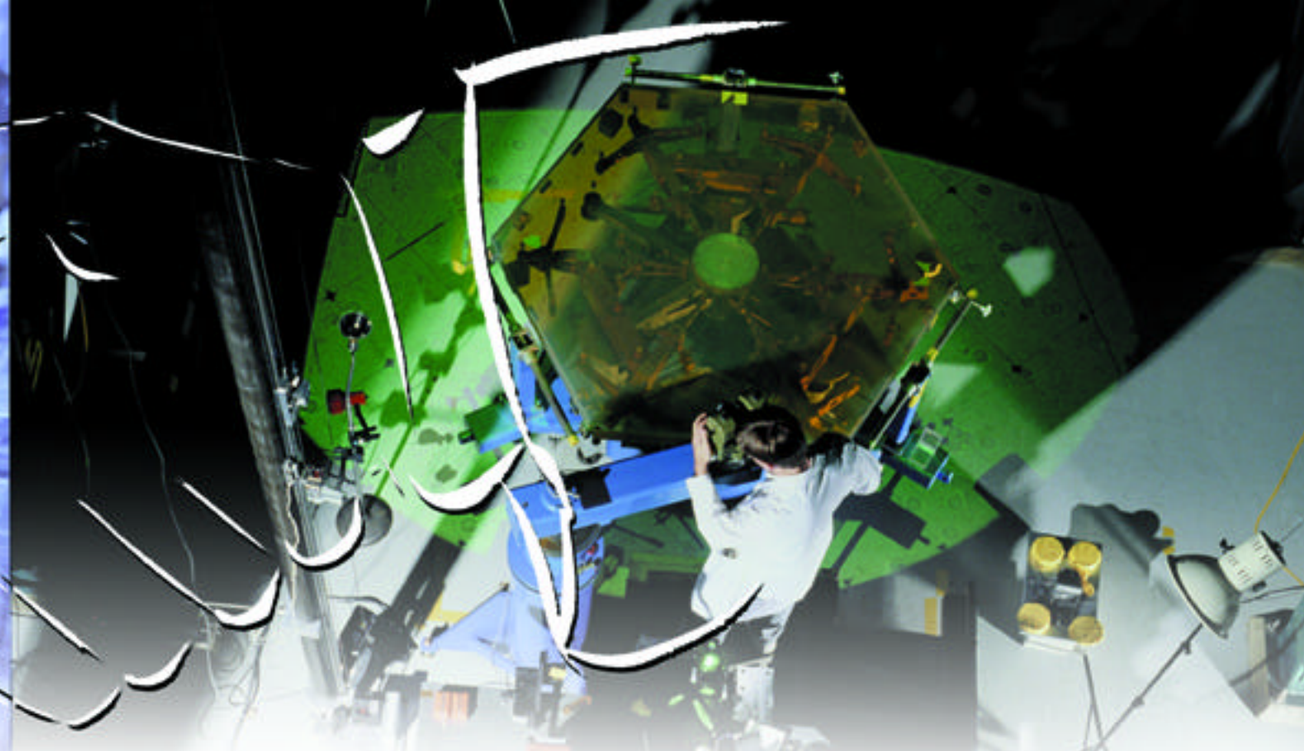


Banking on university–industry partnerships

Advanced manufacturing technologies can improve productivity and save money. But today's "lean and mean" firms often lack the resources to develop and take advantage of them. Forming university-industry research partnerships is a way to "spend smart" to bring new technologies to the shop floor.

by Tim Nye, PhD, P.Eng.

It's no revelation that the environment faced by Canadian manufacturers has become increasingly competitive–partly because of foreign rivals from jurisdictions that devote much higher levels of expenditure to research and development. Firms need to squeeze all the productivity they can from their resources to gain an advantage. Advanced manufacturing technologies (AMTs) can often help. Firms lacking the resources to develop and take advantage of AMTs can leverage their in-house expertise by forming collaborations with engineering researchers at Ontario universities.

A wide variety of AMT expertise and research facilities exist in the engineering faculties across the province (see "Sources of Help" p. 24). These resources can be used to supplement in-house capabilities.

A chief advantage of university-industry research partnerships is the availability of government funding through R&D programs. Such organizations as the Natural Sciences and Engineering Research Council and Materials and Manufacturing Ontario provide funding for AMT research projects at Ontario universities. Substantial tax advantages are also available through the federal Scientific Research and Experimental Development and provincial Ontario Business-Research Institute tax credit programs. Depending on a firm's circumstances, the combined tax benefit can cover up to 67.6% of expenditures.[1]

A number of options are available for firms that would like to work with universities on AMT projects. The options you choose will depend on your firm's level of participation in the project and the level of expected benefits. Often, a small project is useful to make connections and "get your feet wet." More significant projects will frequently suggest themselves as a result.

Common options for working with universities on AMT projects include:

◆ *Course/Thesis projects.* Relatively small problems can be turned into either student projects in AMT courses or stand-alone senior thesis projects on AMT topics. By investing the time required to communicate a problem to instructors and students, a firm can often obtain novel solutions and knowledge of new technologies. For instance, a firm interested in getting started on simulation of its manufacturing system could sponsor a project in a simulation course. The students involved would benefit greatly from being able to work on practical, real-world problems. The sponsoring firm would receive a good introduction on how simulation can be applied to its facility.

