Imagination is more important than knowledge.

– Albert Einstein
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Don’t get stuck in the starting blocks

Canadian sprinters are among the fastest on the planet. Until they botched the baton hand-off at the World Championships last month, our men’s 4 x 100 metre relay runners were two-time defending world champions. Donovan Bailey, Bruny Surin and even Ben Johnson (though we don’t advocate cheating to win) proved that with proper training, talented people from small countries can knock off rivals from superpowers with 10 times their population. These sprinters provide a valuable lesson for our manufacturers: if you don’t explode out of the blocks with tremendous speed and agility you’ll always finish behind the pack. Sprinters also know that it’s much easier to keep a lead than to make up ground after a slow start.

That’s why it’s disappointing to read the findings in a new Statistics Canada report about the pace at which Canadian companies are adopting and integrating advanced technology. While the researchers didn’t offer opinions on their findings, it’s clear that our manufacturers aren’t quick off the mark when it comes to adopting new technologies. Some of the advanced technology in the survey has been widely-available for more than 10 years, yet few manufacturers are using it. One interesting finding is that 43 percent of manufacturers say they are about as advanced as other Canadian plants, but 10 percent fewer think they are as good as the Americans.

The report, “Technology Adoption in Canadian Manufacturing,” by researchers David Sabourin and Desmond Beckstead, (visit our website to download your own copy of the 76-page report) gives an excellent snapshot of the current technology in use across a wide range of industries of various sizes. The researchers grouped 26 different advanced technologies into six main technology groupings: design and engineering; processing; fabrication and assembly; automated material handling; inspection; network communications; and integration and control.

While the Statistics Canada report does an excellent job outlining the extent to which technologies are being adopted, what’s missing is the “So what does it all mean?” Here’s my take: Manufacturers should stop sitting on their hands and should explore and adopt the new technologies appropriate to their businesses. Many technology vendors I talk with say our manufacturers often adopt a “wait and see” approach. If the Americans or Europeans adopt it — and it works — only then are Canadians willing to jump on board.

I can understand why manufacturers might be “technology weary” as a parade of vendors knocks on their factory gates offering the latest technology that promises to overhaul operations and boost productivity. So, why shouldn’t manufacturers continue their typically Canadian, cautious and conservative, steady-as-she-goes approach? Quite simply, manufacturers that don’t recognize that advanced technology is one vital piece of their future success will be standing in the blocks waiting for the starter’s pistol to sound — when the race is already over.

So why do our sprinters do so well and many of our manufacturers finish in the middle of the pack? Nobody told Bruny Surin and Donovan Bailey that they weren’t allowed to win.
Check brains at factory gate?  
This letter is to reinforce your comments (editor’s note, June 1999) regarding the shortage of manufacturing skills.

As consultants to the packaging industry we often help management make decisions related to divestment or rejuvenation of older facilities. Our evaluations include financial, functional, and structural attributes.

I am shocked at the number of organizations that still exist where the workforce is required to “leave their brains at the gate” as they punch in at the beginning of their work day. The untapped resources available are wasted due to organizational barriers, such as myopic management, too many levels of supervision, top-down decision making, inadequate training, and bureaucratic procedures.

In an union environment the collective agreement is often restrictive, inflexible, and weighted with past practices.

In these circumstances, my reports almost always include the following comments and recommendations:
- Future success will be based on employee empowerment on the operating floor. Training therefore must include the social and communications skills to enable small groups of employees to manage their work area.
- Successful managers need decision making, consensus building, and basic business analysis skills. Note that the first focus is management — technology is second. As workers become better managers they will challenge the technology, the operating techniques and the required technical skills. Being responsible for a small business unit within a large enterprise empowers employees. Employees start to behave like owner-operators with an interest in the success of the business. Operations management must then take on the role of removing organizational impediments.
- In almost every workplace I visit, I meet employees who take on leadership roles in their communities. Whether it is as little league coaches, municipal politicians, social club members, or lay ministers, the skills they use outside their workplaces are the same ones needed to run a successful manufacturing operation. The talents you need to organize the movement of materials through a plant, or run a warehouse, are the same ones needed to get a team of seven-year old hockey players on the ice on Saturday morning with the skates on the correct feet. Management must identify these people and foster their skills development. Unfortunately, many managers don’t allow this talent into the plant — it stays at the gate.

In my view, human resources are today’s largest untapped manufacturing asset. Survival will require all of the employees’ talents.

Roger Miller  
President, R.A. Miller & Company, Inc.
Program boosts local skills and knowledge

Last month, Advanced Manufacturing correspondent Leslie Wu toured the Business and Advanced Technology Centre in Kuala Lumpur, Malaysia. She files this report.

In today’s competitive job market, do employers prefer experience or education? Although most employers value proven skills, workers who lack proper certification still have a hard time competing with university or college graduates.

The Business and Advanced Technology Centre (BATC) in Kuala Lumpur, Malaysia was created to help teach people with professional manufacturing experience, but who don’t necessarily need a degree. Established in 1992 by Malaysia’s Prime Minister, BATC is designed to help Malaysian industry become more competitive in regional and world markets. The Centre provides business management and best practices knowledge to technologically challenged industries in Malaysia.

The BATC’s work include the Lumut Naval Base, where retired naval officers are given the chance to start new careers by learning business management and entrepreneurial skills and obtaining formalized post-graduate certification. BATC is also involved in a joint operation with Bridgeport Manufacturing to support local industries, and emphasize localization.

Apart from training and certification, BATC also serves as a “meeting point of manufacturers,” says Prof. Zainal Ahmad, the Centre’s director. It focuses on computer-aided design, and will soon be expanding into other areas such as virtual manufacturing in conjunction with Proton (Malaysia’s national car company) and other automotive manufacturers. BATC associates include international members such as the UK-based Warwick Manufacturing Group, Bridgeport M achines, Hay/M cBer and General Physics Corporation, and local organizations such as Penang Skills Development Centre, Jayadiri Institute of Technology, Project Management Institute and the Executive Development Centre based at Kompleks Teruntum Kuantan. You can visit the BATC website at (www.batc.utm.my).

Revolutionary robot reconfigures itself

For more than 20 years, Joe Michaels worked on his idea of creating a fractal shape-changing robot. At the heart of the invention are mini-computers that can be put inside individual building blocks and then be programmed to reconfigure themselves as required.

“I had always dreamed of digitally controlled matter and wanted to find a way of manipulating atoms so that they could alter the nature of an object — its color, shape, size, temperature — via computer,” says Michaels, who has now patented the device and won a prestigious inventors’ award. “I hit upon the idea of using a cube to simulate the atom but eventually realized it was impossible to manipulate atoms directly, so the cubes themselves became the tool. The applications are complex but the idea is simple.”

The ability to repair itself is one of the invention’s most innovative capabilities. If one brick gets damaged, surrounding bricks can be programmed to detach and put a new one in place. A fractal machine also offers greater dexterity and can change shape to get from one point to another regardless of the terrain.

The robot could also maneuver through holes and build itself on the other side. Each cube could house tools such as cameras, wheels, drills, and sample collectors that could push themselves out and be used.

For detailed papers, and to see examples of fractal robot applications, visit (www.stellar.demon.co.uk).

ABOVE: This fractal shape-changing robot can reconfigure and repair itself. The invention has raised eyebrows and won awards.
Design software gets STEP certification

A popular 3D design software package has cleared one of the major hurdles that should now make users more confident that they can share their data with others. IBM/Dassault Systems announced that their CATIA Version 4 Release 2.0 achieved ISO 10303 (STEP) certification. This allows their customers to exchange digital product data across many disciplines including design and manufacturing as well as throughout the entire supply chain.

Robert Kiggans, general manager of PDES, an industrial and government consortium aimed at STEP development, says software users have long been asking for a certification mechanism. STEP AP203 is the result — an international standard for the representation of product model data for configuration controlled design of 3D mechanical parts and assemblies.

“We have been actively participating in STEP standardization committees and we are very proud today to be the first company to get a STEP certification for its product,” says Bruno Latchague, executive vice-president for research and development at Dassault Systemes.

The product certified was the Release 4.2.0 running on an IBM RS/6000 under AIX Version 4.3 using an IBM-developed STEP Product Data Management Information Processor (PIP) tool set. For more information visit www.catia.ibm.com.

Trade trends reflect high-tech emphasis

If trade in high technology products is any indicator of science and technology development in China, then the government’s policy of setting a high priority for its high-tech industries is proving to be a success.

Since the beginning of the 1990s, the value of China’s high technology products’ import and export activity increased dramatically. In 1987, the annual value of total high tech imports and exports was US$6.24 billion; increasing to US$12.32 billion in 1991; and going as high as US$29.47 billion in 1997.

While import and export rates have grown in high tech, commodity, and manufactured goods, the highest growth rate of 16.8 percent was in high-tech goods.

Between 1987 and 1997, the import rates for high-tech products were higher than for exports, particularly in the early 1990s. Since 1995, however, the balance of payments for high-tech products has been decreasing.

The Asian Technology Information Program predicts that with internal reforms deepening and the country’s science and technology abilities increasing, increased imports and exports of high-tech products are likely to continue.

Russians probe advanced membranes

Moscow-based journalist Sergey Panasenko reports that his country’s scientists are busy working on membrane technologies.

Think there is no such a thing as innovative technology in Russia? Think again.

BF Goodrich and Los Alamos National Laboratory are among those who have turned to Russian scientists for what some consider the technology of the future: membranes.

Membranes are hollow fibers of thin films of porous material. The small pores serve as a physical barrier, preventing the passage of certain substances while allowing the free passage of others.

Membranes are used in various industries from food production to waste recycling to nuclear power. Kidney machines just can’t make it without them, and neither can manufacturers of the super-pure materials micro-electronics rely so much upon.

Membranes are produced in other countries, but there are some specific fields where Russian researchers are still most advanced. This is true, for example, for the direct fuel recovering from natural gas — the technology that is now used for feeding pumps on gas mains from Russia to Europe.

NATO’s Science For Peace program granted money to develop and implement this technology. Another big advantage is that while being equal or better in quality, Russian membranes are two to three times cheaper than those made in the West.

During the 1980s, the government created a huge membrane production capacity with the flagship “Polimersintez” plant in the city of Vladimir, 180 kilometers east of Moscow. Now called “Vladipor,” this plant is now only 20 percent employed.

Fortunately, there are some recent signs of recovery. The Ministry of Science has included membranes on the list of so called “federal critical technologies” along with genetic engineering, catalysis, new synthetic materials, and about a dozen other technologies. This status should ensure additional state support for researchers and new results in the future.
This sounds like way too much fun to be work.

