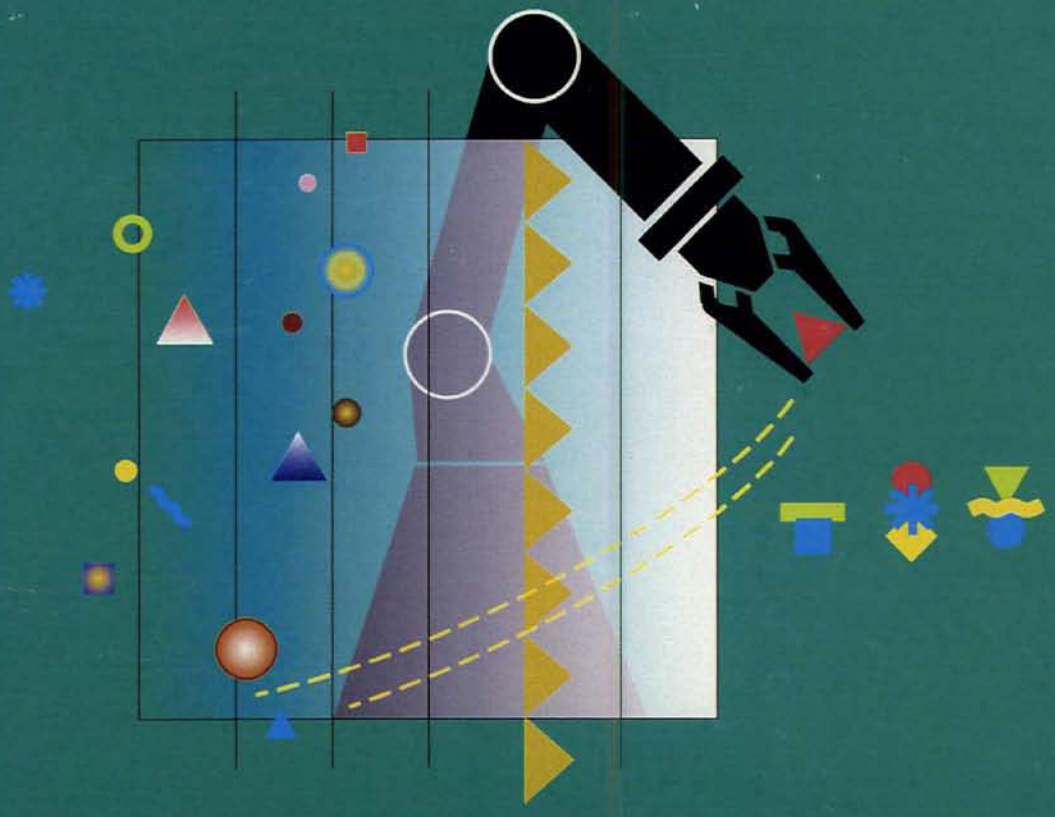
Industry, Science and Technology Canada
Industrie, Sciences et Technologie Canada

# Advanced Manufacturing Technologies



Canada

YEAR 2000 - SUMMARY

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ADVANCED MANUFACTURING TECHNOLOGIES

# THE YEAR 2000

# SUMMARY

INDUSTRY, SCIENCE AND TECHNOLOGY CANADA

## 1.1 INTERNATIONAL TRENDS AND STRATEGIC ISSUES

### 1.1.1 COMPETITIVE FACTORS

World-class manufacturing is the basis of competition in the 1990s. In addition to advanced manufacturing technologies it involves management and people concepts including concurrent engineering, just-in-time (JIT) production, flexible manufacturing, supplier partnerships, employee empowerment and total quality management.

Customers are demanding world-class supplier performance in terms of products, service and support They are learning to look for the "best value", defined in terms of quality, variety, price and timeliness. Despite conventional wisdom that "you get what you pay for", customers are finding that they can often get high quality, wide variety, and quick delivery at reasonable prices.

World-class manufacturers are developing global reach. Trade barriers are diminishing. In general, world markets are open to "best value" suppliers. There are global opportunities for world-class manufacturers and home markets are threatened for those that don't measure up to that standard.

### 1.1.2 ECONOMIC PATTERNS

World economic growth in the 1990s is expected to approximate that of the 1980s at about a 2.8% annual rate.

North America buys more than half of the AMT sold in the world at 53% in 1990, down from 60% in 1985. North American market growth over the past five years has been at 15% per annum while growth in Asia and Europe has been greater than 20% annually. The rest of the world grew at 25% per year from a very small base. Manufacturing investment in Europe in the 1990s will be driven by the opening of the East Bloc, EC92, and an aging labour force in the west.

