise excepted, an explosive substance must be subjected to the Drop Weight Impact Sensitivity Test (Test Method 3(a)(i)), the Friction Sensitivity Test (Test Method 3(b)(iii)), the Thermal Stability Test (Test Meth-

Appendix D

* * *

Aggregate Statistical Tables

(116)

Table 1: FOREIGN SOURCING OF CAD/PAD MATERIALS		
Foreign Source	Imported Components	Reason(s) for Importing
Societe Swisse Des Explosives, Switzerland	Petn	No known domestic source
Canada	Dextrinated lead azide	No known domestic source
Norabel, Sweden	HNS	No known domestic source
ICI, Canada	Petn	No known domestic source
Germany	Zirconium	No known domestic source
Bofore, Sweden	HNS powder	No known domestic source
Chemtal, Germany	Zirconium	No known domestic source
Government of China	PVX explosive	No known domestic source,
Thiokol/Venton (acq. by Ger. co.	Zirconium-nickel alloys and zirconium powder	No known domestic source
Ambersil Ltd., England	Silcoset	No known domestic source
Llewellyn Ryland, England	QX lacquer	No known domestic source
Royal Ordnance, England and Scotland	Propellants and powders	No known domestic source
Sherman Chemical, England	Chemical rd (1286)	No known domestic source
B & K Resins, England	Resin	No known domestic source
Sil-Mid, Scotland	Araldite	No known domestic source
Med-Labs, England	Compound	No known domestic source
CM Chemicals, Germany	Titanium powder	Domestic source inadequate
Kyocera, Japan	Alumina oxide	Lower cost
Cemex, Slovenia	Aluminum	Lower cost
Bofors/Dyno, Canada/Sweden	Explosive materials	Lower cost
Hummel (supposedly acq by foreign co.)	Barium chromate	Quicker delivery; Better quality/reliability
Sammi, Korea; Daido, Japan	Stainless steel tubing	Brand stocked by supplier

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

Table 2: FOREIGN SOURCING OF CAD/PAD COMPONENTS		
Foreign Source	Imported Components	Reason(s) for Importing
Canada	Electronic Fuze Components	No known domestic source
Martin-Baker, England	Assorted Parts	No known domestic source
Expro, Canada	Extruded double base propellants	Supplement to domestic source; Lower cost; Quicker delivery
Davez Bickford, France	Electric Matches	Lower cost; Better quality/reliability
Comet GMBL, Germany	Electric Connectors	Lower cost; Better quality/reliability
Martin-Baker, England	Labels	Quicker delivery
Kyocera, Japan	Charge Cups Alumina Ceramic	Lower cost; Better quality/reliability

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

Table 3: FOREIGN SOURCING OF CAD/PAD MACHINERY & EQUIPMENT		
Foreign Source	**Imported Components**	**Reason(s) for Importing**
Imoberdorf A.G., Switzerland	Rotary index machining centers	No known domestic source
Auto-Roll, Switzerland	Marking machine	No known domestic source
Germany	Plasma etch machine (clean parts)	No known domestic source
Werner Pfleiderer, Germany	Continuous process extruder	No known domestic source
Hermann, Germany	Ultrasonic welder	Domestic source inadequate
Hitachi Seiki, Japan	CNC lathe	Lower cost; Better quality/reliability
Okama, Japan	CNC lathe	Lower cost; Quicker delivery; Better quality/reliability
Makeno, Japan	CNC mills	Lower cost; Quicker delivery; Better quality/reliability
Arburg, Germany	Arburg mold used to mold phenolic plugs	Lower cost
Hitachi; Mitsui Seiki, Japan	CNC mills	Lower cost
Astro Pysics, Germany	X-ray machine	Lower cost
Enco, Taiwan	Milling machines	Lower cost, Quicker delivery
Fagor, Spain	CNC machines	Lower cost; Quicker delivery; Supplement to domestic source
Feeler, Taiwan	Lathe	Lower cost; Quicker delivery
Gildemeister, Germany	Primary machining	Better quality/reliability
Daewoo; Dainichi; Kitamura; Mazak; Miyano	CNC machine	Beter quality/reliability
Toyoda; Yam; Yokihama, Japan	NC lathes	Better quality/reliability
Dyno Nobel, Sweden	HEX/aluminum-powder processing and handling equipment	Production process designed and roofed

