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An Integrated and Comprehensive Approach to Engineering Curricula, Part Three: Facilities and Staffing*

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There is widespread acceptance of the importance of including, within an engineering education, the development of professional skills, of social and environmental awareness, of lifelong learning skills and of a broad knowledge of other engineering disciplines. Integrated Learning is an effort to employ a broader range of learning techniques, including a conscious use of both structured and unstructured experiential learning, in order to address these issues in a comprehensive way without increasing the length of the program. The previous two papers discuss the objectives and techniques adopted in Integrated Learning. This paper addresses issues of facilities and staffing.

INTRODUCTION

THE PREVIOUS PAPERS described the objectives [1] and the chosen techniques [2] of a comprehensive reform of learning methods within the Faculty of Applied Science at Queen's University. This reform is called *Integrated Learning.* Its curriculum objectives include improved communication and team skills, increased design content, the development of lifelong learning skills, better integration of curriculum elements, an increased knowledge of other engineering and non-engineering disciplines, and the development of societal understanding and social responsibility. Pedagogical objectives include increased student interest and motivation, deeper learning, and increased attention to monitoring and measuring the effectiveness of learning techniques. Additional objectives include promoting engineering as a career in schools, increasing public understanding of the capabilities and limitations of technology, and an increased involvement of practising industrial engineers in the undergraduate programs.

The techniques adopted in order to meet these objectives involve wider use of active learning; increased use of lectures-combined-with-projects and lectures-combined-with-discussions, and much more extensive use of team-based, project-based learning. They also include a deliberate effort to allow students to learn from their environment [2]. To provide facilities which are tailored to these techniques, the Faculty of Applied Science is building the Integrated Learning Centre or ILC.

The fundamental vision is to develop a multidisciplinary learning environment which integrates engineering theory with practice. The ILC will provide both staff and facilities to help improve learning effectiveness and to develop enhanced professional skills. It will be a high-use facility which will support new learning approaches, and create not only new learning opportunities but also new attitudes to learning.

Its staff will include 'master practitioners', people with exceptional records of accomplishment in engineering practice. There will also be a position for a specialist in engineering education, responsible for continuous quality improvement, and for measuring the success of learning innovations and for developing new ones. The Centre's facilities will support many facets of engineering practice, including simulation, design, manufacture and presentation.

THE INTEGRATED LEARNING CENTRE

At present, each Department in the Faculty of Applied Science has a building in which its main operations are centred. Some have outgrown their building and have staff and operations scattered in one or more other sites. There has been no building in which the members of the Faculty collaborate in any extensive way in joint offerings, even in the teaching of the common first year.

The Integrated Learning Centre is to be a three-storey, infill structure which links three of the existing buildings housing departments of the Faculty of Applied Science. It is designed to provide facilities to be shared by all faculty, staff and students in the Faculty. Planning took place over several years. A Committee of the Faculty Board, the Academic Planning Committee, carried the burden of the early development using two specially struck subcommittees. External space planners were used to carry out interviews with

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faculty in order to establish the nature of existing facilities and to develop a list of aspirations and needs.

The ILC has an area of 7200 square metres gross, of which 6500 square metres are new. The remaining 700 square metres are located in the adjacent buildings and allow for more intensive use of the space involved. Both the Dean's offices and the offices of the student society, the Engineering Society, will be relocated in the new building.

In designing the building, a high priority was given to making it a warm and attractive place. The structure is built around an atrium, and incorporates a café and lounge areas. Such amenities encourage students to utilise this building in evenings and on weekends. Too often, those knowing little about technology associate it with a cold and often ugly aesthetic. Since Integrated Learning includes a mandate to educate school age children, and non-engineers generally, about technology [1], it was important to demonstrate that highly technical buildings can be very inviting.

The design allows for views into many of the working rooms from halls and overlooks. A user, or indeed a passer-by (an existing pedestrian pathway is intentionally retained within the building) will catch glimpses of a broad range of engineering activities.

INDIVIDUAL FACILITIES WITHIN THE INTEGRATED LEARNING CENTRE

Teaching studio

The studio approach has been the norm in schools of architecture, where the teaching of theory and its application to design have long been well integrated. Studios permit immediate application of theory to practice and promote deeper learning.

While most institutions have examples of such teaching in engineering, few have pursued the issue as consciously and as extensively as Rensselaer Polytechnic Institute. Rensselaer has constructed a progression of studio types, of which the most recent is a set of circular and semicircular layouts in which the student can slip back and forth between a lecture mode, facing inward, and an application mode, facing outward.

One such studio, accommodating up to 76 students, is included in the ILC. Facing inward, the student views a monitor on which the instructor can show any material. An instructor located in front of all of the students can lecture, using the monitors to show close-up views or other material. Facing outward, the student has access to a computer and, where required, equipment for constructing components, performing tests, simulating equipment or performing any other application of the theory learned in the lecture.

