

## ACCELERATING THE IMPROVEMENT OF U.S. MANUFACTURING

Our universities, government laboratories and the private sector have undertaken substantial research and development projects for years in the fields of computer-aided design, computer-integrated manufacturing and robotic technology, and the United States possesses the most advanced integrated manufacturing technologies in the world.

Tragically, despite their great potential for arresting and reversing our rapidly declining trade competitiveness, our advanced technologies remain in our laboratories, largely unused; and, even then, the use, except in a handful of cases, is so fragmented and unsystematic that the benefits for U.S. competitiveness are terribly dissipated. Meanwhile, foreign competitors are exploiting technology created in the U.S. to improve their competitive position in world markets, while we ignore both our technology and theirs which, in some instances, is more advanced than ours.

Many recent publications warn us that the vast majority of American companies are moving too slowly in the implementation of advanced manufacturing systems. The Congressional Office of Technology Assessment reported, last summer, that, "Many U.S. industries have fallen behind foreign competitors in manufacturing technology. The weak performance of American manufacturers is one of the most important underlying forces behind the large trade deficits of the 1980s. The United States has to improve its manufacturing performance if it is to prevent further erosion in living standards." That conclusion is supported by Department of Defense studies, which also show that the competitive decline of our defense-critical industries is undermining America's security.

There are many reasons for this condition. They include the lack of common standards to guide the compatibility of enabling technologies and their assembly into coherent integrated systems; the low level of relevant technical capabilities in most manufacturing companies; the high cost of equipment, computer software and training; the high cost and risk of integrating enabling technologies into practical and rugged manufacturing systems; and the reluctance of many manufacturing companies of all sizes to accept the gravity of the threat from overseas.

These problems have caused industry management correctly to view past investments in advanced manufacturing systems to have higher risk and lower rate of return on capital than they can accept. Their judgement will not change until the problems

outlined above are resolved. Even then, few medium-sized and small companies will, in the early days, be able to afford implementation.

Given the shortage of both money and skilled people to apply to the problem, a major part of the solution must be to improve the nature and extent of cooperation among government, universities and industry in the development, integration and use of manufacturing technology. The nation is denying itself many of the efficiency gains which result from cooperation; a condition exacerbated by lack of common standards and information on manufacturing research and development programs underway across the nation. As a result, the wheel is being reinvented in many places. We cannot afford such waste, considering the ferocity of foreign competition and the certainty of its inexorable growth in the years ahead.

#### A Powerful Response

How can we overcome these formidable problems and assure that advanced manufacturing technology is rapidly deployed to our competitive advantage? Progress is needed on many fronts. We need to improve the technical curricula and teaching in our schools and universities. We need to attract more and better students to the manufacturing sciences. We need to improve the status and rewards for achievement of advanced manufacturing skill in our society. We need to focus more attention on research and development in design and manufacturing and do it more efficiently. We need to modify our culture better to accept long term benefits at the expense of short-term gain. All these things and more are needed. But, above all, we need to concentrate, cooperatively, on expediting the transfer of existing technology, from the laboratory to the marketplace, to meet the competitive threat from other nations.

The Advanced Integrated Manufacturing Service Center (AIMSC) Partnership is a powerful response to that need. AIMSC is a public/private cooperative initiative catalyzed by the Midwest Technology Development Institute (MTDI), which was formed in early 1985 by a consortium of nine Midwest states to foster large scale public/private cooperation. MTDI has selected advanced manufacturing as a productive field for a major cooperative initiative.

A nationwide program to accelerate the widespread systematic use of computer-aided design and advanced manufacturing technology is being planned. Its main objective is the integration and use of technology, not the research and development to create it. The AIMSC Partnership will encourage cooperation in ongoing research and development, especially among universities and government laboratories, by forging close working ties with them to help assure adherence to common standards, minimize necessary duplication and assure that the R&D is responsive to the need.

The centerpiece of the AIMSC program is a nationwide network of regional computer-aided design and manufacturing centers, utilizing the most advanced technologies. Regional centers will be interconnected and conform to a common set of standards for equipment interfaces, computer software, data bases and communication protocols. Each regional center will have access to the data bases of all others. Regional centers will also connect with and serve local centers by providing them access to the data bases containing information for the automatic manufacture of a wide range of components, subassemblies and equipments.