At the LEGO Virtual Village, designers use virtual reality (VR) products to construct future LEGO toys. The company’s research and design team use a 3D graphics database of toy kit elements to develop the toys. Multigen’s immersive 3D scene assembly package, SmartScene, is used to create the networked, collaborative play space.

The designers enter LEGO Village after putting on their virtual research or N-Vision head mount displays and Fakespace Pinch gloves from SGI, equipped with Polhemus or Ascension trackers.

Inside, the designers access a virtual palette providing hundreds of photorealistic LEGO parts and textures. With a fingertip, a designer picks any part. It appears in mid-air, ready to grab by hand for building.

The designers grab space to navigate through the scene, shrink to LEGOman size, or swell to giant size to overlook LEGOdom. After the scene is complete, the system generates a parts list. The scene can then be built in the real world. If it looks as good as it did in the Virtual Village, you may find it at your nearest toy store.

“We’re using a two-handed immersive interface because it’s a better way to play with the data,” says research and development director, Dandi du Midi.

Instead of using networked VR to link people separated by distance, the village enables two designers in one lab, each wearing VR goggles, to play together in virtual space. Ultimately, the company wants to put someone in the design lab to work with the package designer, so that the company can support non-sequential design.

The goal is to promote collaborative virtual reality so that there is less distinction between people and machine, between people and people, and between machine and machine.

Collaborative VR at LEGO works on Onyx or Onyx2 supercomputers, and on Indigo2M aximum IMPACT workstations. The system works most reliably when the machines at each end of the connection provide the same performance specs.
Automation makes company a winner

Rockwell Software has racked up awards over the past few months for its automation software. The company’s enterprise controls software won a “Technology of the Year” award from Industry Week magazine.

Entries were judged on the potential the product offered for redirecting business opportunities and creating new growth in the manufacturing world. Enterprise controls software converts data from a design engineer’s CAD system into a control program that can be used to animate a “virtual machine” simulation.

Later, it can be used for direct control of the machine on the plant floor. The software allows design engineers and equipment designers to validate manufacturing processes before they are committed to developing machinery, thus allowing greater flexibility in the manufacturing process.

The company was also honoured for a second consecutive year with a Technology and Business Award as a “technology enabler.” The award is presented by startmagazine, in cooperation with Microsoft Corp., to a supplier that provides superior technical solutions for an end-user using Windows-based technologies.

Rockwell was cited for its work with Colorado Springs Utilities in Colorado. Rockwell used the RSView32 Active Display System software package to securely control and monitor plant floor applications from local and remote stations. As a result of cost savings, the utility offered residential customers rates 33 percent lower than the national average and commercial customers received a rate that was 60 percent lower.

New standards for robot safety

After more than four years of intensive effort, a new standard for robot safety has been approved. The ANSI/RIA R15.06-1999 offers three times more information than the previous version on how to properly safeguard robots and robotic work cell applications.

“It’s a must-have document for those who use or plan to use, manufacture, or install robots and related equipment,” says Jeff Fryman, Manager of Standards Development for the Robotics Industry Association (RIA).

To order the robot safety standard or to get more information on the RIA’s activities visit www.robotics.org or call (734) 994-6088.

The RIA estimates there are 92,000 robots at work in U.S. factories. The Association offers regional robot safety workshops and makes its proceedings available to the public. The RIA also offers in-house training seminars.

Early Y2K bug has already caused glitches

No one can say they haven’t been warned.

Still, fewer than half of America’s largest companies expect all of their critical systems to be prepared for the Year 2000, according to a new survey by Cap Gemini America. Another 75 percent of the respondents say they have already experienced a Year 2000-related failure.

The survey is one of the longest-running corporate polls dedicated to monitoring Year 2000 preparedness. It includes responses from information technology directors and managers of 144 major U.S. corporations across all major industrial sectors.

“The time has finally arrived when top management views the Year 2000 challenge as a business problem and not merely a technology problem,” says Jim Woodward, senior vice-president of Cap Gemini America. This new concern is reflected in the increase from 62 percent in May, to 84 percent by August, of top managers planning to take charge of the Year 2000 challenge. The number of managers willing to delegate contingency planning has shrunk from 35 percent in October 1998 to 12 percent by August.

Independent verification and validation (IV&V) is the process used to check the quality of renovated code and has emerged as standard industry practice, according to the survey results. Nearly nine out of ten firms consider their needs for IV&V to be high.

While many firms have handled Year 2000 work in-house, they say it is still important to obtain third-party verification. Another clear sign that people are taking the issue seriously is the increase in the number of major corporations likely to sever ties with non-compliant suppliers of services and products.

Early Y2K problems

The following areas were the hardest hit by early Y2K-related problems:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Financial miscalculation or loss</td>
<td>92%</td>
</tr>
<tr>
<td>Processing disruptions</td>
<td>84%</td>
</tr>
<tr>
<td>Customer service problems</td>
<td>38%</td>
</tr>
<tr>
<td>Logistics/supply chain problems</td>
<td>34%</td>
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</tbody>
</table>

Source: Cap Gemini America, August 1999
Gravatom knows no limits

Dave Barker will tell you that wise partnering and diversification are behind the success of his custom engineering company, Gravatom. My visit to the company’s Hampshire office revealed that what makes this company work is its refusal to accept limits.

You have undoubtedly heard these statements in your workplace: “But that’s not our business,” or, “That’s outside of our experience.” Excuses like these aren’t heard at Gravatom. When the company began in 1994, more than 95 percent of its business was in the nuclear sector. Management wanted to diversify, and so their nuclear business slid to 60 percent of operations and automated industrial systems now makes up the other 40 percent. The company now markets itself as a supplier of what it calls “total engineering solutions.” It provides model prototype development, plant performance evaluations, manufacture and testing of manufacturing systems, and systems installation and commissioning.

In the spirit of setting no limits, Gravatom forms partnerships to achieve diversification. One such co-operative venture with another engineering firm, Plascoat, won the company in excess of $250,000 from the British government’s Foresight initiative. The two firms developed a machine that coats the inside of fire extinguishers with a plastic film.

Barker describes the alliance glowingly. “Our combined brainpower has helped us come up with creative strategies and innovative solutions in many different areas of our businesses.”

ABOVE: Gravatom’s credit card packaging line. This machine stacks cards into cardload boxes to ease materials handling downstream in the process. It took four months from design to commission.

British Renaissance: Part two

In May, associate editor Lee Scott visited England to investigate innovative manufacturing. In part two of this series, she tours four leading-edge enterprises and reports on how they are prepared to compete with the world’s best.
IPT, the parent company of Plascoat, specializes in developing, manufacturing, and coating ferrous materials using a thermoplastic powder. It also designed a range of machinery to apply the thermoplastic coating. IPT was looking to outsource some of its engineering activities, and joined forces with Gravatom. Both companies have worked hard to make the alliance work — satisfying IPT's need to sell thermoplastic powder with Gravatom's desire to sell the machines which apply the powder.

"It quickly became clear that one of the key factors to our successful working relationship would be open book costing — from initial estimate through to final project," says Barker. "We put on the table a total breakdown of the design, drawing, manufacture, assembly, and testing of the contract activities. After this we were able to calculate a procured cost and came to an agreement whereby if our internal costs were lower we would share the difference and if the bought-out costs were higher Plascoat would pay the difference."

The experience has encouraged Gravatom to enter into other alliances. During my visit, Gravatom's engineers were working on a semi-automated manufacturing cell that will assemble car doors including side air bags for the Swedish autoparts manufacturer, Autoliv.

Gravatom's dedication to flexible manufacturing, its willingness to cooperate with others to achieve manufacturing solutions, and its courage in diversifying is a benchmark for other engineering firms working in a competitive, global environment.

**ABOVE:** Gravatom's airbag folding machine. This semi-automated car airbag folding machine is for the Rover series. It took four months from design to commission.

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**Renishaw racks up awards**

An unusual manufacturing facility lies in the heart of sheep country in Gloucestershire, England. The idyllic site complete with strutting peacocks and preening swans, is the first clue that this may be a company with a difference. Behind the peaceful grounds is a plant housing one of Britain's most innovative manufacturing stories in the past 25 years. This is the Wotton-under-Edge site of Renishaw — a company at the leading-edge of automated metrology equipment production.

At the heart of the Renishaw operation is chairman and chief executive David McMurtry. McMurtry is an engineer's engineer — a design genius who came up with the touch trigger probe as a weekend project while working at Rolls Royce in 1972. The probe was essentially a simple design using kinematic location principles.

Since that auspicious beginning, Renishaw has been instrumental in pushing manufacturers away from traditional methods of tolerancing — in which parts are removed and transported to a tolerancing machine — to completely automated machining and tolerancing systems.

As early as 1975, Renishaw was promoting the use of touch-trigger probe technology for use on machining centres. The company's probe technology and associated software allows fast and repeatable measurements to be carried out on Co-ordinate Measuring Machines (CMM). While a range of automated probing systems meet the needs of post-processing inspection for quality control, the company also provides capability to Computer Numerically Controlled (CNC) machine tools. This provides measurement capabilities automatically to help control the machining process and to eliminate manual procedures.

Renishaw's list of technological achievements is legendary in the UK. The company won a multitude of technological achievement awards including a prestigious Queen's award in 1980 for its probe. The company also developed an automated manufacturing system known as RAMTIC (Renishaw's Automated Milling, Turning and Inspection centre). Flexible manufacturing is achieved by producing a variety of compo-

**ABOVE:** Renishaw's innovative engineering staff develop advanced manufacturing technologies and then use those techniques to manufacture their own products.
Jaguar goes lean

Between 1940 and 1945 Castle Bromwich was the building site for the famous fighting machine, the Spitfire.

Today it houses the manufacturing facility of another British institution — Jaguar. Last December, Jaguar turned the key on a new manufacturing line for its S-Type car.