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

Table 4: CAD/PAD SHIPMENT AND EMPLOYMENT STATISTICS					
Year	**1991**	**1992**	**1993**	**1994**	**1995**
CAD/PAD Shipments (in $000s)					
Total Shipments	288,184	310,938	334,034	349,353	425,291
Defense Shipments	210,134	209,874	191,303	165,741	177,912
% Defense of Total	73%	67%	57%	47%	42%
Commercial Shipments	78,050	101,064	142,731	183,612	247,379
% Commercial of Total	27%	33%	43%	53%	58%
Export Shipments	21,878	22,927	24,848	22,841	20,282
% Exports of Total	8%	7%	7%	7%	5%
Shipments - Top 4 firms	154,931	175,231	195,804	222,868	273,986
% Top 4 of Total	54%	56%	59%	64%	64%
CAD/PAD Employment By Occupation					
Marketing/Sales	66	64	58	59	55
Technical Services	206	198	183	177	182
Technicians	338	306	292	287	294
Scientist/Engineer	436	408	390	404	414
Production Workers	1,977	1,807	1,831	2,355	2,426
All Others	735	630	610	640	608
Total Employees	3,758	3,413	3,364	3,922	3,979
Salient Employment Indicators					
% Prod. Wkrs. of Total	53%	53%	54%	60%	61%
Empl. - Top 4 firms	1,893	1,787	1,997	2,432	2,563
% Top 4 of Total	50%	52%	59%	62%	63%
Shipments/Empl.. ($000s)	$77	$91	$99	$89	$105

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

Table 5: CAPITAL INVESTMENT IN CAD/PAD OPERATIONS						
	1991	1992	1993	1994	1995	5-year Totals
No. of Usable Reports	32	32	33	33	33	33
CAD/PAD Sales	$305,952	$335,768	$343,770	$360,825	$440,425	$1,786,740
Total Capital Invested	$8,173	$8,330	$20,531	$22,286	$18,821	$78,141
Invested in Plant	$1,539	$2,504	$8,930	$7,453	$4,934	$25,409
Invested in Machinery and Equipment	$6,635	$5,826	$11,601	$14,833	$13,837	$52,733
% Invested per Sales Dollar	2.67%	2.48%	5.97%	6.18%	4.27%	3.00%
REASONS FOR CAPITAL INVESTMENT						
Replace Old Equipment	17	16	14	17	16	80
Improve Productivity	17	17	18	20	13	85
Expand Capacity	11	16	14	13	16	70
Add New Capability	16	18	21	18	16	89
Upgrade Technology	16	15	19	19	19	88
Meet Customer Rqmt.	7	9	9	9	7	41
Comply w/EPA, OSHA	6	9	11	11	10	47
Other	1	1	1	0	0	3

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

Table 6: RESEARCH AND DEVELOPMENT STATISTICS						
Year	1991	1992	1993	1994	1995	5-year Totals
Total All Operations: Commercial R&D (in $000s)						
Materials	655	730	718	848	1,073	4,024
Production Processing	2,260	2,749	2,791	2,899	3,035	13,734
Product Development	7,568	8,647	9,467	13,245	11,164	50,091
Total	10,483	12,126	12,976	16,991	15,271	67,847
Defense R&D ($000s)						
Materials	5,304	5,482	9,741	13,484	19,079	53,090
Production Processing	1,890	2,153	2,775	2,781	2,638	12,237
Product Development	34,436	30,653	64,497	72,020	99,715	301,321
Total	43,716	40,075	78,952	90,209	123,309	376,261
CAD/PAD Operations: Commercial R&D ($000s)						
Materials	90	102	191	215	416	1,014
Production Processing	613	1,170	1,257	1,093	999	5,132
Product Development	776	848	2,354	5,027	3,281	12,286
Total	1,479	2,119	3,802	6,335	4,696	18,431
CAD/PAD Defense R&D ($000s)						
Materials	621	1,145	1,091	1,075	1,129	5,061
Production Processing	1,282	2,735	2,079	1,792	2,055	9,943
Product Development	4,704	5,788	8,758	8,014	7,999	35,263
Total	6,877	9,936	12,236	11,208	11,739	51,996
Reported Sources of R&D Funding: All Operations						
In-House	15,420	16,417	15,676	17,805	17,974	83,292
Customer	607	1,441	2,595	2,789	2,913	10,345
Federal Government	17,547	17,924	26,178	20,978	22,674	105,301

