

Executive Summary

The U.S. imaging and sensors industry is an important and growing part of the U.S. high technology defense and civilian industrial base. The technology and products developed by the U.S. imaging and sensors industry play an important role in maintaining the military advantage the U.S. enjoys today. Imaging and sensors products are used in defense-related applications, such as target imaging, homing, detecting, and tracking. At the same time, the commercial market for such products has grown dramatically over the last five years. Imaging and sensors products have substantial and growing commercial (e.g., surveillance, quality control, process control, and construction and other inspection) and other civil (e.g., astronomy, fire fighting, medical imaging, hunting, and wildlife observation) applications. Imaging and sensors technology and products are continuing to evolve at a rapid rate in both defense and commercial markets.

U.S. firms continue to dominate the defense portion of the industry. However, this is less true for commercial products. Manufacturers in China, France, Germany, Israel, Japan, Russia, and the United Kingdom are increasingly serving the commercial product markets where there is growing global demand.

Increasing global competition, combined with less restrictive export licensing procedures in most overseas markets for both defense and commercial products, has raised some concerns among U.S. industry leaders about their long-term competitive position and ability to maintain technological leadership. To better understand the validity of these issues and their potential implications for current and future U.S. defense production capabilities, the U.S. Army Research, Development and Engineering Command supported the U.S. Department of Commerce, Bureau of Industry and Security's (BIS) concept to initiate an assessment of the U.S. imaging and sensors industry.

This assessment reviews the health and competitiveness of the imaging and sensors industry. The industry, as defined for this assessment, includes manufacturers, integrators, service providers, distributors, retailers, brokers, resellers, and federal and private research laboratories. Industry-specific surveys sent to these groups were used to collect essential employment, financial, product, research and development, and other

data from 2001 through 2005. Survey data was augmented with site visits, attendance at technical conferences, interviews and reviews of other studies of this industry.

BIS's Office of Strategic Industries and Economic Security (SIES) performed this assessment under authority vested in the Department of Commerce through Section 705 of the Defense Production Act (DPA) of 1950, as amended (50 U.S.C. App. Sec. 2155) and related Executive Order 12656. The DPA authority enables SIES to conduct surveys, study defense-related industries and technologies, and monitor economic and trade issues affecting the U.S. defense industrial base. In the past, SIES has performed studies on a broad range of U.S. industrial and technology sectors, including air delivery systems, munitions power sources, biotechnology, ship building and repair, optoelectronics, welding, and the C-17 aircraft program.¹

Background

In the past, highly sophisticated imaging and sensors applications were mainly used for military purposes because of their high per unit cost, while commercial applications utilized more rudimentary technology. In the last ten years, however, the commercial use of imaging and sensors (thermal imaging and image intensification) has grown significantly as have the number of firms producing this equipment. Applications in the medical, automotive, security, firefighting, surveillance, industrial process, and production controls sectors increasingly utilize imaging and sensors technology.

Commercialization of imaging and sensors products has been a slow process because a major portion of the technology has involved expensive hand-crafted components, including subsystems to maintain the devices at cryogenic temperatures. This has changed with development of uncooled detector technologies.

From 2001 through 2005, commercial sales by U.S. firms increased 55.5 percent while defense sales climbed by 51.3 percent. Defense and commercial sales accounted for 70.2 percent and 29.8 percent, respectively, of total U.S. industry sales in 2005.

¹ See the U.S. DOC/BIS/SIES web site for a full listing of published reports: <http://www.bis.doc.gov/osies>.

Product and Technology Scope

The BIS assessment covers forty product categories based on two types of imaging and sensors technologies -- Image Enhancement and Thermal Imaging.

Image Enhancement products require some type of ambient light source (moonlight, starlight or infrared light). Image intensifiers are currently classified into three product generations, each with its own set of design characteristics.

Thermal Imaging products operate by capturing the upper portion of the infrared light spectrum. The two common types of thermal-imaging devices, which are divided into Generations 1, 2 and 3, are uncooled and cooled. The uncooled is the most common type of thermal-imaging device, and infrared-detector elements contained in these devices operate at room temperature. The cryogenically cooled thermal imaging devices are more expensive and more susceptible to damage and performance failure. While they operate in much the same way as uncooled devices, they provide much higher levels of detection and resolution.

Financial Performance

The U.S. imaging and sensors manufacturers witnessed robust overall sales growth during the five-year period, rising from \$2.55 billion in 2001 to over \$3.8 billion in 2005, with defense sales accounting for nearly two-thirds of all sales. Over the same period, earnings from sales as reported by retailers, distributors, resellers, and brokers also grew at a positive rate.

Domestic and Foreign Business Relationships, Content and Sourcing

Imaging and sensors-related firms develop highly specialized products and services to differentiate themselves from competitors. As a result, these firms depend on business relationships, and more specifically on vertical business relationships, to ensure the exclusive specifications of their imaging and sensors products.

Manufacturer and wholly owned subsidiary relationships were identified most often in U.S. firms' relationships with foreign entities. Reviewing both domestic and foreign business relationships, 48.4 percent of relationships involved a supplier relationship with at least one other manufacturing firm. Service provider and product integrator business relationships accounted for 13.7 percent and 13.2 percent, respectively.