Local centers will provide manufacturing services; companies will pay for the service, as they use it, with no investment required in any AIMS Center. Users will task local centers through work stations on their own premises connected by telephone.

Three types of local centers are presently planned: materials forming, electronic circuit card assembly and electro-mechanical assembly. Each will allow a wide range of products to be made with short set-up and throughput time, high quality and low cost, even for small quantities (Figure 1).

When in operation, the AIMSC network will allow a product development engineer sitting at a workstation in a small company in Wisconsin, for example, to design an electronic product for manufacture in an AIMS Center in Kansas.

Local center users will have the right, under license, to replicate all or part of the AIMSC system. Thus, a company may use a local center to manufacture a new part for a time and choose, later, to install an equivalent system in its own plant.

The centers will offer comprehensive education and training in the relevant processes, systems and technologies. Computer-based education will be the primary delivery method, so as to assure the best possible accessibility, quality and cost.

Hands-on skills are critical for success in advanced manufacturing. To facilitate that requirement, user personnel

will operate the facility guided by center staff. AIMS Centers will offer internships to industry and academia. Cooperating universities will sponsor graduate students to fill their internship positions. In this way, channels for training in industry needs and for transferring the results of university manufacturing research to the marketplace will be opened.

Six regional centers are planned in the first implementation. It will take five years to get them into full operation. Most regional centers will serve several states. A tentative grouping of states, by regional center, is shown in Figure 2. The number and types of local centers will be determined by each state, taking into account the needs of its manufacturing sector and the logistics surrounding the hands-on training of user's employees. The initial cost of a network, comprising one regional and six local centers, is estimated to be \$80 million. More local centers will eventually be needed.

#### Organization and Operation

There are three levels of organization in the nationwide AIMSC program. The first is the AIMSC Partnership, a non-profit corporation, which provides strategic direction and determines standards for equipment interfaces, computer software, data bases and communications protocols. Its board of directors is drawn from large and small business, universities, government laboratories, unions and state governments. The staff is small.

The second level of organization is the Regional AIMS Center, with a structure similar to that of the AIMSC Partnership. The staff will consist of a director and about twenty technologists, at first, growing with the demand for the center's services. Regional center personnel will have a broad range of skills in design and manufacturing, in order to integrate the AIMSC system, operate the center and offer technical help and training to local center users.

The third level is the local center. It offers manufacturing services and computer-based training to suit the type of manufacturing performed there. It can be for-profit, or not, as needs dictate. Alternatively, a number of companies may share ownership in a center, which makes product exclusively for its owners. Local center flexibility is a hallmark of the AIMSC design, both with respect to organization and the system configuration. The freedom to innovate to meet local needs, while conforming to common standards in order to benefit from access to the facilities, skills and data available from the AIMSC network, is a central feature of AIMSC.

## Benefits

Once implemented, the benefits of the AIMSC program to industry and the nation will be great. Most importantly, and critical to our security and continued competitive success, it is a key to the acceleration of technology from the laboratory to the marketplace. Other countries, especially Japan, are doing much better in this respect than we are, and they are redoubling their efforts, spurred by competition from the devalued dollar.

Large companies will benefit from the ability to replicate all or part of the advanced manufacturing system under license, with known cost and minimal risk, because reliable system operation is assured by prior performance. They will also benefit greatly because many of their suppliers, with access to an AIMS Center, will be able, flexibly, to furnish them with high quality, low cost and timely parts and products.

AIMS Centers are an even more significant benefit to cash-strapped, medium-sized and small companies because most of them lack access to advanced manufacturing technology and must wait until reliable, affordable, turnkey systems are generally available. Given our current rate of progress, that day is at least ten years away and probably longer for most companies.

Yet, small business is extremely important to our economy; more than 60% of our manufactured goods come from this sector, as well as many of our technical advances. IBM didn't pioneer the computer, two small companies, Eckert-Mauchley and Engineering Research Associates did. Instant photography was invented by a small start-up company, Polaroid, not Eastman Kodak, and the list goes on.

The AIMSC program will permit small business to continue to compete with innovative, high quality products at competitive prices. Small business cannot continue to innovate successfully, if it is denied access to advanced manufacturing technology. If they are to compete effectively in cost and quality, tomorrow's products must be designed coincidentally with the plans for their automated manufacture. Small, incremental improvements in manufacturing systems, the traditional mode for small business, will simply not meet the need.