Note: Some firms provided totals only without reporting dollar values by materials, production processing, or product development. Also, not all firms that reported R&D reported sources of R&D funding.
Source: U.S. DOC/BXA CAD/PADIndustry Survey

Table 7: CAD/PAD INDUSTRY PROFITS						
Year	**1991**	**1992**	**1993**	**1994**	**1995**	**5-year Totals**
CAD/PAD Sales	$174,832	$207,461	$222,852	$220,339	$290,730	$1,116,214
Reported Profits	$14,971	$18,527	$17,257	$4,325	$18,181	$73,261
% per sales dollar	8.56%	8.93%	7.74%	1.96%	6.25%	6.56%
% straight average	6.70%	8.18%	7.53%	1.60%	7.01%	6.38%
Standard Deviation, straight calculation	8.27%	5.99%	8.87%	15.57%	4.86%	4.98%
Standard Deviation, based on sample size	8.47%	6.13%	9.06%	15.89%	4.96%	5.08%
Maximum % Reported	15.98%	20.14%	25.00%	18.01%	17.97%	18.76%
Minimum % Reported	-16.67%	-7.19%	-14.17%	-62.86%	-1.00%	-3.65%
Number of Firms Reporting						
No. of Usable Reports	21	22	24	25	23	25
No. less than 0%	3	2	5	7	3	2
No. less than 5%	7	5	9	13	9	10
No. less than 6%	8	7	10	15	10	13
No. more than 10%	10	8	10	7	7	7

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

Table 8: All U.S. Manufacturing							
	Shipments	Capital Invested	Employment		Shipment Comparisons		% Prod. Wkrs to All Employees
			Total	Prod. Wkrs	% Capital Invested	($000s) per employee	
Year	(in millions)		(in thousands)				
1983	$2,045.9	$61.9	18.7	12.2	3.03%	$109	65.24%
1984	$2,253.4	$75.2	19.1	12.6	3.34%	$118	65.97%
1985	$2,280.2	$83.1	18.8	12.2	3.64%	$121	64.89%
1986	$2,260.3	$76.4	18.4	11.8	3.38%	$123	64.13%
1987	$2,475.8	$78.6	18.9	12.3	3.17%	$131	65.08%
1988	$2,682.6	$80.6	19.1	12.4	3.00%	$140	64.92%
1989	$2,792.7	$97.2	19.0	12.3	3.48%	$147	64.74%
1990	$2,873.5	$102.0	18.8	12.1	3.55%	$153	64.36%
1991	$2,826.2	$98.9	18.1	11.5	3.50%	$156	63.54%
1992	$3,006.3	$103.7	18.3	11.7	3.45%	$164	63.93%

Table 9: Industry 2892, Explosives							
	Shipments	Capital Invested	Employment		Shipment Comparisons		% Prod. Wkrs to All Employees
			Total	Prod. Wkrs	% Capital Invested	($000s) per employee	
Year	(in millions)		(in thousands)				
1983	$919.7	$22.0	12.0	7.9	2.39%	$77	65.83%
1984	$1,135.7	$34.9	13.3	8.9	3.07%	$85	66.92%
1985	$1,110.7	$48.4	13.2	8.8	4.36%	$84	66.67%
1986	$1,020.3	$32.2	13.0	8.5	3.16%	$78	65.38%
1987	$1,117.8	$22.6	13.8	9.2	2.02%	$81	66.67%
1988	$1,128.4	$26.8	13.6	9.1	2.38%	$83	66.91%
1989	$1,151.0	$49.3	13.2	8.9	4.28%	$87	67.42%
1990	$1,324.6	$43.6	13.8	9.4	3.29%	$96	68.12%
1991	$1,572.4	$84.3	14.0	9.2	5.36%	$112	65.71%
1992	$1,237.4	$32.8	11.3	7.4	2.65%	$110	65.49%