The company redeveloped a previously unused section of its 105-acre site and hired 600 new workers to build 35,000 more cars in 1999 than it did in 1998. This was a tall order. They expended considerable effort to develop a lean manufacturing environment and to encourage ownership of the manufacturing process by workers at all levels. “It has been an incredibly rewarding experience,” says Julian Hetherington, a manufacturing program manager. Starting with what they described as a “blue sky” vision, Hetherington and his colleagues have been surprised that they could achieve most of this vision within real life constraints. They focused on four elements of the manufacturing process:

- People: managers developed a work group structure and management gave up its old philosophy of “tell-and-do” and opted for one in which employees are given responsibility for improving work patterns. Management follows up with support for this group work;
- Methods: they introduced a system of standardized work in which team members write out work element sheets and take ownership of the time to complete standardized tasks;
- Material: the plant introduced a “pull” environment for material supply that requires minimal inventory. They use single piece material flow. Raw materials are called by a combination of card and radio telemetry “Kanban” systems and by automatic delivery to line sequence from larger module suppliers;
- Machinery: management wanted to ensure an operator focus for ergonomic operation, excellent communications, and useful operator facilities. They created ergonomic packaging of line side material and the use of racks and tables. Meeting areas are in place right on the plant floor equipped with flip charts, filing cabinets, PCs, and facilities to support process development.

Jaguar used CAD/CAM to its advantage in the design phase of the facility to maximize plant operations. The facility was designed using AutoCAD Version 14. M any of the operations were simulated in RoboCad. This included manual handling operations with complex loads and most of the robotics applications (there are 127 robots on the line).

With its recent move to the SDR C I-DEAS C3P suite of computer-aided design and engineering tools, the plant is able to interface between product design information, RoboCad, and Digibuck allowing them to “virtually” build the car. They will use FIDES to design modifications and for new installations.

Hetherington credits specific technologies with giving the plant an edge. They used Perceptron laser measurement cameras for in-line process measurement. Witness simulations to verify plant output, and M odus-T from Groupe Schneider. QuantumT PLCs handle the data management that sends information to overhead process control boards on the plant floor and provides immediate information to the management system.

The plant uses variation simulation analysis to support Total Vehicle Dimensional Control Discipline. Essentially, they simulate using thousands of run simulations, then build tolerances of each element in the vehicle assembly process.

These technologies have been a big help, but Hetherington stresses that the key factor is the training and development of new workers. “When you bring in lots of new people, you get fresh ideas but little experience,” says Hetherington. “These people have to be supported and their input valued.”

Warwick model widely imitated

Twenty years ago maverick industrial research leader Prof. S.K. Bhattacharyya saw the need for a research centre that put the industrial customer first — a centre whose primary goal is to transfer technology from the laboratory to industry. Today, the Warwick M anufacturing Group (WM G) supports centres around the world, employs 400 staff, boasts more than 1,000 associates, and has forged alliances with 400 blue chip companies including such notables as Deneb, Fanuc Robotics, Rover Group and Sun M idsystems. Research topics include robotics, factory automation, catalytic systems and materials engineering, materials and process research, best practice

ABOVE: The silver car above depicts Jaguar's 1964 S-Type car, and the burgundy car highlights the 2000 model S-Type Jaguars manufactured at Jaguar's new manufacturing facility at Castle Bromwich.
benchmarking, operations design and simulation, logistics performance and quality targeting.

At the International Manufacturing Centre (IMC), a variety of research projects focus on international collaborations. The Controller Area Network (CAN) Centre works at overcoming cumbersome wiring harnesses through the use of intelligent micro controller network control systems. Also, within the IMC is a technical collaboration called the Structurally Advanced Lightweight Vehicle Objective (SALVO) in which 32 companies work in six major research areas relating to the application of new materials and construction techniques for vehicle manufacture. Under the umbrella of the IMC is the Sun European Manufacturing Centre of Excellence (SEM COE). Here, researchers are trying to identify links between the use of information technology (IT) and the achievement of competitive advantage.

The Advanced Technology Centre (ATC) at WMG is dedicated to technological and operational innovation. The most active group in the ATC is the Rover Group. Reducing the time and cost of new product introduction is one of the biggest concerns. Agile manufacturing and best practice initiatives are the emphasis for research to reduce the time and cost to bring products to market. In the Rapid Prototype and Tooling Centre, the Rover Group and Warwick work on a program where concept models are made in powder, wax and paper to reduce product design time.

When you combine government support, strong managers using advanced technologies, and close ties with an elite research community, you’ve got a recipe for success. Look for Britain to play a leading role in manufacturing in the next century.

Lee Scott is Advanced Manufacturing’s associate editor and looks after the World Watch section of our magazine. You can reach her at plscott@cgocable.net. Advanced Manufacturing gives a big tip of the hat to Richard Higgins, Consulate-General, and Melanie Marshall, British Trade and Investment Office (Toronto) for coordinating Lee Scott’s tour of Britain’s manufacturing sector.
Managers are forced to embrace change at an ever-increasing pace. Affordability and improved productivity are fierce business drivers. Business leaders are turning towards automation involving complex technologies to achieve the efficiencies they need to compete. But downsizing has stripped many manufacturers of fundamental skills. To make matters worse, the skills that are required are changing dramatically with the emergence and adoption of complex technologies.

The pressures on business leaders to make the right choices to move forward are greater than ever before. Managers want solutions to position their operations as the lowest cost, highest quality producers of their products or services.

To do that, manufacturers comb their plants for opportunities to improve their bottom lines by increasing their customers' levels of satisfaction, extending the useful life of their plants, employing less capital, and reducing operating costs. And they are not doing it alone.

Many Canadian business leaders are looking beyond the walls of their plants to seek ways to overcome barriers and to establish their competitive advantage. Successful advanced manufacturers are partnering with a variety of players to seek the combination of seasoned experience and innovative thinking needed to navigate through the storm of dramatic change.

JOINING FORCES
CEOs with restricted budgets are moving toward high performance advanced manufacturing by joining consortia of non-competing manufacturing members.

These consortia are formed out of the members' need to address change and seek innovation. Helped by skilled manufacturing specialists, members of the consortia agree to topics and priorities. Often, the consortia decides to hire specialized management consultants who might not be affordable by any one member. It's up to these consultants to demonstrate a proof of concept, and transfer their skills to a cross section of shop floor team members drawn from the various plants. Other members observe the process to critique and learn.

PARTNERING WITH VENDORS
Many manufacturers are tearing down the traditional walls of engineering and design by partnering with their major equipment vendors in design initiatives to create environmentally-friendly and design processes to produce unique high value products.

Once the equipment is commissioned, manufacturers invite equipment vendor specialists into their plants to troubleshoot operational problems.

Intelligent sensors generate the raw data used to analyze the condition of their equipment. With remote Internet access to this data, equipment vendors now have the capability to predict wear and tear on
their equipment, and begin the process of replenishment, rebuild or repair well in advance to avoid deterioration or breakdown in the manufacturing process.

Extending this concept, spare parts manufacturers are also taking the responsibility to have the right part on their customers’ sites at the right time, avoiding costly investments in inventories and holding charges. With assurances built into the terms and conditions of the contractual agreement with vendors and suppliers, the advanced manufacturer need stock only critical parts on site with long lead times for delivery. Consignment inventory is no longer required and all parties win.

BRING IN THE EXPERT
The person who is often brought in to get the most from these partnerships is the subject matter expert. These individuals have the breadth of knowledge and skill to bring diverse partners together within a common framework. Innovation emerges from skillfully run sessions by experts who try to discover the needs of the end users. When issued to the marketplace, these needs often translate into demands for new industry solutions to provide improvement to tried-and-true traditional

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EDUCATION

British Columbia school opens its doors

The partnering of industry with educational institutions is emerging as a win/win model that leverages the strengths of both parties.

The British Columbia Institute of Technology (BCIT), in an effort to fulfill its mission to serve the business community with job-ready skills, now offers innovative high quality training solutions tailored directly to the needs of industry. The Institute is trying to meet the immediate needs of industry and deliver its services and products globally.

One initiative is the SimTech Centre, a joint venture between BCIT and H.A. Simons Ltd., a global engineering firm. Several high-technology vendors (Hewlett-Packard, Oracle, Indus, ABB Elsag Bailey, Rockwell, H.A. Simons, TransTech, Digi-dyne, and BC-Telus) are participating in this mutually beneficial partnership to create integrated solution footprints for process and discrete industry. SimTech’s facilities feature a well-run, highly-functional computer-based training classroom where each seat is individually equipped with up-to-date desktops.

SimTech president Marshall Heinekey, who was recently appointed dean of BCIT’s school of process, energy and natural resources, says centres like this are the way of the future. “The synergy among our technology vendor partners and subject matter experts provide the test beds and staging facilities for affordable world class, industrial business solutions,” he says. The SimTech Centre also provides a state-of-the-art laboratory for participants in BCIT’s new Bachelor of Technology degree in Business Process Integration. Heinekey believes this will give participants hands-on experience that they would not have had elsewhere.

Another initiative, is BCIT’s Learning Resources Unit (LRU) that designs and develops custom designed shop floor training for local and global industries.

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Another initiative, is BCIT’s Learning Resources Unit (LRU) that designs and develops custom designed shop floor training for local and global industries.
If you were to try to imagine what industrial cameras will be capable of by the year 2002, what would you say? Are pixel resolutions of 2,000 x 2,000 at 40 frames per second achievable? How about 14-bit images? More?

In my view, numbers even as powerful as these will be considered conservative by then. After all, technological progress has proceeded at an exponential rate ever since the development of the modern digital computer. I am convinced this exponential trend will continue for several years to come.

Such imaging prowess, however, will not come without its challenges. To understand the problem it will pose for manufacturers, imagine that one of these powerful new cameras has been installed in an industrial environment. They offer expertise and best practices to ensure that the manufacturing process is supported by reliable plants and equipment, a cornerstone to low cost, reliable production and on time customer service.

### EDUCACTORS AND MANUFACTURERS

Progressive educational institutions are no longer building theoretical laboratories but are partnering with industry to create proof of concept solutions in industry sponsored state-of-the-art laboratories. This low risk approach provides the fertile ground to breed innovative solutions in response to industry's ever-increasing complex set of demands and challenges. Educational institutions are increasingly emerging as strong, logical partners.

Partnerships come in many shapes, forms and sizes. Some are disguised as outsourcers, consultants, consortia, and others as educators, vendors, suppliers, and customers — but these players are essential partners in the world of the advanced manufacturer.

### WHY NOT PARTNER?

Canadian manufacturers are being forced to undergo fundamental change to cope with increasing external demands while focusing on redefining their core business. To deal effectively with both the internal and external demands, successful advanced manufacturers are finding they do not have all the skills they require to sustain their competitive advantage. Many have turned to a collaborative partnership model designed to leverage the strengths of each partner as a key to success.

This trend towards partnering is successful only with a balanced approach, clearly defined terms of reference and a shared commitment to success. Success is the key to sustainability. So why not partner?