It is also relevant that the space containing the teaching studio (as with the design studio and the active learning centre discussed below) is curved and a bit unusual. It is intended to create an expectation of change and innovation. If one wishes students to 'think outside the box', it is advantageous not to locate them in a box.

First year studio

The first year curriculum is common to all programs. Since the introduction of Integrated Learning, all 600 students in year one take a course, APSC 100, which comprises two team projects, one of which involves design. The projects may draw on any portions of the year one material, and often require students to learn new material on their own. A few lectures are included at the beginning on personality issues and team organisation.

Currently, the nature and extent of the projects undertaken are limited by the facilities available. The first year studios in the ILC are intended to relieve this restriction, providing an excellent location for a great variety of projects, and allow mixing of theory and application in numerous ways. They also support development of team skills.

Modelled after somewhat similar spaces at the University of Colorado at Boulder [3], each studio accommodates 36 students. Each has facilities for a variety of activities: benches, hand tools, storage lockers, and a few computers. Tables, chairs, whiteboard and projection equipment allow lecture material to be delivered if required in support of a group of projects. Such rooms allow an instructor and teaching assistants to work in many ways with students engaged in projects. Theory and application can be readily interwoven.

Design studio and prototyping shop

Design studios and prototyping/manufacturing facilities are common enough in engineering schools, but they are often associated with one particular program or department. The ILC contains a design studio and a prototyping centre which are available for multidisciplinary usage, as in the Learning Factory at Pennsylvania State and the Multidisciplinary Design Laboratory at Rensselaer. The design studio contains workstations and working places for twelve teams. A few of the working places are secure for projects involving confidential material. These facilities link theory to practice, develop design capability, support interdisciplinary work, and contribute to developing team skills.

The prototyping facility has machine tools, printed circuit manufacturing capability, at least one 'rapid prototyper' and other tools. These facilities allow the prototyping of a certain proportion of design projects from courses in any year. They also assist in supporting the competitive teams (see below).

Plazas

The building incorporates 'plazas' of 'instrumented benches'. These support laboratory-type activities and provide both structured and unstructured opportunities for learning about related disciplines.

The three main plazas are centrally located in the atrium. Collectively, they contain sixty benches, each holding a computer and measuring equipment. Each bench accommodates teams of up to four students. Activities from different courses, different years, and different programs can be undertaken at these benches, using a combination of the standard bench top equipment and equipment specific to any particular activity. The latter can be collected by the students from one of the storage areas when required, and returned there when that activity is complete.

There are also two specialised plazas, one accommodating chemically based projects requiring special ventilation and the other accommodating certain electrical engineering work with high power requirements.

Data obtained from the benches are stored centrally and can be recovered through the web in residence, in other engineering buildings, or indeed anywhere with web access. The main plazas will be open to students at all times where there is sufficient use to justify it. Such usage patterns have two major benefits. First, they remove the artificial constraint of a two- or three-hour laboratory slots, allowing longer and more complex activities, different students to move at different paces, and students to repeat or vary measurements if they wish. Secondly, they allow for intense use of space and equipment, by functioning in the evenings and on weekends. The main plazas are located in areas open to the atrium and can be viewed from several parts of the building.

Active learning centre

An 'active learning centre' is simply a classroom in which the furniture can be quickly reconfigured to accommodate various arrangements of seating. It incorporates individual chairs and tables for each student. These can be quickly reconfigured, during a class, to switch from lecture (where the arrangement can be circular, semicircular, rows or whatever the instructor prefers) to discussion or project activity, where each group of students push their tables together and work as a team. There are whiteboards and projection capabilities on most walls. Many schools have such classrooms and Queen's has utilised such spaces for several years. The active learning centre in the ILC accommodates 80 students, and can be divided into separate rooms for 30 and 50. The name 'active learning centre' comes from the University of Colorado at Boulder [3].

Site investigation facility

Students conducting field work return to the university with samples of rock, soil or water which must be analysed and studied. Many aspects of that analysis inevitably occur in specialised facilities primarily devoted to research. The site investigation facility is accessible to undergraduates. They can carry out the initial processing of their samples, perform some types of analysis, and gain access to data banks relevant to their needs. This suite of rooms is located near a loading bay. The site investigation facility promotes linking theory to practice within the disciplines using it, and makes a sometimes unseen aspect of engineering visible to all students.

Group rooms

Team-based, project-based learning techniques require students to meet as teams to search for solutions to their problems, discuss alternatives, consider results, and prepare written and verbal presentations. Most universities do not provide many spaces suitable for these activities, although Aalborg University is outstanding in doing so, in that it provides a *permanent* office for every team in every year of every program.

Since Integrated Learning involves a significant increase in team-based activities, over forty additional team meeting rooms are provided. About one third accommodate teams of up to twelve people, and the remainder serve teams up to six. Furnishings are simply a boardroom table, chairs, and computer connections. These rooms will be available during most hours of the day, seven days a week.