Source: U.S. Dept. of Commerce, Bureau of the Census, Census of Manufactures

Table 10: Industry 3483, Ammunition, Except for Small Arms, N.E.C.							
	Shipments	Capital Invested	Employment		Shipment Comparisons		% Prod. Wkrs to All Employees
			Total	Prod. Wkrs	% Capital Invested	($000s) per employee	
Year	(in millions)		(in thousands)				
1983	$2,014.0	$32.5	25.9	17.3	1.61%	$78	66.80%
1984	$2,249.8	$74.0	27.8	18.1	3.29%	$81	65.11%
1985	$2,754.2	$50.8	31.7	20.9	1.84%	$87	65.93%
1986	$3,204.6	$56.6	34.8	22.7	1.77%	$92	65.23%
1987	$3,983.2	$77.0	41.5	25.8	1.93%	$96	62.17%
1988	$4,290.8	$83.6	39.9	24.2	1.95%	$108	60.65%
1989	$3,521.4	$54.4	32.4	19.2	1.54%	$109	59.26%
1990	$3,128.6	$39.0	27.1	14.6	1.25%	$115	53.87%
1991	$3,102.9	$37.2	27.2	14.9	1.20%	$114	54.78%
1992	$3,118.4	$35.4	23.6	13.8	1.14%	$132	58.47%

Table 11: Industry 3489, Ordnance and Accessories, N.E.C.							
	Shipments	Capital Invested	Employment		Shipment Comparisons		% Prod. Wkrs to All Employees
			Total	Prod. Wkrs	% Capital Invested	($000s) per employee	
Year	(in millions)		(in thousands)				
1983	$1,575.8	$17.3	26.7	14.3	1.10%	$59	53.56%
1984	$1,925.0	$25.4	27.7	14.7	1.32%	$69	53.07%
1985	$1,790.5	$28.9	27.3	14.6	1.61%	$66	53.48%
1986	$1,625.9	$32.2	26.9	13.7	1.98%	$60	50.93%
1987	$1,678.1	$50.0	23.9	12.1	2.98%	$70	50.63%
1988	$1,679.1	$14.6	24.0	12.2	0.87%	$70	50.83%
1989	$1,688.6	$19.7	23.2	11.5	1.17%	$73	49.57%
1990	$1,643.6	$23.1	22.4	10.8	1.41%	$73	48.21%
1991	$1,480.2	$13.2	21.5	9.3	0.89%	$69	43.26%
1992	$1,393.8	$19.4	22.1	9.0	1.39%	$63	40.72%

Source: U.S. Dept. of Commerce, Bureau of the Census, Census of Manufactures

Table 12: U.S. Department of Defense Procurement Authorizations and Outlays, 1985-2000						
Year	Procurement		$95 price index	Procurement		Annual Percent Change
	Authorized	Outlays		Authorized	Outlays	
	(billion of historic $s)			(billions of constant $95s)		
1985	96,842	70,381	0.7175	134,976	98,096	-
1986	92,506	76,517	0.7390	125,185	103,548	5.56%
1987	80,234	80,744	0.7591	105,700	106,372	2.73%
1988	80,053	77,166	0.7865	101,787	98,116	-7.76%
1989	79,390	81,620	0.8208	96,725	99,442	1.35%
1990	81,376	80,972	0.8564	95,023	94,551	-4.92%
1991	71,740	82,028	0.8944	80,209	91,712	-3.00%
1992	62,952	74,881	0.9248	68,073	80,972	-11.71%
1993	52,789	69,936	0.9498	55,578	73,630	-9.07%
1994	44,141	61,758	0.9725	45,388	63,503	-13.75%
1995	44,619	54,671	1.0000	44,619	54,671	-13.91%
1996	39,409	48,630	1.0318	38,194	47,131	-13.79%
1997	43,464	45,734	1.0651	40,806	42,938	-8.90%
1998	51,446	44,816	1.0982	46,845	40,808	-4.96%
1999	54,236	48,050	1.1321	47,908	42,444	4.01%
2000	62,277	51,389	1.1671	53,362	44,032	3.74%
Percent Change from 1989-1995				-53.9	-45.0	
Percent Change from 1985-1995				-66.9	-48.6	

Source: Office of Management and Budget, 1995

Appendix E

* * *

Survey Instrument

OMB Control 0694-0080
Expires 12-31-94

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 on a national security assessment of the U.S. CAD/PAD industry. The goal of this joint assessment is to analyze the long-term health and competitiveness of the CAD/PAD industry and to develop recommendations to ensure the continued ability of the industry to support defense missions and programs.