### MACHINE VISION SYSTEMS

**Tomorrow's smart cameras leave you smiling**

New technology developments will catapult machine vision systems to new limits

BY VIC WINTRISS

If you were to try to imagine what industrial cameras will be capable of by the year 2002, what would you say? Are pixel resolutions of 2,000 x 2,000 at 40 frames per second achievable? How about 14-bit images? More?

In my view, numbers even as powerful as these will be considered conservative by then. After all, technological progress has proceeded at an exponential rate ever since the development of the modern digital computer. I am convinced this exponential trend will continue for several years to come.

Such imaging prowess, however, will not come without its challenges. To understand the problem it will pose for manufacturers, imagine that one of these powerful new cameras has been installed in an industrial environment.

Consider that it is collecting 14-bit, 2,000 x 2,000-pixel images at the rate of 40 frames per second. That's 2.24 gigabits/second, or 280 megabytes/second (2,000 x 2,000 x 14 x 40). Even in 2002, a two-gigabit serial interface will be considered fast, and processing 280 megabytes of pixel data per second in a...
personal computer won’t be easy.

The increase in the rate of pixel generation will likely outrun channel and PC capabilities within a few years.

A good question to ask at this point is, “Why would anyone want to dedicate such tremendous serial bandwidth for sending frames of raw pixel data to a computer?”

In usual machine-vision scenarios, only a small fraction of a picture frame comprises the region of interest (ROI). In fact, often no visual image of the ROI is even required. The object of a machine-vision system, after all, is to make a decision: “Is there a blob?” and “Where is the blob?” and “Is this a defect?”

This raises another question: What if all that pixel pre-processing and decision-making could be done within the camera?

If all the processing were done inside the camera, the blob analysis of a gigabit image might result in only a few hundred bytes of data which need to be sent somewhere. Such compact packets of data could be easily transmitted directly to a machine control without even passing through a PC.

The answer to the limitations stated earlier is a stand-alone, smart camera which can internally perform at least 20 BOPS (billion operations/second) of effective pixel processing power. This camera...
would have discrete digital outputs for applications where fast, machine-control response is required.

High-speed Ethernet connectivity should also be available for transmission of pre-processed picture data directly to existing network assets. Each camera must have synchronization inputs for applications that require multiple, synchronized images.

GAF Materials Corporation needed to devise a way to inspect fiberglass moving at 1,900 feet per minute for the presence of streaks, holes and clumps. A series of ten, synchronized cameras with the characteristics listed in Table 1 on page 22 could be used for this application.

A major stumbling block in the implementation of smart camera systems is the technical expertise needed to program these complex devices. Programming is normally required in both the host computer (typically a PC) and within the camera. For applications where pixel processing can be accomplished in a PC, a number of third-party vendors provide software packages for image processing.

VisionBlox by IntegralVision (a subsidiary of Medar, Inc.) has developed an excellent set of extremely powerful image-processing tools that can be dragged and dropped into a Visual Basic or Visual C++ program running on a PC. Using VisionBlox, an experienced programmer can develop a typical application in less than a day. National Instruments also has a vision system processing package called IMAQ. For real-time, pipeline-processing applications where pixel processing must be done in the camera, a graphical user interface (GUI) for the PC which communicates with a real-time operating system — such as VxWorks — running within the camera will be necessary.

Wintriss Engineering has developed such a system called the WebRanger for web inspection applications. Wintriss manufactures a line of smart, pipeline-processing cameras which match the specifications described earlier. These cameras can crunch large amounts of pixel data within the camera and send the results over the Internet. They can also send real-time data over a fibre channel interface.

The machine vision industry is rapidly moving away from the video camera / frame grabber systems of the 20th century to a new breed of smart-camera-based systems for the 21st century. These 21st century smart-camera systems will perform real-time, pixel-data extraction and processing operations within the camera at extremely high...
speeds and at a cost, which is consider-
ably less than required today for compa-
rable capabilities. Eventually, complete
vision processing systems on a sensor chip
will be available. Until that time, howev-
er, it is my belief that the smart camera
approach described here will be the gold
standard for line scan cameras.

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mail at: vic@weco.com or visit his compa-
ny's website at (www.weco.com).

### Year 2002 smart camera specifications

The specifications for a smart, stand-alone camera which
will meet year 2002 requirements are listed below:

**FEATURES:**
- 5000-10,000 pixel line-scan sensor
- 40 mega-pixels per second pixel rate
- S/N greater than 50dB
- Variable line length from 256 to 10,000
  pixels/line
- Variable line rates:
  - 3750 lines/second at 10,000 pixel resolution
  - 150,000 lines/second at 256 pixel resolution
- Sync modes:
  - External encoder locked
  - Internal fixed
- Exposure control:
  - 1 microsecond to 1 second

**ON-BOARD PIPELINED PROCESSING FEATURES:**
- Corrected video (digital gain and offset per pixel)
- 10 bit look up table providing 1,2,4 or 8 bits per pixel

**DATA OUTPUT MODES:**
- Raw video via Ethernet
- Packed video data 1, 2, 4, 8 bits per pixel
- Real-time streak data (Xstart, Xstop, Line Number)
- Real-time raw video via 400 MHz hotlink
  fiber channel (ANSI X3.230)

**I/O CONTROL AND DATA:**
- Ethernet (100 Mbit, 100 Base TX)
- Serial (RS-422)
- Digital inputs (TTL Level)
- Digital outputs (TTL Level)
- Analog Control Outputs

---

**TABLE ONE**

**ABOVE:** A typical WebRanger defect analy-
sis operator screen.

Need to make an instant connection
with an advertiser?
Use our ONLINE READERSERVICE!
Every advertiser has their own
unique address at the bottom of their ad.
Just search for that address
on the Internet and you’ll have an
instant connection with that advertiser!
Relative

Imagination is more important than knowledge.
- Albert Einstein
As technologists and scientists, the industrial thinkers of the 19th and 20th century were instructed and trained to rely on “knowledge” and were rewarded for doing so. This path of thinking allowed for the commercialization of leading-edge technology products and processes. They were, however, only leading-edge technologies, not what one would consider “next generation manufacturing technologies.”

One hundred years ago, when craftsmen made industrial products and when communication was done primarily by word-of-mouth, knowledge dominated the industrial world. Imagination was only found in the minds of a few advanced thinkers.

As we enter the 21st century, however, knowledge and imagination must take on different roles. Knowledge continues to rely on fitting data points together to define an equation and direction, while imagination emphasizes the single data point (multiple data fitting curves) to construct anything you can hypothesize.

Albert Einstein was instructing us to consider this directional change with his quotation “Imagination is more important than knowledge”. Departing from the “box of knowledge” where data dominates, and entering into imagination, will open a new world of thinking. Here, imagination and knowledge will co-exist to improve 21st century industrial manufacturing.

If we would only close our eyes and let our imaginations run free, we could build on the knowledge of yesterday and create the knowledge of tomorrow.

Recently, I came across a Japanese quote that translates into something like this: “To speak and understand one word implies that you know all words.” This is the root of imagination.
Consider this: a press release from the Profinet Trade Organization recently announced that the three main fieldbus organizations that represent three major international fieldbus standards have agreed to work toward a single, common international fieldbus standard under the IEC by the end of this year.

The ControlNet International, Fieldbus Foundation, and Profinet International fieldbus organizations, as well as vendors Fisher-Rosemount, Rockwell Automation and Siemens AG are working toward a common standard. The organization behind the P-N et fieldbus standard has also indicated it will join this effort.

This announcement comes at a crucial point in the development of fieldbus technology.
The competition among fieldbus choices, particularly between the North American-born DeviceNet and ControlNet, and the European-bred ProfiBus has become almost as politicized and as personal as the age-old debates about whether MacIntosh’s are better computers than PCs and whether Beta is superior to VHS technology.

The end-users have been demanding more open systems, and this news of a common fieldbus standard would be a crucial development in fieldbus technology and in manufacturing automation as a whole. It will mean a stronger, more robust and more widely distributed network; it will simplify software and hardware development and allow
vendors to devote resources to enhancing connectivity and performance and to develop new applications, rather than on ensuring compatibility with several different fieldbus standards.

But how long it takes for a truly vendor-independent, common fieldbus architecture to take hold is still an open question.

The history of connectivity Fieldbus may seem like an established technology now, but it only began life within the past decade.

Until then, most factory floor communication was proprietary. As information technology entered the factory floor, users demanded more and better communication between control systems and automated equipment.

We wanted machines to be able to “talk” to one another in an increasingly intelligent manner — to enable automatic shut-down at critical points, adjustments in speeds, reporting of status and productivity to the front office system.

The front office and as management wanted better communication between the front office and the factory floor, third-party connections to the shop floor network began to arrive.

By about the mid-1990s, “fieldbus” architecture started to take hold: an open network supported by several vendors.

In the U.S., Allen-Bradley developed standards which grew into DeviceNet and ControlNet.

In Europe, Siemens helped develop Profibus.

Through the late 1980s and early 1990s, a number of systems vendors developed their own kinds of proprietary factory communications systems.

As the personal computer standardized applications in the front office and as management wanted better communication between the front office and the factory floor, third-party connections to the shop floor network began to arrive.

By about the mid-1990s, “fieldbus” architecture started to take hold: an open network supported by several vendors.

In the United States, Allen-Bradley developed standards which eventually grew into DeviceNet and ControlNet; in Europe, Siemens and other manufacturers developed a protocol which evolved into Profibus.

Users like open systems that allow them to mix the best components from different manufacturers for different functions. It also significantly empowers the customer — they’re no longer as tied to a single supplier.

“The right to fire your vendor is a tremendous power,” says Bill Moss of the Open DeviceNet Vendors Association.

In the U.S., Allen-Bradley developed standards which grew into DeviceNet and ControlNet.

In Europe, Siemens helped develop Profibus.

The fieldbus layers

To understand the differences between fieldbus standards, it’s necessary to understand how field networks are designed. Network communication comes in eight “layers,” numbered from 0 to 7.

(0) The basic layer is the physical one — the actual wire (or wireless connection) that connects the components. This can be twisted-pair wiring, fiber-optic cable, coaxial cable (occasionally) or, increasingly, wireless radio-frequency connection.

(1) The next physical layer is the transceiver — the components that connect the wire (or wireless) network to the devices, controllers, and so on.

(2) The data link — an electronic board with a co-processor (chip) that tells the components how they “communicate.” This level defines the type of communication, such as master-slave, source-destination, producer-consumer and so on. DeviceNet, for instance, is based on the producer-consumer model, while Profibus is based on a source-destination model.

(3) The transport layer — the protocols that determine how the information is moved across the network, that handles network traffic, defines the number of retries to get a message through and so on. A commonly-understood example of the transport layer is IP, the Internet Protocol.