Switzerland, U.S. and Canada are the top three countries in terms of worker productivity but Japan is closing the gap and the developing Asian nations are improving fast. Fundamental education is a problem in North America with U.S. and Canadian high school students scoring far lower on standard math tests than their counterparts in Asia and Europe

### 1.1.3 TECHNOLOGY TRENDS

Computing Technologies are a critical element in AMT. Artificial intelligence (AI) is becoming pervasive in advanced software. High speed computing architectures are becoming more prevalent. Integrated circuits (ICs) are advancing on all fronts (materials, processes, and architectures). Digital imaging will impact displays, image processing, and data input.

A key factor in reaping the benefits from new computing technologies is standards. Compatibility and connectability have become chief priorities of the user. Standards are a prerequisite to achieving these goals. The development and adoption of standards will play a critical role in utilizing the full potential of the advances in computing expected during the next ten years. These standards will enable computing and communications to become a utility that is readily available to users of AMT equipment at multiple locations, much like electric power or telephone service.

Smart sensors will become "brilliant" and more important to AMT. There is a continuing trend toward putting more processor functions onto sensor chips. Optoelectronic sensors are emerging that are fast and accurate and can withstand manufacturing environments. Discrete manufacturing is moving toward "process type" quality control techniques requiring sensor inputs for continuous machine status monitoring and control.

Advanced materials (e.g., high temperature ceramics, superconductors, and composites) will continue to impact manufacturing, both in terms of their use in AMT equipment and relative to the machinery and equipment needed to work the materials

Technology transfer works best on a one-to-one, experiential basis. Classroom and videotape programs are not as effective. Apprenticeship programs have been used in Germany and Sweden to promote widespread application of new technologies. Japanese joint development

programs have proven to be effective tools for technology diffusion. The Japanese are also proficient at spreading technology to small plants.

### 1.1.4 MANAGEMENT ISSUES

Manufacturing management in North American apparently lacks an understanding of the competitive potential of world-class manufacturing and the related opportunities and threats. Management is often reluctant to apply AMT. It is not necessary to "bet the company"; low investment techniques (e.g., JIT) should be implemented first to get the benefits of inventory and cost reductions. Refusal to move ahead is more certainly fatal than potential mis-investment.

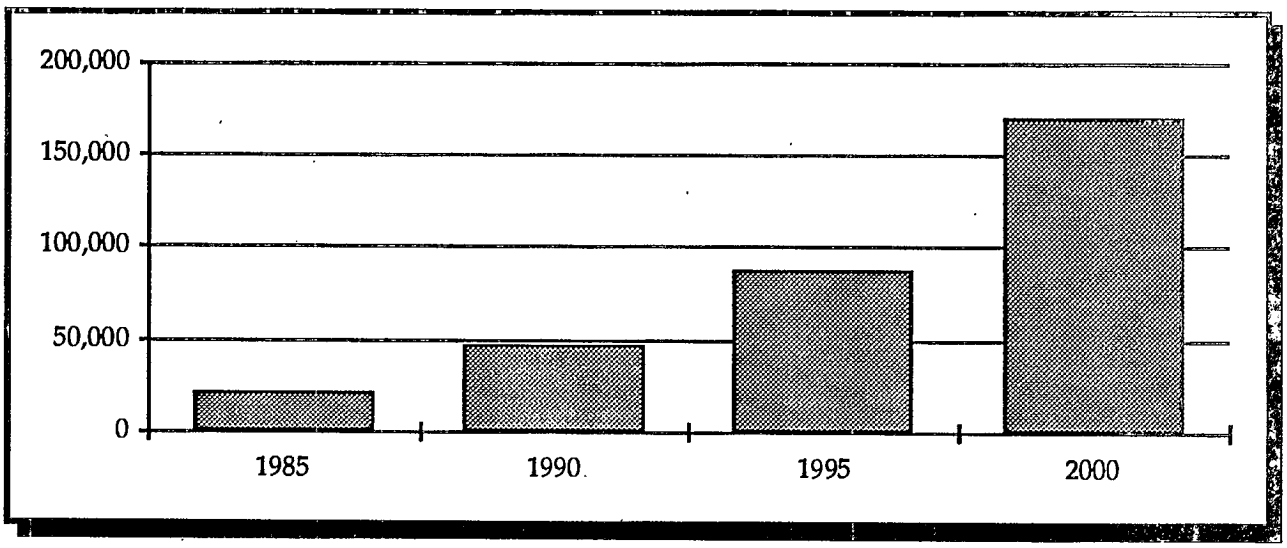
One basic tenet of competing on the strength of manufacturing capability is that a long term commitment to the business is required.