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. (1993)) 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: Public reporting burden for this collection of information is estimated to average 8 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 4513, 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 #0694-0080), Washington, DC 20503.

EXEMPTION

If your firm has not produced Cartridge or Propellant Actuated Devices in the United States since January 1, 1991, 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**

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:

SECTION 1	PART I	FIRM IDENTIFICATION
	PART II	PRODUCTION CAPABILITIES
	PART III	SHIPMENTS, IMPORTS, EXPORTS AND EMPLOYMENT
	PART IV	INVESTMENT AND FINANCIAL
	PART V	RESEARCH AND DEVELOPMENT
	PART VI	COMPETITIVENESS

SECTION 2 SUBCONTRACTOR IDENTIFICATION

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 items in Parts I, II and II.

5. Questions related to the questionnaire should be directed to Rachel Dumas, Trade and Industry Analyst, (202) 482-2322, fax (202) 482-5650 or John Tucker, Senior Trade and Industry Analyst, (202) 482-3984 at the U.S. Department of Commerce.

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 3878, BXA/OIRA
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 IMPULSE CARTRIDGES: Cartridges using electrical energy to initiate the energetic material.

   2B. PERCUSSION INITIATED IMPULSE CHARGES: Cartridges 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 items 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:** Items 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/ SONOBOUY EJECTION CARTRIDGES:** Cartridges and ignition elements, employing energetic materials such as propellants and explosives, used to eject bombs, sonobouys, 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 items; 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 items of similar design and used in a similar manner.

- **9A.** Automatic Inflators
- **9B.** Gas Generators
- **9C.** Automotive Airbags
- **9D.** Laser Initiated Cartridges and Initiators
- **9E.** Fire Extinguisher Cartridges

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: 1) weapon systems, support equipment, and all other defense related end-use items, 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) items 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 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.

SECTION 1

PART I: FIRM IDENTIFICATION

1. COMPANY NAME AND ADDRESS: Please provide the name and address of your firm or corporate division.

____
Company Name

____
Street Address

____
City, State, Zip Code

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:_________(percent) Year acquired ___________

3. ESTABLISHMENTS: Please identify the location of each of your U.S. CAD/PAD manufacturing establishments. 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)

4. ADDITIONAL COMMENTS TO PART I:

____

____

PART II: <u>PRODUCTION CAPABILITIES</u>

1. PRODUCTION CAPABILITIES:

A. Please list other CAD/PAD products that your firm could manufacture (in addition to those products listed in Part I, item 3) with current equipment and facilities that you are not producing now. Please use **product codes** at the beginning of the questionnaire and give further explanation where necessary.

B. Please list any CAD/PAD products that your firm could not manufacture with current equipment and facilities. Please use **product codes** at the beginning of the questionnaire and give further explanation where necessary.

2. CEASED PRODUCTION: Identify any U.S. CAD/PAD manufacturing facilities or production of a CAD/PAD product line which you have ceased since January 1991 or you expect to discontinue over the next two years. Please indicate the reason production was or will be curtailed (use letter codes provided below).

REASONS

a. Loss of market share to imports
b. Loss of market share to domestic competition
c. Declining demand
d. Left voluntarily-low profitability
e. Firm restructuring
f. Inability to comply with environmental regulations
g. Inability to comply with safety regulations
h. Other (Specify: ______________________________)

YEAR	LOCATION (CITY/STATE)	PRODUCT OR PLANT (Circle One)	PRODUCT CODES	REASON(S) (USE CODES)
		P or PL		
		P or PL		
		P or PL		
		P or PL		
		P or PL		
		P or PL		
		P or PL		

3. BOTTLENECKS:

A. Identify the top three bottlenecks your firm would encounter as you ramp-up to full capacity CAD/PAD production. Please select from the list shown below to identify the bottlenecks, as well as the cost to correct in $000s (for example, $25,000 = 25) and the time to correct in weeks.