(4) Sessions layer — the network layer that contains the bus addressing. Examples in the sessions layer include TCP (also used on the Internet), broadcast and multitasking.

(5 and 6) Higher sessions layers that are used in dial-up connections and similar applications — typically not used in manufacturing.

(7) The application layer — the layer that determines the meaning of the messages. It’s at this layer that network vendors create the user interfaces.

Ethernet buses are determined by layers 0 and 1 (the physical connections), 2 (the data link) and 7.

Ethernet, which is now being used by some fieldbus manufacturers, is defined by layers 1 — the transceiver and other physical components that connect the wires — and 2 — the data link. Where fieldbuses and Ethernet have the physical connections in common, such as 100Base-T wiring, Ethernet can be used as a low-cost, easy-to-install fieldbus network.

Perhaps the best working definition of “fieldbus” comes from the U.S.-based Fieldbus Foundation:
So, who’s winning?

It’s very difficult to compare the market share of the fieldbuses for one thing, not all “installed nodes” are reported, so the respective organizations cannot tally them. But the hardest part is that the applications are specialized and fragmented.

Engineers and consultants who select the fieldbuses will tend to use the network they’re familiar with.

For instance, ProfiBus may have the largest total installed base, at around three million worldwide; it may lead in Europe and in certain industry sectors in certain countries or regions — but “DeviceNet owns the discrete manufacturing sector in the U.S.,” says Matt Kuzel, president of network interface module manufacturer Huron Net Works, Inc. of Ann Arbor, Michigan. Kuzel has worked with a number of fieldbuses.

Foundation Fieldbus is very strong in certain process flow applications in North America and in Europe, but Profinet PA is historically stronger in European applications. And other fieldbuses often were designed for specific kinds of applications and industries, so that their lack of market share in other industries really doesn’t mean anything.

The relative market strength in particular industry sectors seems to have more to do with the history of the development of the fieldbus. One of the first fieldbuses was CAN, developed by Bosch for the automotive manufacturing sector. CAN evolved into CANopen, which today is used widely in robotics manufacturing, motion control systems, medical equipment, public transportation and areas where decentralized machine control is important.

Allen-Bradley used CAN as a basis in the early 1990s when it developed the fieldbuses that eventually became DeviceNet and ControlNet. These two fieldbuses were intended to be complementary: DeviceNet is for the device level, and ControlNet is forhigher-level communications as well as enterprise-wide communications. ControlNet can be used to connect a number of DeviceNets, but as Matt Kuzel points out, “ControlNet takes over when DeviceNet runs out of gas.”

Kuzel says that ControlNet’s strength lies in its high speed — it’s used where time-critical data is needed, such as coordinated drive systems, synchronized processes, complex batch or process control systems with large data requirements, and systems with multiple controllers.

William Moss of the Open DeviceNet Vendors Association (ODVA), which promotes DeviceNet worldwide, says that DeviceNet is suited to “90 percent of all discrete manufacturing processes.” Because it’s so widely used in the automotive sector, DeviceNet is the be one of the best networks for analog control, but there is still work to be done.”

But Kuzel says, “the architectures of DeviceNet and ControlNet are as well-suited to the ‘wet’ (process automation side) as they are to discrete manufacturing processes.”

Profinet grew out of the German automation sector; Siemens did much of the development work and plays as crucial a role in it today as Allen-Bradley does for DeviceNet. There are three versions: Profinet FMS, the “universal” solution for a variety of applications; Profinet PA for process-oriented systems; and Profinet DP, which the Profinet Trade Organization describes as its “performance optimized version — specifically dedicated to time-critical communication between automation systems and distributed peripherals.” All the Profinet standards are included in the European Fieldbus Standard EN 50170.

Other networks have specific uses or niche applications. Foundation Fieldbus, for example, while it is widely used in process applications in North America, lends itself well to highly volatile environments because of its very low power requirements. Meanwhile, the semiconductor industry, which in a way combines discrete and process manufacturing models, has gone crazy for DeviceNet,” says Kuzel.

Today, all the fieldbuses are controlled by trade organizations. DeviceNet’s specifications are under the auspices of the ODVA, ControlNet under ControlNet International. Development of the Profinet specifications is controlled by the Profinet Trade Organization, Foundation Fieldbus by the Fieldbus Foundation, and so on. (For contact information see page 30.)

While the initial developers of the standards — Rockwell/Allen-Bradley for DeviceNet and ControlNet, Siemens for Profinet, and so on — still play an important role, they by no means control where the technology is going. The technical committees comprise representatives of many different companies. Some, such as SS Technology of Waterloo, Ontario, are on the committees of more than one fieldbus organization.

Still, the history plays an important role in the development of the technology and also in where it gets implemented. Naturally, the engineers and consultants who select and specify the fieldbus will tend to continue to use the network they’re most familiar with. As Michael Bryant of the Profinet Trade Organization points out, “Rockwell doesn’t do Profinet, and Siemens doesn’t do DeviceNet.”

“Fieldbus is an all-digital, serial, two-way communications system that interconnects measurement and control equipment such as sensors, actuators and controllers. At the base level in the hierarchy of plant networks, it serves as a Local Area Network (LAN) for instruments used in process control and manufacturing automation applications and has a built-in capability to distribute the control application across the network.”

Furthermore, a fieldbus must be an open system that is supported by several vendors, and not tied to a single technology. The various fieldbuses, however, are not interchangeable. The differences between them are so profound, they cannot be easily connected to each other.

So, how do the fieldbuses communicate? Profinet, Modbus, InterBus-S and Ethernet (which is used many office LANs) use “source-destination” communications: the message packets have destination information in them, and the fieldbus passes a token from node to node in a timed fashion.

DeviceNet, ControlNet, CAN and WorldFIP (a French fieldbus) use a broadcast, producer-consumer model for communications: messages are broadcast to all nodes, and each node only “hears” messages intended for it.  

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Another major difference among fieldbuses is the format of the communications themselves. DeviceNet and CAN open messages are eight bytes long, while Profinet has a “word-oriented” with a 256-byte “stack” per message.

Profinet and ControlNet are quite fast networks — 12 megabits per second and 500 M b/s, respectively. The trade-off is cost — DeviceNet is cheaper than the other two.

Fieldbuses also handle network traffic in different ways. DeviceNet uses “non-destructive bitwise arbitration.” When two messages collide, the higher priority message goes first.

If the two are equal priority, there is a mechanism within DeviceNet (as well as CAN) that decides which one should go first.

By contrast, when a collision occurs in Ethernet, all devices “back off” and re-send their messages, which results in slower transmissions. Competing standards

None of the fieldbuses has a commanding lead in market share today. Even defining the market for fieldbuses is not easy, because the applications are so different. Profinet has the largest market share in Europe among comparable and increasingly integrated, convergence is not only inevitable, it’s necessary.

The agreement between the organizations behind Profinet, Foundation Fieldbus and ControlNet is just one sign of convergence. Another is in the drive toward even more common so,” says Bryant. “Why put Ethernet on a switched network down to the factory floor when you have controllers that can communicate between the factory floor and the front office?”

While the number of applications for remote control of factory devices through a PC

The advantages of Ethernet are lower cost —

Ethernet cards cost as little as $20 compared to $200 or more for fieldbus devices — and familiarity. It’s well-established inside offices and on factory floors.

Communication Models

How fieldbuses talk with devices

Fieldbuses tend to use one of two models for communications: Producer-consumer or source-destination.

Source-destination messages are passed on a token-ring or polled network, while producer-consumer messages are broadcast and are understood only by their intended recipient. Both have inherent advantages and weaknesses.

<table>
<thead>
<tr>
<th>Producer-Consumer</th>
<th>Source-Destination</th>
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<tbody>
<tr>
<td>DeviceNet</td>
<td>Profinet</td>
</tr>
<tr>
<td>ControlNet</td>
<td>Modbus</td>
</tr>
<tr>
<td>WorldFIP</td>
<td>InterBus-S</td>
</tr>
<tr>
<td>Foundation Fieldbus</td>
<td>Ethernet</td>
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<tr>
<td>CAN</td>
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<td>CANopen</td>
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Those who passionately believe in Total Quality Management (TQM) might be surprised to learn that in the past few years, many business magazines and newspapers have attacked it as nothing but a failed management fad because it has delivered lackluster economic returns. For example, when the 1995 Baldrige Award winners were announced, USA Today welcomed them by posing the question “Is TQM Dead?” A recent Wall Street Journal article raised the issue “Is Total Quality Management (TQM) yesterday’s news or does it still shine?” The Washington Post wrote about “Totaled Quality Management”, The Economist talked about “The Cracks in Quality”, and a Business Week article on management paradigms proclaimed that “TQM is as dead as a pet rock”. It’s ironic that the magazines and newspapers that are now thrashing TQM are the very same ones that in the 1980s were singing its praises and promoting it as the paradigm that every organization should adopt. Nonetheless, to respond to the critics, it is important to understand why TQM is currently being lambasted.

Unrealistic expectations and a quick-fix mentality are the two main reasons why TQM is getting a bad rap. Many firms adopted it with inflated expectations of what it could deliver — it was expected to be a sure bet to reverse poor performance. When TQM didn’t deliver the hoped-for results, it was deemed a failure. Furthermore, contrary to TQM’s philosophy, many firms adopted it seeking instant and swift gratification. Often, implementation efforts were measured against short-term financial performance. When short-term improvements didn’t materialize, many firms got disillusioned.

Proponents of TQM are obviously unhappy with the bad publicity that the system has received. Many have pointed to the popularity of quality awards at the state and national levels as evidence that TQM is alive and well. Some have indicated that there is growing interest among organizations to use the Baldrige and other quality award criteria for internal self-assessment. Many have also used anecdotes of performance improvements (typically of Baldrige winners) to make the case that it does work. Finally, some have simply stated that the link between TQM and financial performance is strong but hard to establish.

Unfortunately, the arguments offered by the proponents haven’t been enough to counter the criticisms. The negative publicity has caused firms to question the relationship between TQM and financial performance. A recent survey of 27 vice presidents of quality shows that nearly 75 percent of them are under considerable pressure to show the pay-off from TQM. An article in the September 7, 1998 issue of Fortune reported survey results about tools that were management’s favorites in 1997. TQM was ranked 10th among all tools, with 16 percent of respondents indicating they were extremely satisfied with it and 14 percent indicating dissatisfaction.

It appears that the debate about the value of TQM is based more on anecdotes, impressions, opinions, and less on what one would consider to be scientific and objective evidence.