Managing new and changing business relationships will be a key factor. Understanding customer needs requires continuing detailed assessment of a broad set of needs and desires. Suppliers must be treated as partners, not adversaries. Employee teams must be empowered to make decisions. Investors and lenders must be convinced to take a long view. Alliances can be used to fill strategic product or market gaps. AMT users and suppliers must both learn to use system integrators effectively.

## 1.2 AMT MARKET FORECAST

Worldwide, purchases of AMT products are growing rapidly. Advanced manufacturing technology is one of the most dynamic areas of industrial investment in all regions of the world. From purchases of just over $20 billion (US) in 1985, the market is expected to expand to over $170 billion by the turn of the century. In the year 2000, total purchases of advanced manufacturing technology products and services are forecasted to be eight and a half times their 1985 level, having expanded at a compound annual rate of 15% over the last decade of the Twentieth century. From 1985 to 1990, purchases of AMT products and services are estimated to have grown at 18% annually. Although slowing somewhat, the growth rate is forecast to remain in double digits through the 1990s.

**CHART 1A**
**WORLDWIDE PURCHASES OF AMT PRODUCTS AND SERVICES**
**1985-2000**
**(In Millions of US Dollars)**




Source: Table 4-1

## 1.3 THE CANADIAN PERSPECTIVE

### 1.3.1 CANADIAN AMT INVESTMENT

Canadian manufacturers have invested substantially in AMT. However, their investment growth rate considerably lags that of their U.S., European, and Asian competitors. The trends are disturbing.

Canadian users of AMT are increasing their purchases at a much lower rate than the other major regions of the world. Within North America, Canada's growth rate is 11.9% and the U.S.'s is 15.3%. The overall difference is greatest when comparing Canada with Europe and Asia, where growth rates range in the upper teens and low twenties. Labour costs in Canada are high. Productivity must also be high for manufacturers to be competitive internationally. Although Canada's worker productivity is still among the highest in the world, Canada's productivity growth has become the slowest among the seven major industrialized nations. Japan may already have overtaken Canada's third place position in worker productivity and several other countries could pass Canada during the 1990s. Canadian manufacturers may find themselves at a considerable competitive disadvantage by the year 2000.

### 1.3.2 CANADIAN STRENGTHS AND WEAKNESSES

Canada has a major open market at its doorstep and successful Canadian companies consider the United States as part of their primary marketplace. In fact, some Canadian AMT suppliers have found acceptance in the U.S. market in advance of selling their products or services in Canada.

Some Canadian manufacturers of such diverse products as sportswear, lumber, integrated circuits, injection molding machines and automotive parts, as well as AMT suppliers, are competitive on a global basis and recognized outside of Canada as quality suppliers. Additionally, there is evidence that Canadians are viewed by offshore companies as easier to work with and less aggressive than Americans. Canadians have the vision, technological prowess and entrepreneurial spirit to start new businesses. Additionally, there is external recognition of Canada as possessing a skilled and cooperative labour force. Canada's extensive natural

resources can contribute to its ability to be world-class as an AMT producer as those industries demand world-class performance from their suppliers.

Although there are disadvantages to manufacturing in Canada and to being in the AMT business from a Canadian base, none appear to be so serious that they are insurmountable barriers.

Disadvantages related to a small home market disappear when the home market is defined as North America. The inclusion of the United States as part of the home market provides access not only to a large consumption area but to technology as well. The computer industry and semiconductor industry in the U.S. are as geographically accessible to the major industrial centres in Canada as they are to many sections of the U.S.

The cost of capital in Canada is high, putting Canadian companies at a competitive disadvantage. Venture capital firms in Canada have generally been more conservative than those in the U.S. In today's environment, it is even more difficult to acquire venture capital on reasonable terms. Partially offsetting the difficulties in raising private sector funds is the availability of financial assistance from various Government programs, including provincial programs, however in recent years these programs have been cutback substantially.

Canada's labour rates are high. However, in most manufacturing plants the cost of direct labour runs between 5% and 10% of total costs, so the cost of labour may not be as much of a disadvantage as it appears to be. Generally, Canadian companies do not attempt to compete in markets where a low labour cost factor is a requirement. By focusing on high value-added products Canadian companies can offset labour cost rates via an emphasis on quality and productivity.