◆ *Hiring students.* Many manufacturers have important AMT projects that are not completed simply because their engineers lack the time. Many companies employ summer, co-op or internship students enrolled in engineering programs, who can devote themselves to these projects full-time for a fixed term–up to 16 consecutive months in the case of internships.

◆ *Graduate studies.* Part-time graduate degree studies are a good way for working engineers to increase their knowledge of AMT. By providing some flexibility in work hours to accommodate class schedules, firms can benefit by having their engineers work on in-house AMT projects as part of their thesis projects. By making this investment, firms can also benefit from having engineers with upgraded skills.

◆ *Sponsored research.* Larger projects normally involve an engineering professor, who supervises the graduate student(s) working on them as part of research for their master's or doctoral degrees. Aimed at developing new knowledge, these projects benefit from the substantial resources of the university, and the essentially full-time efforts of the graduate students. The level of support required from the firm is therefore greater than in some other options. Firms may be expected to provide a scholarship or scholarships to support the student(s) doing the research. Firms also cover the university's overhead costs and direct costs of the research, less any funding obtained from public agencies.

◆ *Faculty consulting.* Many faculty members perform some level of part-time consulting in their fields. This option can enable firms to acquire very specific expertise rapidly.

◆ *Consortium projects.* These are large-scale research efforts that tackle common research problems faced by several companies. They are usually conducted by

groups of professors and graduate students, often from several universities. These projects will involve substantial levels of participation from members of the consortium, but can leverage each firm's investment significantly.

Finding the right project

Universities' primary mission is the creation and dissemination of knowledge. Activities that don't involve research or training can probably be done more efficiently by private firms. For example, although a research collaboration might result in a new machining process, the design, construction and qualification of production machinery using the new process is not the type of work the university partners are likely to be interested in, or even capable of doing. Commercial machine tool and automation systems builders excel at these kinds of activities and are a better choice.

The manufacturing researchers at Ontario universities are world class. We know this because their work is published in peer-reviewed, international research journals. In fact, much of a professor's employee evaluation is based on the quality of his or her research, usually measured by the number of papers published in respected international journals. This is the so-called "publish or perish" dilemma–for academics, no publication leads to no job.

What does this mean for successful AMT collaborations? While companies are motivated to achieve a positive bottom line, university professors are motivated by being able to work on "interesting" research problems–that is problems that will result in the discovery of new knowledge and journal papers. Routine, cut-and-dried projects that require only the application of standard engineering knowledge provide little benefit to professors (although they may make great student projects). On the other hand, "blue-sky" research efforts that don't solve real problems are of little benefit to industry practitioners. As in any venture, successful industry-university collaborations depend on each party understanding the motivations of the other, and only going forward with those projects that benefit both parties.

Yours, mine or ours?

When entering into a university-industry research partnership, it's important to consider the issue of intellectual property–that is who will own the rights to the research results. Universities typically have established policies on the confidentiality of research results and ownership of intellectual property developed in conjunction with industry. When research is funded by a firm, the firm usually retains full ownership of the intellectual property. This is an issue that should be addressed, with the agreed terms put in writing, as part of agreements between industry and university research partners.

On the surface, there appears to be a fundamental conflict between the goals of the university (i.e. to disseminate research results) and those of the industrial partner (i.e. to control distribution of results). In practice, however, this problem can usually be easily overcome. The type of material suitable for publication in research journals by the university partners tends to be more theoretical and abstract. Since the information deemed to be confidential by the industrial partner typically isn't of interest to the academic community, there is often no need to include it in published papers.

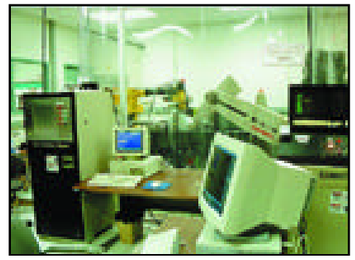
Mechanisms exist to protect confidential information, such as confidentiality agreements signed by university and industry partners. In addition, the industry partner can ask to review material before publication. If necessary, the publication of theses containing confidential information may also be delayed.

The pros and cons

Industrial partners need to be aware that, except for large, well-funded projects with full-time staff, projects in university research labs are part-time endeavours. Professors may be engaged in several research projects at a time, along with teaching and administrative commitments, while students spend much of their time with course work. The timelines for collaborative projects necessarily increase compared to what private consulting organizations will offer. Projects that must be completed quickly are not the best candidates for collaborative work with universities.

You should also bear in mind that by its nature, research involves risks. The desired outcome might not be obtainable. For instance, a project to develop a new fabrication process might result in the finding that the process is not technically or economically feasible. On the other hand, serendipitous discoveries may occur. For example, the discovery that radar sets operating at a particular frequency (which turned out to be the resonance frequency of water molecules) suffer from dramatically degraded performance during humid weather led to the concept behind the microwave oven.