Dr. Vinod R. Singhal is an associate professor at the Dupree College of Management at the Georgia Institute of Technology. Dr. Kevin B. Hendrick is an associate professor at the School of Business, the College of William and Mary in Williamsburg, VA.
proves that TQM improves performance
by Dr. Kevin B. Hendrick and Dr. Vinod R. Singhal

Evidence. The arguments advanced by both the detractors and proponents of TQM do not stand up to the standards of scientific evidence. More evidence is needed to resolve this controversy, and the best way is to use objective and verifiable data to link TQM to bottom-line measures of performance. This article describes an approach for doing this, and discusses results from a research study whose primary objective was to document the financial impact of TQM.

Methodology
There were four main steps in developing the research methodology.

The first step was identifying a set of firms that have effectively implemented TQM. To be considered an effective implementation means that the key principles such as focus on customer satisfaction, employee involvement, and continuous improvement are well accepted, practiced, and deployed within the firm. The winning of quality awards was used as proof of effective implementation.

The study included winners from about 140 different award givers, some of which are listed in Table 1 on page 34. Many award givers are customers who have developed quality award programs for their suppliers. These include most major automobile manufacturing firms in the U.S. and many large manufacturing firms. Award givers also include independent organizations such as the National Institute of Standards and Technology (which administers the Malcolm Baldrige National Quality Award) and various other U.S. states that give quality awards. To avoid biases associated with asking winners to self-judge the impact of TQM, the sample of winners was restricted to include only publicly-traded firms. This provided the flexibility to use objective and historical financial data as far back as necessary, and to uniformly define performance measures. The sample consisted of about 600 winners representing nearly 50 distinct two-digit Standard Industrial Classification (SIC) Codes, with 75 percent of the sample winners coming from the manufacturing sector.

The second step was deciding the time period over which the performance would be examined. Two five-year time periods were chosen. The first five-year period (referred to as the post-implementation period) began one year prior to and ended four years after the date of winners winning their first quality award. Since it takes award givers about six to nine months to evaluate and certify the effectiveness of the implementation, it was assumed that the winner’s TQM implementation was effective about a year before the date of winning the first award. Examining performance from this time period that winners were likely to implement TQM and incur the associated implementation costs. To provide a balanced perspective on the net benefits of TQM, it is important to estimate the magnitude of these costs. Figure 1, on page 34, depicts the determination of the two periods for a winner that won its first award in 1990.

The third step was choosing performance measures. Stock price performance was an obvious choice as this measure is easily understood and extensively tracked by various stakeholders. The study also examined the profitability of award winners by estimating the changes in operating income, defined as net sales less cost of goods sold plus selling and administrative expenses. Operating income is influenced by changes in the growth rate and efficiency. Growth is measured by estimating the percent change in sales, total assets, and employ-

The study found that stock prices of award winners significantly outperformed their benchmark portfolios — by 34 percent, which in the sample translated into $669 million dollars.
ees. Improvement in efficiency is measured by estimating the percent change in return on sales and return on assets. Return on sales is the ratio of operating income to sales and measures the profit per dollar of sales. Return on assets is the ratio of operating income to assets and measures the profit per dollar of assets.

The final step was choosing appropriate benchmarks for comparing the performance of the award winners. The performance of all firms is influenced by industry and economic conditions, which may have nothing to do with whether firms have an effective TQM implementation. Benchmarks serve the purpose of adjusting a firm’s performance for the relevant industry and economic influences. Stock market portfolios such as the S&P 500 Index were used to benchmark the stock price performance of award winners. For the other performance measures a benchmark was created by matching each award winner to a firm of similar size from the same industry.

**Results for the implementation period**

No significant differences in performance were observed during the implementation period. Basically, there was no difference in the performance of the winners and the benchmarks. This is good news, since one might have expected declining performance during this period because of the direct and indirect costs in implementing TQM. It is plausible that during the implementation period winners find easy improvement opportunities. Capitalizing on these opportunities pays for the implementation costs. The results could also suggest that the implementation costs might not be as high as widely believed.

**Results for the post-implementation period**

Results for the post-implementation period indicate that on almost every performance measure, quality award winners outperformed the benchmark.

Figure 2, on page 35, compares the stock price performance of award winners against the various benchmark portfolios computed using the following process: For each award winner, a hypothetical $100 was invested in the winner’s stock one year prior to the date of winning their first quality award. At the same time an equal amount was also invested in a benchmark portfolio. Both investment strategies were tracked for the next five years. At the end of five years the stock price returns from holding the stocks of the award winners were compared against the returns from investing in the benchmark portfolio.

The results indicate that award winners significantly outperformed the benchmark portfolios. The stock prices of award winners increased by an average of 114 percent over the five-year period. Over this same time period an alternative strategy of investing a similar amount in S&P 500 Index and holding it over the same time period would have resulted in a 80 percent return. The difference of 34 percent is a statistically and economically significant level of outperformance. This difference translates to an average market value creation of an extra $669 million. Award winners outperformed a benchmark consisting of all stocks traded on the New York, American, and NASDAQ stock exchanges. This portfolio experienced a 76 percent gain as compared to the 114 percent gain from investing in award winners. Award winners also beat a benchmark consisting of firms in the same industry by 26 percent and a benchmark consisting of firms of similar size by 34 percent.

A more detailed analysis of the pattern of stock price outperformance reveals some additional and interesting insights. Figure 3 compares the stock price performance of the award winners against the S&P 500 Index and NASDAQ benchmark portfolios.
Index on an annual basis for each of the five years in the post-implementation period. The award winners beat the S&P 500 Index in four out of the five years, with most of outperformance occurring from the third year onwards. Award winners beat the S&P 500 in the third year by five percent, in the fourth year by seven percent and in the fifth year by 12 percent.

Since award winners are likely to have an effective TQM implementation a year before they win their first quality award, the pattern of annual stock price performance of Figure 3 suggests that it might take a couple of years after effective implementation before the benefits of TQM begin to show up in the form of higher stock returns. Organizations should view TQM as a long-term investment and must allow time for its benefits to show up in financial performance.

Figure 4 (page 37) depicts the performance of award winners and benchmark firms on accounting based performance measures. Operating income for award winners increased by an average of 91 percent over the post-implementation period. This is in contrast to an average 43 percent increase over the same time period for the benchmark firms. The difference of 48 percent is a statistically and economically significant level of outperformance. Award winners also experienced higher growth as compared to the benchmark firms. Winners improved sales by 69 percent sales (compared to 32 percent for the benchmarks), improved total assets by 79 percent (compared to 37 percent for the benchmarks), and increased the number of employees by 23 percent (compared to seven percent for the benchmarks). Winners also showed higher improvement in efficiency measures. The return on sales improved by eight percent, compared to no improvement for the benchmarks, and the return on assets improved by nine percent compared to six percent for the benchmarks. These results clearly indicate that TQM does improve profitability, leads to higher growth, and improves efficiency. Furthermore, they provide additional validity to the winners' stock
price performance shown in Figure 2. The improvement in profitability is the reason for the rise in stock prices of the award winners.

Figures 5 through 7 present results on how the performance of award winners differs by their characteristics. These results are useful in setting expectations from effective TQM implementations. All performance numbers reported in these figures are the average of the differences between the performance of the winners and their respective benchmarks. The numbers indicate the extent to which the winners outperformed the benchmarks.

**Independent versus customer award winners**

There are some very dramatic differences among firms that won independent awards, such as the national and state quality awards, and those winning customer awards such as those given by Chrysler, Ford, and Texas Instruments. The national and state awards have more comprehensive and stringent evaluation criteria, and use a multi-stage evaluation process conducted by independent third-party examiners. Thus, winning independent awards could indicate more mature TQM implementations when compared to the maturity of implementations at firms that have only won awards from their customers.

Figure 5 shows that independent award winners significantly outperformed customer award winners. In terms of improvement in operating income, independent award winners outperformed their benchmarks by an average of 73 percent whereas customer award winners outperformed their benchmarks by 33 percent. Independent award winners do better than customer award winners on sales (33 percent vs. 23 percent increase), on return on sales (17 percent vs. nine percent increase), and return of assets (10 percent vs. six percent increase). Independent award winners also do better on stock price performance. They outperformed the S&P 500 by 51 percent compared to the 26 percent increase.
outperformance of S&P 500 by customer award winners. Although independent award winners do better than customer award winners, it is important to emphasize that winning customer awards also pays off since these winners do better than their corresponding benchmarks on all performance measures.

**Smaller versus larger award winners**

Many managers believe that TQM is less beneficial to smaller firms as such firms cannot afford the high implementation costs. Figure 6 shows the contrary. Both smaller (total assets less than $600 million) and larger (total assets larger than $600 million) award winners gain from effective TQM implementations. For example, in terms of growth in operating income, smaller winners outperformed their benchmarks by an average of 63 percent, whereas larger winners outperformed their benchmarks by about 22 percent. Figure 6 also shows that smaller winners fared better than larger winners. Smaller winners experienced a 63 percent improvement in operating income (compared to 22 percent for larger winners), a 39 percent increase in sales (compared to 20 percent for larger winners), and a 17 percent improvement in return on sales (compared to seven percent for larger winners). The observation that smaller winners did better than larger winners is not surprising considering many key elements of TQM such as teamwork, worker empowerment, and spirit of cooperation across functional departments are already present to some extent in smaller firms. Additionally bringing change can be more difficult in larger firms. Clearly, the results do not support the conventional wisdom that TQM is less beneficial to smaller firms.

An important component of TQM is adopting practices such as employee training, involvement and empowerment, and information sharing. Employees are the driving forces for improvements originating from activities such as suggestion programs, quality circles, cross-functional teams, and process improvement teams. Clearly, the opportunities for gains from these activities are likely to be higher in a less capital-intensive environment than in a more capital-intensive environment. Capital intensity is measured as the ratio of net property, plant, and equipment to the number of employees. For the purposes of this study, winners with assets per employee less than $25,000 are considered low capital-intensive, and winners with assets per employee greater than $25,000 are high capital-intensive.

Figure 7 (page 41) shows that low capital-intensive award winners do better than high capital-intensive award winners on all performance variables except growth in employees. For example, in terms of improvement in

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**FIGURE SIX**

Comparison of the average percent change in performance of smaller and larger award winners.