### 1.3.3 MARKET OPPORTUNITIES AND THREATS FOR CANADIAN COMPANIES

Although the U.S. market has always been reasonably open to Canadians, the FTA enhances that. New market opportunities are developing on other continents as well. Europe is going to be more open as a result of EC92. The opening of the East Bloc and an aging labour force should drive the

growth of AMT and other manufactured products. Except for Germany, EC countries are relatively receptive to North American suppliers. The emerging economies of Southeast Asia have needs in terms of AMT and those requirements, which will be increasing throughout the decade, will be filled by products and systems offering the best value, from whatever country or continent they may originate.

The FTA is a double-edged sword. An open North American marketplace offers the potential of increased business for Canadian manufacturers, however, it also represents a serious threat when coupled with a declining relative level of productivity.

Canadian manufacturers have the opportunity to turn the productivity curve upward through the use of advanced manufacturing techniques and technologies, coupled with effective human resource programs.

## 1.4 RECOMMENDATIONS

### 1.4.1 RECOMMENDED ACTIONS FOR AMT USERS

❶ Define the Home Market to Include all of North America

If Canadian companies don't take advantage of their status as a partner in the world's largest market, then they will experience only the negative effects of FTA as they lose large portions of their domestic market to aggressive U.S. competitors.

❷ Adopt a Global Perspective

Canadian manufacturers may or may not develop a strategy to operate globally; but their scanning horizons must be global. Global scanning is needed to stay abreast of technical, competitive, and economic developments that could represent opportunities or threats.

❸ Analyze the Competitive Environment

Determining who the competitors are and are likely to be on a worldwide basis is a necessary step. This includes understanding competitors' product lines, manufacturing methods, marketing strategies, distribution channels, pricing policies, territorial strengths as well as growth patterns and goals.

❹ Assess Customer Needs and Desires

Understanding what customers expect and what they are getting from their suppliers is imperative to developing a manufacturing strategy including the use of AMT. This includes competitors' customers. Information needed includes expectations of quality, price, variety, service and delivery as well as levels of satisfaction with current suppliers.

❺ Forecast Technology Changes

Technology development must be monitored regularly on a global basis; the next generation of product or process technology may come from any where in the world.

❻ Conduct a Critical Self Evaluation

How does your company stack up against competitors in terms of satisfying critical customer requirements? Are your products as technologically advanced as those of the other suppliers (whether or not they are currently competitors in your market)? How well prepared are you for the next wave of technological product advancements? What is your relative status in terms of process technology? Are you as productive as the best in the world? Are you as customer oriented, as timely, as quality conscious? Does your product mix meet customer needs? Are your distribution channels serving customers as completely and conscientiously as you expect? What are your critical core competencies and how do they differ from those of the other suppliers? What are your relative strengths and weaknesses? Where and what are your opportunities and threats?

❼ Develop Target Market Plan

A marketing strategy focused on specific geographic and industry targets should be developed based on the evaluation of customer needs as well as competitive strengths, weaknesses, opportunities and threats. The marketing plan defines key manufacturing issues including the product variety and volumes to be produced, thus defining manufacturing strategy and the application of AMT.

❽ Select and Prepare Distribution Channels

The correct form of distribution is a function of several variables. The variables include the territory to be covered, the technical complexity of the product being sold, the size of the average sale or the annual sales value of the average customer, the technical competence of the customer, the nature of the customer (e.g., end-user vs. reseller), the size of the market in the territory being covered, local buying preferences, the competitive environment, and the relative market position of the supplier company. An analysis of the variables is required to determine the appropriate channel. The nature of the distribution channel may suggest benefits that can be designed and built into the product. Training is a key issue, both in terms of finding a channel with people technically capable of being trained in the product line and making distribution channel personnel available for training.

⑨ Study World-Class Manufacturing

From the CEO down, the company must learn what it takes to be world-class. Top executives must be deeply involved; those who don't get involved don't understand the stakes. Visits to world-class manufacturing plants with similar processes and problems are important to develop ideas and to benefit from the experience of others. Employees, including top management, should take advantage of the several means available to learn about AMT applications; these include professional or trade association meetings, conferences and trade shows.

⑩ Strive for World-class Manufacturer Status

Implement a manufacturing program to meet the marketing plan, striving to meet or beat the best in the world. Establish benchmarks as to current standing as well as long and short-term goals based on the evaluations of customer needs and competitors' performance. The program should operate on three general levels of activity: Management Practices, Human Resources, Application of AMT.