On the upside, Ontario manufacturers can enjoy many benefits by collaborating with our universities in developing and applying AMTs. Not only do substantial AMT resources already exist at Ontario universities, but the costs of AMT projects to industry can also be significantly reduced by the various government grants and tax incentives available for university research. University-industry partnerships can improve the training of engineering students, further increase the technological leadership of universities and help manufacturers compete more successfully in the global marketplace. ◆



Ontario engineering schools offer a wide variety of advanced manufacturing technology expertise and research facilities. The trick is to find the right project for your firm.

References

1. Ernst & Young. *New Ontario R&D Tax Incentives*, Tax Brief 97-08, September 1997.

Tim Nye, PhD, P.Eng., is an assistant professor at McMaster University's Mechanical Engineering Department.

Sources of help

Interested in knowing more about university-industry research partnerships? The following websites can help get you started.

- Industry Canada's list of industry liaison contacts at Ontario universities–http://strategis.ic.gc.ca/SSG/tf00143e.html
- Industry Canada's "National Expertise Index"–http://strategis.ic.gc.ca/sc_innov/cite/engdoc/search.html
- The Natural Sciences and Engineering Research Council's research support programs–http://www.nserc.ca/programs/resguide/resguide_e.htm
- Intelligent Machines and Manufacturing Research Centre's research and training programs–http://immrc.eng.mcmaster.ca/research/immrc.htm
- Materials and Manufacturing Ontario's (MMO) research support programs–http://www.mmo.on.ca/offer.htm

MMO also has a database of researchers and facilities in Ontario. For more information, contact MMO at (905) 823-2020 or by email: info@mmo.on.ca.

For further information on research and development tax credit programs, it's best to consult an accountant who can help you navigate the tax laws involved and determine which programs are appropriate for you.

The next generation of machine tools

Located at McMaster University, the Intelligent Machines and Manufacturing Research Centre (IMMRC) is where engineers and engineering students are dreaming up many of tomorrow's manufacturing technologies–including the next generation of machine tools. The IMMRC is also a vehicle for university-industry-government interaction in the field of intelligent machines and manufacturing. Further, the IMMRC helps transfer new technologies to industry and disseminate knowledge and research results through contractual research and development projects, research reports, short courses and workshops/seminars. It was established in 1992 by Dr. Mohamed Elbestawi, P.Eng.,who is its current director, and professor and chair of mechanical engineering at McMaster.

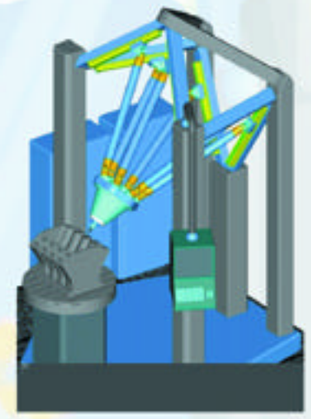
One of the IMMRC's current advanced manufacturing projects is the TIARA hexapod (see diagram),which is aimed at creating the technology for high-speed, high-performance machine tools. The first machine tool of its kind to be developed in Canada,the hexapod comprises six struts or legs connected in parallel, which move the machine's spindle through coordinated motion. Several major machine tool manufacturers around the world have begun to commercialize similar systems.

Sponsored by Cobra Machine Tools in Windsor, and Materials and Manufacturing Ontario, this project has provided IMMRC members with a variety of research areas to investigate, including machine design, parallel kinematics (movement), machine dynamics, and machine tool accuracy and controls. The use of novel materials, specifically carbon composites, is also under study.

Graduate students involved with the hexapod are benefiting from participating in a "real-life" industrial project, and from the experience of industry engineers. According to Dick Lunn, manager, advanced engineering,Cobra Machine Tools, the project should bring all parties "up to date with modern methods of producing five-axis machines."

In conventional machine tools, such as classical milling machines, axes are arranged serially, which can inhibit accurate performance. To minimize deflection of the cutting tool and improve accuracy, machine components are made stiffer by increasing their size and mass. However, this increases the machine tool's inertia and can limit its dynamic behaviour.[1] Unlike conventional machine tools, parallel machine tools like the hexapod have smaller masses to accelerate and configurations that make their structures quite rigid. Lunn says dvantages of the hexapod system also include faster, lighter, more stable and cheaper construction.According to Cobra, the project has the potential to put Canada in a leading-edge position and provide the company with technological and economic gains.

A quarter-size prototype of the TIARA hexapod machine tool is due to be completed by December 2000, with development of a full-scale version to follow.



The TIARA hexapod is a high-speed, high-performance machine tool currently under development at the Intelligent Machines and Manufacturing Research Centre in Hamilton.

Paula Meyer, EIT, is a master's of mechanical engineering student at McMaster University.

References

1. Weck,Manfred and Dammer, Michael."Design,Calculation and Control of Machine Tools Based on Parallel Kinematics," Proceedings of the ASME Man - ufacturing Science and Engineering Division, 1998, vol. 8, pp. 715-721.

by Paula Meyer, EIT