- Operating income: Smaller firms vs. larger firms
- Sales growth: Smaller firms vs. larger firms
- Total assets: Smaller firms vs. larger firms
- Employee count: Smaller firms vs. larger firms
- Return on sale: Smaller firms vs. larger firms
- Return on assets: Smaller firms vs. larger firms

**PERFORMANCE MEASURES**

- Operating income
- Sales growth
- Total assets
- Employee count
- Return on sale
- Return on assets

- 63% vs. 22%
- 39% vs. 20%
- 42% vs. 18%
- 25% vs. 22%
- 17% vs. 19%
- 10% vs. 10%

**Comparison:**

- Smaller firms outperform larger firms in all performance measures except growth in employees.
A Message from the Publisher

With more than thirty years in the publishing industry I’ve seen numerous magazine launches; they’re exciting, full of promise and create high expectations. Few ever live up to the hype.

After just four issues, Advanced Manufacturing is recognized as one of the finest business publications produced in this country or anywhere else in the world. There is no doubt that anyone who is serious about the future of manufacturing will benefit by reading Advanced Manufacturing.

Many talented individuals contributed to the final product. Additional accolades, however, must be paid to Editor and Associate Publisher Todd Phillips, Editorial Director Jackie Roth and Art Director Ian Phillips. They brought the magazine to life and gave it a distinct look and content.

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operating income low capital-intensive winners outperformed their benchmarks by an average of 65 percent and high capital-intensive winners outperformed their benchmarks by 21 percent.

In contrast to the anecdotal and perceptual evidence that has been used by many experts to pass judgment on whether TQM is valuable, the evidence presented in this article provides a statistically valid assessment on the impact of TQM on financial performance. The message from the analysis of the financial performance of 600 quality award winners is clear and simple — when TQM is implemented effectively, financial performance improves dramatically. The criticism that TQM has produced lackluster economic gains is unwarranted. The proclamation that TQM is dead is premature. TQM is alive and well. These results should be reassuring to those firms that have made heavy investments in TQM and had to defend themselves against both internal and external critics. For those firms that were considering disbanding their TQM, these results should cause them to rethink their decision. One would hope that managers responsible for implementing TQM would use these results to debate, and perhaps put to rest many questions that others might have about the legitimacy of TQM as a viable and effective management system.

The results also support what many quality gurus have said repeatedly — firms that want to adopt TQM must have patience. It is widely accepted that TQM takes a long time to implement as it requires major organizational changes in culture and employee mindset. Hence, the benefits will be realized in the long-run. The evidence shows that even after effective implementation, it still takes a couple of years before financial performance starts to improve.

Firms should also be realistic about what to expect. They shouldn’t be carried away by the hype. Keep in mind that TQM is a philosophy or foundation to develop a management system. A management system based on TQM can only improve the probability of making the right decisions. It cannot guarantee that all decisions will be right.

Furthermore, organizational characteristics such as size, capital intensity, and the maturity of implementations all influence the gains from TQM. Finally, the gains from TQM are likely to be tempered by the behavior of competitors. As more firms in a particular market segment adopt TQM, the extent of gains will diminish.

To get more information about this research contact Dr. Vinod Singhal at 404-894-4908 (e-mail: vinod.singhal@mgt.gatech.edu).
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From CAD file to castings in two weeks or less

Rapid prototyping system saves time and money for medical parts manufacturer

BY TODD PHILLIPS

The Company: Biomet Inc., a Warsaw, Indiana-based designer and manufacturer of products used by orthopedic medical specialists in surgical and non-surgical therapy.

The Challenge: To find a rapid prototyping technology that could build both casting patterns and anatomical models.

The Strategy: Work with a rapid prototyping firm to develop a casting procedure for acrylonitrile butadiene styrene (ABS) material.

The Solution: Once the casting process was proven successful, Biomet bought the rapid prototyping systems, stopped outsourcing the process to service bureaus, and generated estimated savings of $120,000 a year.

John M McDaniel says Biomet is “very careful” when it comes to trying new technologies. They must help us get our products to market faster and decrease our research and development costs, or we don’t incorporate them into our development process,” says McDaniel, Biomet’s supervisor of engineering services.

So when Biomet, a designer and manufacturer of medical products for orthopedic medical specialists, wanted a castable material it could easily create in-house, M McDaniel shopped around. “We could purchase another type of rapid prototyping technology, or we could work with Stratasys to develop an alternative casting material.”

McDaniel says the company wasn’t eager to switch to another technology, because Stratasys’ fused deposition modeling (FDM) machines were already successfully creating anatomical models for the company. They were so successful, in fact, that they were running 24 hours a day and there was no time to run the machines for casting the patterns needed to create their customized medical devices.

Rather than develop a new material, Stratasys and Biomet engineers decided to test the acrylonitrile butadiene styrene (ABS) material for casting. It was a good choice because ABS has a clean burnout and is durable for shipping. “Even though ABS had never been tested as a casting material, we were able to obtain successful castings from the ABS patterns on the second try,” says McDaniel.

The ABS has a very low softening temperature, but it melts at a very high temperature. This is a benefit during firing, because the material will soften and collapse in on itself before expanding, leaving the shell intact. “We can now use the same rapid prototyping process for both our anatomical models and our casting patterns,” says McDaniel.

“Cost savings was a major factor in our decision,” says McDaniel. “Our parts were costing $300-400 a piece using an SLA service bureau. We were spending $180,000 annually on patterns.” McDaniel says he now averages $120-125 per part, including overhead, using the in-house machines.

“It’s pretty easy to justify purchasing your own RP system with that kind of savings opportunity,” he says. He estimates the company is saving $120,000 per year. Biomet now produces more than 750 castings per year using ABS patterns directly.

Now, in less than two weeks, a custom implant can go from completed CAD design to finished casting.

Biomet engineers also use castings for...
testing and design verification. Once the standard design is finalized, they cut a steel tool and then create traditional wax patterns by injecting wax into the tool. Biomet’s foundry handles wax and ABS patterns, and the company builds about 25 anatomical models and 30 prototypes in ABS each month for review by physicians.

SO HOW DOES IT WORK?

The process starts with the company’s QuickSlice software that processes a user’s CAD file, exported in .stl format, and it mathematically slices and orients the model for the build process.

Then, the inert, non-toxic modelling filament is fed into an extrusion head and heated to a semi-liquid state. The head extrudes the material and deposits it accurately in ultra-thin layers, building parts one layer at a time. The models are made with a variety of materials, including casting wax, acrylonitrile butadiene styrene (ABS), ABSi and elastomer.

After the ABS pattern is removed from the machine, it’s finished to help ensure a strong casting. At Biomet, they dip the parts into methylmethacrylate, and then blow the parts dry with an air hose. Then they are dried at room temperatures for about 30 minutes.

The next step is to mount the part onto a “tree” with other patterns and dip it into a ceramic slurry. “We use seven or eight coats of ceramic,” says McDaniel. The ceramic shell and pattern are then put in a furnace at 1030°C for about two hours while the ABS pattern burns out. The shell is cooled to a workable temperature, any residual ABS ash is blown out with compressed air, and the finished shell is cast with cobalt or stainless steel.

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Snowmobile maker cranks it up with torque control

Digital hand-held device improves accuracy

**The Company:** Arctic Cat Inc., a Thief River Falls, Minnesota-based manufacturer of off-road recreational vehicles like snowmobiles and all-terrain vehicles.

**The Challenge:** To improve the quality of its products by better monitoring of the torque levels used to fasten and bolt the machines together.

**The Strategy:** To find a more sophisticated torque control device that can be used anywhere in the manufacturing plant.

**The Solution:** The company bought a hand-held TorqueMate 200 device from the San Jose, California-based company Mountz, and uses it in on its three assembly lines.

As the consumer demand for well-made products has increased, manufacturers have had to develop new quality control systems. Because of the fast pace of the manufacturing process, and short shipping times, now much of this testing has to take place right on the assembly line.

One of the key areas that is critical in monitoring quality is torque control, because this can also affect things such as product reliability, safety, and even liability. Controlling torque precisely keeps a fastener from vibrating or working loose, or if tension is too high, from snapping the bolt in half or stripping its threads.

Arctic Cat, a Minnesota-based manufacturer of off-road vehicles wanted to find a better torque control system to make its snowmobiles, personal water craft, and all-terrain vehicles (ATVs).

Workers used bench model torque analyzers, but this didn’t help with total precision, accuracy and repeatability. “The way we were torquing fasteners was not very accurate and was very time consuming,” says David Ulrich, the company’s quality analyst. “So it was easy to over- or under-torque a fastener on any given joint. We knew we needed to improve our ability to accurately measure torque, especially when we got into the ATV market where quality control criteria was more stringent.”

The company formerly used impact wrenches to snug down fasteners, then torqued them to specs using a clicker or a dial torque wrench. “The nature of a click wrench is such that if you don’t feel or hear the click, or know that it’s clicked, you can continue to turn the wrench, and then all of a sudden the nut’s over-torqued,” says Ulrich.

Ulrich says the company searched for a torque analyzer to help it increase its production capabilities, and decided upon a hand-held model, developed by the San Jose, California-based company Mountz, that can be used anywhere in the plant. “It didn’t take long before we started improving our productivity, and it was versatile enough to use in engineering, quality control, and on the production line,” says Ulrich.

He says workers now use the tool that shuts off at a specified torque for consistent efficiency. The quality control people also have the ability to measure the tool which gives them the repeatability and accuracy they were looking for.

Arctic Cat’s engineers also use the device to develop new fasteners and clamping methods. They can simulate a particular joint in one of their vehicles, and then try to get the fastener to jam, strip out, or break to test its strength. “It’s really speeded up the time that engi-
neers take to do their testing,” says Ulrich. The device is digital and computer compatible, so that engineers can use an RS-232 serial port cable and hook the analyzer into one of their personal computers to compile test data for future use.

The torque analyzer has streamlined the production on the assembly line, and has allowed quality inspectors to calibrate torque sensors and verify torque readings on fasteners. The unit’s memory records up to 1,000 readings and it can store calibration data for 15 torque sensors. “It’s saved quality control inspectors time as well, since they don’t have to go out on the line and randomly check clamped joints as often,” says Ulrich. “It’s taken away the human element and consequently the need for constant evaluation. So we now have a production process that’s more stable and quality we can prove with compiled data.”

Arctic Cat’s management and engineering department conducted cost and efficiency studies, and estimate the torque sensing tools will save about 3,335 work hours which translates into about $50,000 per year in labour savings.

ABOVE: Arctic Cat didn’t want the nuts and bolts on its snowmobiles and all-terrain vehicles wobbling loose.
Mid-sized companies the focus for ERP vendor

Navision Manufacturing integrates with the company’s suite of financial accounting software.