1. Raw Materials Handling
2. Other Materials Availability
3. Component Testing & Inspection
4. Production Scheduling
5. Assembly & Testing
6. Engineering (Design and Production)
7. Packaging & Delivery
8. Labor Costs and Training
9. Other ___________________

RANK BOTTLENECKS	BOTTLENECK (Specify)	COST TO CORRECT ($000)	TIME TO CORRECT
Bottleneck No. 1			
Bottleneck No. 2			
Bottleneck No. 3			

B. What is the average lead time (from order to delivery) for your CAD/PAD products?

(WEEKS) ____

4. ADDITIONAL COMMENTS TO PART II:

____

____

____

PART III: SHIPMENTS, IMPORTS, EXPORTS AND EMPLOYMENT

1. SHIPMENTS IN UNITS: Please report the number of CAD/PAD units manufactured by your firm for the years below. Use the product code definitions at the beginning of the survey and report your response in thousands of units.

(THOUSANDS OF UNITS)

PRODUCT CODES	1991	1992	1993	1994	1995
AIRCREW ESCAPE PROPULSION SUBSYSTEM					
IMPULSE CARTRIDGES					
ELECTRICALLY INITIATED IMPULSE CARTRIDGE					
PERCUSSION INITIATED IMPULSE CARTRIDGE					
INITIATORS (IMPULSE)					
DELAY CARTRIDGES AND DELAY INITIATORS					
AIRCRAFT STORES, FLARES, CHAFF, SONOBOUY EJECTION CARTRIDGES					
DETONATING CORDS AND CHARGES					
CUTTERS					
CATAPULTS, THRUSTERS, REMOVERS					
OTHER (specify) ____________					

2. SHIPMENTS IN DOLLARS: Please report the amount of CAD/PAD sales by your firm for the years below. Use the categories listed below and report your response in thousands of dollars.

(THOUSANDS OF DOLLARS)

PRODUCT CODES	1991	1992	1993	1994	1995
AIRCREW ESCAPE PROPULSION SUBSYSTEM					
IMPULSE CARTRIDGES					
ELECTRICALLY INITIATED IMPULSE CARTRIDGE					
PERCUSSION INITIATED IMPULSE CARTRIDGE					
INITIATORS (IMPULSE)					
DELAY CARTRIDGES AND DELAY INITIATORS					
AIRCRAFT STORES, FLARES, CHAFF, SONOBOUY EJECTION CARTRIDGES					
DETONATING CORDS AND CHARGES					
CUTTERS					
CATAPULTS, THRUSTERS, REMOVERS					
OTHER (specify) ____________					

3. DEFENSE SHIPMENTS AND EXPORTS IN UNITS: Please provide the amount (as a percentage of total shipments) of your firms defense shipments and exports for the following years.

YEAR	DEFENSE % of total	EXPORTED % of total
1991		
1992		
1993		
1994 E		
1995 E		

4. DEFENSE SHIPMENTS AND EXPORTS IN DOLLARS: Please provide the value (as a percentage of total shipments) of your firms defense shipments and exports for the following years.

YEAR	DEFENSE % of total	EXPORTED % of total
1991		
1992		
1993		
1994 E		
1995 E		

5. SALES LOST TO IMPORTS: Since 1991, has your firm's CAD/PAD division lost major sales or markets (including products whose production has moved offshore) to imports? Please explain.

6. BARRIERS TO EXPORTS: Please comment on any trade practices (e.g., tariffs or other trade barriers, export controls, market access, foreign government subsidies or incentives, etc.) that you have encountered in the marketplace.

7. IMPORTS OF MANUFACTURING EQUIPMENT: Please complete the following table addressing what types of foreign manufacturing equipment you use in your CAD/PAD operations and the reason for using foreign sources. Use the following coded reasons to complete the table.