Approximately 66 percent of the 141 respondent manufacturing firms procure products or services from at least one foreign firm. Leading foreign sole-sourced items (based on the number of cases reported) were raw materials with 17.7 percent, image intensifier devices with 13.9 percent, and electronics/electrical controls at 10.1 percent.

The top three reasons mentioned for foreign sourcing were: (1) foreign products and services were less expensive than domestic sources; (2) the products and services the firms required were not available from domestic sources; and (3) the foreign sources were of better quality.

Research & Development

The rapid advances in product capabilities and applications among global suppliers are an indication of the importance of Research and Development (R&D) funding to the imaging and sensors industry. To remain competitive in the global marketplace, U.S. suppliers of imaging and sensors products acknowledged that they must continue to invest aggressively in R&D, especially in commercial applications.

Domestic manufacturers of imaging and sensor products spent over \$1 billion on R&D from 2001 to 2005. Annual research expenditures topped out at \$61.4 million in 2005 from \$15.4 million in 2001, while development spending reached \$187.6 million in 2005 from a low of \$129.5 million in 2001. Total R&D expenditures for manufacturers increased from \$146 million in 2001 to \$249 million in 2005. This increase in R&D expenditures represented a compound annual growth of 11.2 percent over the period. Expenditures for R&D by laboratories and research organizations rose from \$200.9 million to \$327.1 million in the period, or by 62.8 percent.

Employment and Workforce

The U.S. workforce in the imaging and sensors industry reported steady annual job growth during the 2001-2005 period. Based on responses to the BIS survey, the industry has created more than 3,000 new jobs since 2001, with employment climbing to 10,918 in 2005 from 7,721 in 2001.

Despite the increase in industry employment, U.S. companies of all sizes raised concerns about shortages of qualified personnel, including research and design engineers, skilled technicians, and production line workers.

Imaging/Sensor Imports and Exports

The United States has historically been a net importer of imaging and sensors products, however, this trend has been declining as the value of exports has outpaced that of imports during 2001-2005. As a result, the trade deficit in these products has substantially decreased from \$376 million in 2001 to \$272 million in 2005.

Since 2002, U.S. imports have increased from \$587 million to \$734 million in 2005. Although the value of U.S. imports continues to increase, the level of import penetration in the U.S. marketplace has declined. For 2001-2005, the majority of imaging and sensors equipment imports included electrical instruments that use optical radiations (almost \$2 billion) and electrical spectrophotometers using optical radiations (\$976 million).

U.S. exports of imaging and sensors products have steadily increased from 2001 to 2005, reflecting increasing demand for both commercial- and defense-related applications. The export figures, as reported by 91 firms, highlight that imaging and sensors product exports grew from \$280 million in 2001 to \$462 million in 2005. Exports in two product categories, night vision system devices/components and infrared (thermal) imaging system devices/components (cooled), dominated the value of U.S. exports. Combined, these two categories captured almost 43 percent (\$930.1 million) of the value of total exports (\$1.96 billion) during 2001-2005.

The majority of these imaging and sensors products were exported to Western Europe and Asia – especially Japan and South Korea. The European Union (EU), during 2001-2005, was the largest consumer of U.S. imaging and sensor products, representing 72 percent of cumulative exports over the five years.

The global market for defense and commercial imaging and sensor products has grown in recent years. Global exports climbed to \$4.3 billion in 2005 from \$2.7 billion in 2001, or an annual compound growth rate of 9.8 percent. U.S. exports, as reported by survey respondents, grew at a compound annual rate of over 10.5 percent, the seventh largest growth rate behind Belgium-Luxembourg, China, France, Canada, Germany, and Ireland. Despite double-digit U.S. export growth, the U.S. share of global exports increased by only 0.3 percentage points from 10.5 percent in 2001 to 10.8 percent in 2005.

Although the value of overall exports of industry products increased during 2001-2005, exports of uncooled infrared (thermal) imaging system devices, a significant growing product category, declined by 63.9 percent (from \$54.6 million in 2001 to \$19.7 million in 2005). This is in contrast to the rest of the U.S. imaging and sensors industry exports and to exports by foreign manufacturers of uncooled thermal imaging products.

U.S. manufacturers noted that restrictive U.S. export controls have severely hampered their ability to supply the increasing global commercial demand for uncooled thermal products. Further, U.S. manufacturers stated that European and Asian suppliers of uncooled thermal products face fewer export restrictions by their licensing authorities and are therefore capturing a growing share of this important market.

Five major U.S. manufacturers of higher-end uncooled thermal products incorporating 640x480 focal plane arrays (FPAs) noted that, because of export controls, they are not currently exporting these products from the United States. However, U.S. manufacturers stated that foreign firms within the European Union (EU) are currently exporting these devices with EU-manufactured 640x480 FPAs.

A total of 33 of 106 survey respondents (31 percent) specifically recommended that current U.S. export control policies be modified as they are an impediment to how firms do business, particularly in allied countries. Fourteen of these respondents had either reported a denied export license, lost sales due to the licensing process, or a combination of the two.

Conclusion

For the foreseeable future, the financial performance of the overall U.S. imaging and sensors industry will depend on U.S. Department of Defense acquisitions and, to a lesser extent, on commercial demand. However, the future health of the uncooled thermal device subsector will depend on the ability of U.S. manufacturers to compete on a level playing field with European and Asian competitors.