BY TODD PHILLIPS

If you are a mid-sized manufacturer looking to buy some new enterprise resource planning (ERP) software, chances are you won’t be that familiar with Navision Software. Although the Denmark-based parent company has been around since 1984, and has 31,000 installations in 75 countries, the company is just now setting up shop and aggressively marketing its software in Canada.

In July, the people running the Canadian office of Navision Software hosted more than 100 people, including the business press, sales prospects, and industry analysts in their new 4,500 square foot Canadian headquarters in Richmond Hill, Ontario. That office will also be the training centre for the people who want to sell and implement the Navision suite of software, consisting of Navision Financials, Navision Manufacturing, Navision Advanced Distribution and coming soon, Navision Web Shop.

Navision’s parent company insists that before anyone can sell their software, they must first take a minimum four-week training course and pass a written exam. Not everyone passes. The company doesn’t sell its software directly — you have to talk with certified sellers at what the company calls its Navision Solution Centres (NSC). There are about 800 of these NSCs worldwide, and about 110 in the United States and Canada.

To sell the manufacturing-specific package, Navision Manufacturing, certified sellers have to take additional training, and again, must pass a course. The reason for all this training, explains John Macdonald, Navision’s Canadian marketing director, is that the company takes a cautious long-term approach, and can’t afford any messed up implementations to damage its reputation. “Navision is very careful,” he said during a recent product demo of Navision Manufacturing. “We err on the side of caution and we recruit the very best.” He says his experience has shown that Canadians are “extremely cautious” buyers. “There’s a ‘show me’ attitude in the Canadian market,” says Macdonald.

That caution might partly be because of the mixed reputation that many ERP-related packages have among manufacturers. The backbone and the heart of ERP systems came from the world of accounting and finances, and was mainly aimed at helping the people in head office better track the spending, ordering and financial accounts of their manufacturing plants. The software was never specifically designed to help improve the nuts and bolts of a manufacturing operation, and this in part helps explain why it’s not as popular among the people whose main job it is to “make stuff” and get it out the door.

Company officials say that one of the strengths of the Navision manufacturing package is that it can be easily customized and adapted. “A key for the mid-market is agility,” says Karim Budhwani, Navision’s product manager. “We want the software to be as agile as they are going to be... Companies are evolving — they don’t want their software to be static.”

IN BRIEF

Navision Manufacturing
Vendor: Navision Software Canada, Inc.
Main purpose: Enterprise Resource Planning (ERP) software
Contact: (905) 707-3300
Website: www.navision.ca

Navision Manufacturing integrates with the company’s suite of financial accounting software.

BY TODD PHILLIPS

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Navision’s menu screens use the familiar “look and feel” of the Microsoft applications many users are familiar with.

Navision’s sum index flow technology (SIFT) lets users slice and dice data quickly with field filters, table filters and flow filters.
Delcam's suite of software packages is aimed at makers of tooling for injection molding machines, shops which make tools for metal stamping, dies for die casting and forging, and patterns for casting.

Despite the diversity of these businesses, all need CAD/CAM software for low-volume, high-precision manufacturing and "sculptured" or doubly curved surfaces.

PowerSHAPE is what Delcam calls its "modelling for manufacture" software, a hybrid modeller with solids and surfaces in the same database. Both are fully integrated and accessed from the same user interface.

COMING SOON: WEB SHOP
If you want to really see their faces light up, ask Navision staff about the new Web Shop program they are currently beta testing. It's scheduled for release in the next few months. Web Shop won a "Best Solution Award" at the Softworld trade show in Munich in June. That award was for the most successful integration of e-commerce functionality in an ERP solution. The consulting firm Koeppler & Partner and the German-based computer magazine IS-report presented Navision the Microsoft-sponsored award.

Most ERP vendors recognize that manufacturers are now insisting on electronic-commerce functionality. Even if they aren't doing e-commerce now, most manufacturers are making sure that any major software purchases will keep this door open.

Navision's Web shop lets users set up and maintain online shops using the same consistent Windows 98 graphical user interface found in Navision Financials. "Our focus is on the mid-market," says Budhwani. "They are missing out on the Internet."

Navision Software has 22 different country-specific version of its software, and it supports and translates financial figures into international currencies. The Canadian version is also customized.

Software tools for tool and die makers
Delcam's CAD/CAM software can shape, mill and inspect

ABOVE: PowerINSPECT verifies the critical elements of the geometry of a mold for part of the plastic housing of a chainsaw.
PowerSHAPE files can contain a mixture of surfaces and geometric primitives such as cylinders and planes. The Hybrid modeller has specific pluses for designers. Surface modelling simplifies and speeds up styling of simple or complex visible surfaces while solids can be used to model internal features such as ribs and bosses, which can quickly be built up from geometric primitives. Solids are invaluable in offsetting exterior (mold cavity) surfaces to generate internal surfaces, that is, a mold’s core.

Hybrid modelling also better accommodates reverse engineering and CAM. Compared to solids, it’s easier to move surfaces “upstream” and “downstream” in the tooling process. Users can change surfaces and shapes volumetrically, dimensionally, with constrained geometry using XYZ data, and dynamically with PowerSHAPE’s Intelligent Cursor.

PowerSHAPE allows users to think in terms of features and “whole model” operations such as a skin over a frame, and local-area modifications to shape.

PowerMILL is CAM tailored for at-the-machine programming and high-speed machining (both of which are near and dear to mold shop owners). PowerMILL allows users to tweak the toolpathing process. Tweaks are needed because the margin for error keeps getting smaller and there is less time for planning and checking jobs.

PowerMILL’s high recalculation speed is a key factor in keeping up with today’s machine tools. As they run faster, they require more tool paths yet allow less time for programming. Better as-machined finishes are in high demand and harder mold and tool steels are used. Collision avoidance is also needed more now than ever before.

PowerINSPECT is Delcam’s package for dimensional measurement. The module handles points taken from surfaces with coordinate measuring machines (CMMs). Points are compared with their analogs in the CAD file and the differences are presented graphically. Because PowerINSPECT puts lots of data on the screen, the exact situation with a given part can be quickly grasped.

Until recently Delcam was among the better-kept secrets in the CAD/CAM business. This should change as Delcam continues to make strong inroads in Canadian mold making, especially in the Windsor area.

Delcam now has 3,000 sites and 9,000 users worldwide, up from 2,000 sites and 5,000 users as recently as 1996. At the user level, full-year 1998 sales were $83 million Canadian.
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<td>Columbus McKinnon Ltd.</td>
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<td>905-372-0153 or 800-263-1997</td>
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<td>CompAir Canada</td>
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<td>905-847-0688</td>
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<td>613-952-8761</td>
<td><a href="mailto:sam@ic.gc.ca">sam@ic.gc.ca</a></td>
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<td>905-624-5973</td>
<td><a href="mailto:inteltooling@iprimus.ca">inteltooling@iprimus.ca</a></td>
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<td>Rockwell Automation</td>
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<td>905-639-6878 or 888-748-8677</td>
<td>905-639-4632</td>
<td><a href="mailto:marcusu@topsconveyor.com">marcusu@topsconveyor.com</a></td>
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<td>Valiant Machine Tool Inc.</td>
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<td>47</td>
<td>519-974-5200 or 888-825-4268</td>
<td>519-979-0415</td>
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<td>905-624-9151</td>
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<td>Xerox Engineering Systems Canada</td>
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<td>905-946-7522 or 800-268-3335</td>
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Companies that work in isolation risk being left in the dust, says David Hogg, the driving force behind the High Performance Manufacturing Consortium (HPMC) and a former senior manager with the Ontario Centre for Advanced Manufacturing.

Establishing simple consortiums and inter-company networks may seem like old news. Working together, however, has never had a more strategic competitive value for firms that must compete and win against the world’s best. It’s also a low cost and high return strategy that you can control. Time is the currency of the future according to the next generation manufacturing (NGM) model adopted by The Alliance of Manufacturers & Exporters Canada.

All the NGM’s six attributes for winning global competitors deal with the time-responsiveness of people, plants, equipment, practices and cultures—all dedicated to making the customer not just satisfied, but successful. That means changing the way we think, which in turn will cause the required processes to fall into place. Changing our thinking and understanding how to deal with ever-shortening cycle times isn’t done in isolation. Which is why some manufacturers are quietly doing their Canadian thing—without fanfare—as they “open their kimonos” and share information like never before.

One sign of this trend is the increasing use of the popular “Kaizen blitz”—a simple term coined by the Association for Manufacturing Excellence to describe a compact process that can bring big change in little time.

It’s recognized as a low cost “brains over bucks” tool according to Burlington-based consultant Lloyd Phillips. “A few years ago the term ‘Kaizen blitz’ was not on the radar scope. But today you can find them being installed across Canada under a variety of names to address the need for ever-reducing cycle times.”

More evidence of greater cooperation is the increase in the number and the importance of consortia and business networks that are used to support value-adding operations.

Why is this 40-year-old tool only taking off now? It’s a matter of timing. Many new technologies don’t become widely used for many years. This tool also requires a no-blame, continuous improvement culture that requires people to be open, to share and to trust. Our newfound willingness to work together hasn’t been voluntary—it’s been brought on by the realization that our survival depends on our ability to “go fast—or go broke” as manufacturing guru Tom Peters describes it.

The 17-company Ontario HPM Consortium described by the MIT Sloan Management School as a “leveraged learning network” has a philosophy that goes to the heart of the issue. Simply stated it says, “No one can live long enough to make all the mistakes themselves—so let’s work together.”

This five-year-old consortium, an offshoot of the Rockwell Automation Allen-Bradley Suppliers’ Network started nine years ago, and has built solid relationship among members at the operations level so changes can occur quickly. Each member is welcomed as a pair of “outside eyes” that can help the host firm. After one on-site visit, the host walked away with more than seven pages of suggested improvements they are still working on.

There’s much to be excited about in Canada as European visits sponsored by an NRC / Alliance Technology Visits Program showed to HPM members over the past two years. “It’s clear to me now that we need to pick up the pace,” says Rockwell Automation’s Paul Deckert who is also chairman of the board for the HPM Consortium. “The insights were eye-opening and motivating for us all,” says Jon Fenwick, the Alliance’s executive director for the program.

The lessons consortium members learned led to the creation of the 14-company Excellence in Manufacturing Consortium in Owen Sound. More recently, HPM exchanged know-how on value stream mapping—and much more—with a cluster of progressive manufacturers in British Columbia.

It starts with the belief that by working together you can take on the world’s best—and win. It’s not rocket science, but it demands a commitment to relationships, simplicity, and the will to develop teaming and learning as core competencies.