A. No known domestic source
B. Domestic source inadequate
C. Supplement to domestic source
D. Offset agreement (See Definitions)
E. Lower cost
F. Quicker delivery
G. Better quality/reliability
H. Other - specify:

____

I. Other - specify:

____

Equipment (Specify)	Foreign Producer Firm(s)	Country of Origin	Reason Foreign Sourced (use codes)

8. IMPORTS OF PARTS AND RAW MATERIAL: Please complete the following table addressing what types of foreign parts and raw material you use in your CAD/PAD operations and the reason for using foreign sources. Use the following coded reasons to complete the table.

A. No known domestic source
B. Domestic source inadequate
C. Supplement to domestic source
D. Offset agreement (See Definitions)
E. Lower cost
F. Quicker delivery
G. Better quality/reliability
H. Other - specify: ______________________

I. Other - specify: ______________________

Parts and Raw Materials (Specify)	**Foreign Producer Firm(s)**	**Country of Origin**	**Reason Foreign Sourced (use codes)**

9. CONTINGENCY PLANNING: For dependencies cited in the last two questions, please identify actions you would take if your foreign source were interrupted.

____

____

____

____

____

10. FUTURE DEPENDENCY: Does your firm expect to become dependent on imports of equipment, parts and raw material in the next two years? If so, please list the item(s), the company name and the country of origin.

____

____

____

____

____

11. SHORTAGES: 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.

12. DEFENSE CONVERSION: Please discuss the convertibility of your CAD/PAD defense production operations to commercial operation. Describe any successes or difficulties resulting from conversion. Please indicate if your operation has not attempted conversion and the reasons why.

13. EMPLOYMENT BY OCCUPATION: Enter the number of employees (end of year) from 1991-1993 for your CAD/PAD manufacturing/ non-manufacturing facility, as requested below.

OCCUPATION	1991	1992	1993	1994 E	1995 E
Marketing/Sales					
Technical Services					
Technicians					
Scientists and Engineers					
Production Workers					
All Others					
Totals:					

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

____

____

____

____

15. PROJECTED LABOR CONCERNS: If in the **next five years** you foresee experiencing any labor concerns, such as shortages of certain skills, excessive turnover, etc. that could adversely affect your CAD/PAD manufacturing or R&D operations, please describe them below:

____

____

____

____

16. ADDITIONAL COMMENTS TO PART III:

PART IV: INVESTMENT & FINANCIAL

1. INVESTMENT: Enter expenditures for plant, new machinery and equipment, and used or rebuilt machinery and equipment (in $000) from 1991 to 1993, and projected amounts for 1994 and 1995 for your entire firm. Please indicate the reason(s) for the investment (use the letter codes provided).

A. Replace old equipment.
B. Improve productivity.
C. Expand capacity.
D. Add new capability.
E. Upgrade technology.
F. Meet specific customer's requirements.
G. Comply with environmental or safety requirements.
H. Other____

	INVESTMENT IN OPERATIONS		
	Plant	**Machinery and Equipment**	**Reason(s)**
1991			
1992			
1993			
1994 E			
1995 E			

What percentage of your firm's total investment applies to your CAD/PAD operations?

%__________

2. INCOME STATEMENT: Enter the financial information for your entire firm (in $000s) as specified below for the years 1991-1993; use projections for 1994-1995.

(in thousands of dollars)

	1991	1992	1993	1994 E	1995 E
Sales					
Net Income:					

3. INCOME STATEMENT FOR CAD/PAD OPERATION(S): Enter the financial information <u>for your CAD/PAD operation only</u> (in $000s) as specified below for the years 1991-1993; use projections for 1994-1995. Please estimate if this information is not collected separately.

(in thousands of dollars)

	1991	1992	1993	1994 E	1995 E
Sales					
Net Income:					

4. BALANCE SHEET: Please provide the balance sheet information for your entire firm (in $000s) as specified below for your latest accounting period.

CURRENT ASSETS	**$**	**CURRENT LIABILITIES**	**$**
PROPERTY, PLANT, EQUIPMENT	**$**	**NON-CURRENT LIABILITIES**	**$**
TOTAL ASSETS	**$**	**TOTAL LIABILITIES**	**$**

Specify period provided____________________

5. BALANCE SHEET FOR CAD/PAD OPERATION(S): Please provide the balance sheet information (in $000s) as specified below for your latest accounting period. Include only dollar amounts that apply to your CAD/PAD operation.