### 1.4.2 CAUTIONARY POINTS FOR PROSPECTIVE AMT USERS

- Don't try to automate what doesn't work well manually
- Don't attempt to apply AMT to an overly complex product design; first, redesign to simplify and standardize components
- Don't apply flexible automation techniques to high volume requirements
- Don't bite off more than you can chew; start with relatively simple projects
- Don't deal with more variables than necessary at one time; if a project can be implemented in stages, get stage one working before moving ahead with stage two

- Don't attempt to implement AMT without employee participation and cooperation at all levels and in all affected departments

- Don't skimp on employee training; make sure everyone gets sufficient training, including operators, supervisors and maintenance personnel

- Don't wait too long to get started; chances are that some competitor somewhere already has

### 1.4.3 STRATEGIES FOR AMT SUPPLIERS

❶ Define the Home Market to Include all of North America

As with AMT users, Canadian AMT suppliers must target the U.S. as part of their home market. This will be necessary to achieve a critical mass of sales volume, to toughen their competitive skills, to expand their application base, and to gain an additional window on technical trends.

❷ Adopt a Global Perspective

Canadian AMT suppliers may or may not decide to operate globally, but their scanning horizons must be global. A global technology and market information base must be actively developed and managed. This involves participation in standard-setting bodies as well as active participation in industry associations and international trade fairs. Periodic market research must be conducted in key markets in order to identify trends in competitive position and customer needs and requirements.

❸ Use Regional Roll-out to Achieve Direct Selling in North America

In the long run a direct sales force targeting key customers and industries will be necessary for sustained competitive growth in several product classes. Otherwise, the supplier becomes virtually a private labeler for the entity controlling the marketing and sales function. North America is a large continent with many pockets of industrial

activity. It will likely not be economically feasible for smaller suppliers to institute a direct sales force in all areas simultaneously. Thus, a regional roll-out (i.e., establishing a direct sales presence in one or two markets at a time, leading to complete geographical coverage over a period of several years) may be the best way to focus limited resources, establish a direct salesforce and penetrate the market.

❹ Leverage Home Market Customers into Global Accounts

Canadian AMT suppliers can leverage their North American customer base to help reach global markets. Valued suppliers can build on their track record with North American customers to identify overseas opportunities with respect to timing and project scope, establish key buyer contacts and introductions, and determine important purchase criteria. A strategic effort is needed to identify, understand, track, and market these global sales opportunities.

❺ Address The Western European Market Excluding Germany

The several forces driving European countries to invest in AMT make this an attractive market. Within Europe, Canadian companies should concentrate on markets in the U.K., France, Italy and Spain, which are generally open to outsiders. Germany is the largest, single country market in Europe, but is generally inhospitable to outside sources of supply, especially with regard to technical products. Germany has made a major commitment to its eastern sector which may divert the resouces of world-class German suppliers from competing as effectively in other established markets within Europe.

❻ Use Reciprocal Partnerships to Penetrate Asian Markets

Canadian companies possess valuable access to the North American market. The Asian markets, especially Japan, are best penetrated via marketing partnerships. To the extent possible, these relationships should be chosen in such a way that they also provide complementary product and technology for sale in the North American market. In addition to the obvious sales revenue impact of this strategy, it will provide a Canadian company with leverage on its partner, i.e., each side is hostage to the good will and best efforts of the other.

❼ Focus on Packaged Software Products for Standard Platforms

Standard computer hardware platforms and standard operating systems represent a major opportunity for growth by AMT software suppliers. Software offered in a transportable form (e.g., Unix) will reach several times the number of customers as software developed for a proprietary computer. AMT software suppliers that wish to expand outside North America should avoid support-intensive applications. They must develop software which is internally complete.

❽ Offer Specialized Machine Controls Based on Advanced Sensors

New sensor technologies offer opportunities that can be capitalized upon by Canadian AMT suppliers who posess in-depth understanding of machines and processes. Improved sensors and related controls are needed in each of the machinery product categories. Successful product development will rely on the convergence of sensor technology with machine technology. The goal will be to incorporate sensors to develop machines that achieve zero defects on an inherent quality basis, i.e., make products so reliably that no inspection or test is required.

❾ Build Training Into The Product

A breakthrough is needed with respect to AMT training. Most AMT products include a computer or controller with one or more processors that can be programmed for multiple functions. The opportunity exists, using this processing power, to build the training into the product. To be most effective the training approach should be interactive and allow the trainee to move at his/her own speed.

❿ Develop Telecomputer Product Support Systems

Canadian AMT suppliers should take advantage of telecomputer technology to establish systems linking designers, application engineers, service support staff, sales force, marketing partners and customers around the world. This type of approach has proven to be a powerful competitive tool for those who have implemented it. It can be used to support sales staff, as well as to provide customer application support, maintenance information, and software product upgrades.