Geographical diversification, especially in rural communities and inner cities, can be improved with the operation of AIMS Centers in those locations, directly, by providing better-paying jobs where they are most needed, and indirectly, by acting as magnets for the formation of small manufacturing companies.

## Impediments

Impediments to the acceptance and successful implementation of the AIMSC program are many. They represent a formidable challenge. Funding is a major one. The fact that benefit accrues to both the private and public sectors is readily apparent, so it is appropriate that costs be shared among federal, state and local governments and industry. But we have no precedent for equitably dividing the cost. For example, the fact that less populous states and smaller companies need the advanced manufacturing service more than large states and large companies because their resources are less and their choices more limited, should be taken into account.

To get a state legislature to approve funding for any new activity in an era of tight budgets, calls for political leadership of the highest order. Most states show little interest in cooperating with other states. Competition, not cooperation, more often characterizes their relationship. A typical governor's first reaction to a cooperative proposal is, "How can I justify using taxpayers money in my state to fund a project that will benefit another state?" Of course, this reaction is a derivative of the lack of appreciation of the benefits of large scale technological cooperation and how to distribute them equitably.

The impediments at the state government level indicate that a major part of the start-up funding should be underwritten by the federal government. The benefits to our armed forces from a nationwide network of advanced manufacturing centers in maintaining military preparedness, is a compelling reason which supports this conclusion. Benefits include:

- o Capability to provide "surge" and sustained production capacity at minimal cost in the event of a national emergency.
- o Reduction in stockpile costs and inventories of obsolescent spare parts.
- o Modernization of the manufacturing systems of third and fourth tier suppliers.
- o Shortened lead-times to introduce new weapon systems.
- o Reduction in vulnerability of production facilities to sabotage or attack via geographical dispersion.
- o Last, but not least, quality is improved and standardization is achieved.

The cost savings to be realized from those benefits will quickly pay for the startup costs of a program such as AIMSC. It is, therefore, proposed that the federal government underwrite 75% of the cost, with the balance to be assumed by state and local governments and companies.

### Federal Legislation

Special legislation will be required to provide AIMSC funding and to designate an organization to administer it. Administration could be performed either by a government agency or by the National AIMSC Partnership. The latter is preferred because it will be free of political influence and the inertia of bureaucracy. It will also be closer to the needs to be served and, therefore, more responsive to them.

### Program Status

The National AIMSC Partnership, currently funded by the William C. Norris Institute, has been created. It is preparing the overall design for the AIMSC network and seeking state participation. The Minnesota Advanced Manufacturing Centers Corporation has also been formed to operate a Regional AIMS Center in Minneapolis to serve local centers to be built in Minnesota and to assist in the establishment of local centers in other Midwest states.

### A Page from History

The AIMSC program has conceptual similarities to computer services. In the early days of the computer industry when computers were expensive, small companies occasionally needed the power of large computers, but only large companies, major universities and government agencies could afford them. So, computer service centers, to serve smaller companies on a time-shared basis, were created, allowing them to increase their contribution to the economy. Their creative use of the new tool was a major force in broadening the application of computers in new domains. Large companies benefited from computer services by being able to gain more economical and timely access to the new applications. Clearly, computer services played a major role in the rapid advance of computing in the U.S. after World War II, with attendant economic and security benefits to the nation.

During the twenty years which followed the installation of the first large scale computer service centers, computer costs decreased dramatically and their power increased exponentially with the result that every small company is now able to afford a computer that can handle most of its needs. Given their resolve to get on with it, similar benefits could accrue in manufacturing during the next twenty years.

### A Daring Plan

The AIMS Partnership plan has been characterized as "daring," mainly because of the unprecedented degree of cooperation that will be required, especially among states. However, if Congress were to pass legislation supporting startup of the AIMS program, many states would quickly perceive its benefits and decide to participate.

Congress is becoming increasingly concerned that too little progress is being made in getting advanced manufacturing technology in use to improve U.S. competitiveness. Committee hearings have been held during past years on the issue. More are scheduled. Legislation is pending, but none propose a program of the size and scope to adequately address manufacturing improvement over a broad spectrum of national needs.

A program such as AIMSC is the giant step that is needed to get our manufacturing technology out of the laboratory and into the factory on a track fast enough to assure our national security and our competitiveness for decades to come.

k/2709/9/88