CURRENT ASSETS	**$**	**CURRENT LIABILITIES**	**$**
PROPERTY, PLANT, EQUIPMENT	**$**	**NON-CURRENT LIABILITIES**	**$**
TOTAL ASSETS	**$**	**TOTAL LIABILITIES**	**$**

Specify period provided____________________

6. ADDITIONAL COMMENTS TO PART IV:

____

____

____

____

____

____

PART V: RESEARCH & DEVELOPMENT & TECHNOLOGY

1. RESEARCH AND DEVELOPMENT EXPENDITURES: Please enter your firm's research and development (R&D) expenditures from 1991 to 1995 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	1991	1992	1993	1994 E	1995 E
Materials					
Production Processing					
Product Development					
TOTAL					
DEFENSE RESEARCH AND DEVELOPMENT EXPENDITURES (in thousands of dollars)					
DEFENSE	1991	1992	1993	1994 E	1995 E
Materials					
Production Processing					
Product Development					
TOTAL					

2. CAD/PAD RESEARCH AND DEVELOPMENT EXPENDITURES: Please enter your firm's related research and development (R&D) expenditures, **as they apply to your CAD/PAD operations,** from 1991 to 1995 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	**1991**	**1992**	**1993**	**1994 E**	**1995 E**
Materials					
Production Processing					
Product Development					
TOTAL					

DEFENSE RESEARCH AND DEVELOPMENT EXPENDITURES (in thousands of dollars)					
DEFENSE	**1991**	**1992**	**1993**	**1994 E**	**1995 E**
Materials					
Production Processing					
Product Development					
TOTAL					

3. 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?

____

____

____

____

____

4. SOURCES OF R&D FUNDING: Please enter research and development expenditures, by source of funding, from 1991 through 1994 (estimated).

(THOUSANDS OF DOLLARS)

FUNDING SOURCES	1991	1992	1993	1994 E
IN-HOUSE				
CUSTOMER				
FEDERAL GOVERNMENT				
OTHER:________				

Please Describe All Sources of Federal Government Funding (E.g. Army, Navy, Nasa, Etc.)

____

____

____

____

5. CEASED RESEARCH AND DEVELOPMENT: Please describe any R&D applicable to your CAD/PAD operations that you have ceased since 1991. Indicate the year and the reason R&D efforts were discontinued.

6. ADDITIONAL COMMENTS TO PART V:

PART VI: COMPETITIVENESS

1. COMPETITIVE PROSPECTS: How do you foresee the competitive prospects for your firm's U.S. production operations (regarding, for example, price and technology) over the next five years?

Our competitiveness should:

A. Improve greatly
B. Improve somewhat
C. Stay the same
D. Decline somewhat
E. Decline greatly

Please discuss the basis for your answer.

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2. DEFENSE BUDGET CUTS: Please indicate what impacts defense spending reductions have had or will have on your CAD/PAD operations. Also indicate what steps your company is considering to offset any negative impact that these reductions have had on your business (i.e. reduced employment, entered new lines of business, closed plants, consolidated product lines, reduced costs).

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3. ENVIRONMENTAL AND SAFETY REGULATIONS: How have environmental and OSHA regulations affected your CAD/PAD operations?

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4. 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:↓

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

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5. GOVERNMENT POLICIES: What reasonable adjustments could be made in 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?

6. GOVERNMENT COMPETITION: Do you think that your firm is in direct competition with U.S. government manufacturing facilities? If yes, please explain.

7. MERGERS, ACQUISITIONS AND TAKEOVERS: Have mergers, acquisitions and takeovers in the CAD/PAD industry affected your company? If yes, please specify and explain.

8. FUTURE STRATEGIES: Please describe any future strategies your firm is implementing or thinking of implementing to ensure your long-term participation and competitiveness in the CAD/PAD industry.

A. Mergers, Acquisitions, Consolidations
B. Conversion
C. Expansion of Current Operations
D. Exports
E. Testing
F. R&D
G. Other

9. Additional Comments To Part VI: Competitiveness

169

16B

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STRATEGIC ANALYSIS DIVISION
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