Space for competitive teams

There has been a growth in international competitions for engineering students. Students design and build various robotic devices, vehicles (from solar cars to concrete canoes) and other engineered devices which then form the basis for competitions to test the design and the construction. Although these events typically take place partially or entirely outside of the curriculum, they are excellent examples of team-based, project-based learning. They are also highly motivating, both to participants and to observers. They involve design, sometimes at a high level, are inherently interdisciplinary, and require self-learning.

In order to support some of these teams, and showcase their activities to other students who might be drawn into the activities, a considerable space has been allocated for the use of such teams. A complex of rooms of different sizes can be used singly or in combination by different teams, and all have access to some common areas devoted to teams (such as a well vented room for painting and the like) as well as to all of the other building facilities, including the prototyping shop. This suite of rooms has direct access to the outside.

Multimedia training

The ILC incorporates a room where students can learn and practise a variety of techniques of presentation. It represents one aspect of the support needed to improve communication skills.

Outreach facilities

Since 1988, students in Applied Science have operated a summer outreach program, Science Quest, directed to grades 5 to 8 [4]. The program seeks to interest boys and girls in engineering as a career. This involves both classroom visits by Science Quest staff and one-week campus visits by elementary school students. The program operates from May to August. The ILC incorporates an office for Science Quest. The ILC is an ideal place in which to operate such a program, since it is built to have highly visible technology and since it inherently contains important elements of all major fields of engineering.

The nature of the building makes it very suitable for visits by high school students, since many of the activities are easily viewed. As discussed in a previous paper [2], an outreach coordinator will have responsibility for developing such usage. The outreach coordinator will also develop outreach activities based on the building's 'live building' capability.

Facilities that are not included

The building contains no lecture theatres of any size, no research laboratories, no graduate student space, and no faculty offices other than those provided for a Chair in Engineering Education and a Chair in Design Engineering, both Faculty appointments as discussed below. It also contains little or no support for computer-aided learning, its extensive computing resources being devoted to engineering tasks—data collection, modelling and the like. While most of these facilities are clearly needed in an engineering school, they are facilities which are already in place. The ILC is largely concerned with complementing them with new types of space which are currently lacking, or in short supply.

THE LIVE BUILDING

The Faculty seeks to utilise the building's structure and functions in the learning program. At its simplest level, this involves signage explaining the function of particular building elements. Of even greater interest are data collected on building parameters. The operation of all large buildings requires the monitoring of certain building parameters in order to operate the HVAC system, the power system, and so on. Some recent buildings monitor performance beyond operational requirements, purely for educational purposes. The United States Department of Energy, for example, advocates both energy efficient schools and the incorporation into the curriculum of monitoring of energy-efficient features. The ITLL at the University of Colorado at Boulder uses the 'Building as a Learning Tool'.

The ILC incorporates an extensive system of sensors to monitor structural, electrical and mechanical elements. In a few cases, technologies have been included more for their teaching value than for their contribution to the building's operation. In this class are a photovoltaic array and a fuel cell. Each makes a relatively small contribution to the electricity requirements of such a large building, but all are important technologies which we wish to make available to students.

All data will be on the net, available to be used by students in other engineering schools, in outreach programs to schools, and by architects and engineers interested in some of the performance data.

THE GREEN BUILDING

Experiential learning was discussed in the previous paper [2]. The 'live building' provides a way of magnifying one's opportunities for such learning. The next step is to use these capabilities to enhance the student's understanding of environmental issues.

We have therefore sought to incorporate high environmental standards in the building, and to demonstrate some of the technologies available. Creating a building with exemplary environmental standards has been challenging, and our success is far from total. The obstacles lay in long-held opinions and established practices among administrators, architects, engineering consultants and colleagues. Interestingly, this very problem relates to our reasons for incorporating green technology in the building. We believe that the reluctance of engineers to incorporate green technology often stems from unfamiliarity. Given that engineers bear the ultimate responsibility for performance, it is not surprising that they so often adopt familiar and well proven technologies. In Canada, even technologies long-established in Europe are often ignored in favour of the locally established methods. Building codes can reinforce this behaviour and slow the adoption of environmentally superior technologies. By incorporating many green technologies in the ILC, so that the student sees them and can monitor their performance over several years, we hope to overcome the barrier of unfamiliarity, and to educate engineers who are confident of the reliability and aware of the limitations of such technologies.

Reference has already been made to incorporating data from sustainable energy sources. Because there are important energy-generating technologies that cannot be located on site, data will be available from two off-site sources, a large wind mill located about ten kilometres from the University and a run-of-water hydroelectric generation site located several hundred kilometres from the University. Data from these last two sources are provided courtesy of the corporate owner. In addition, a large photovoltaic array will be installed on an adjacent building and its performance will be monitored and available.

Other features related to sustainability include attempts to maximise natural ventilation and daylight, despite the building being a three-storey building in the shadow of a seven-storey building. Air purity in office areas is improved by an experimental vegetation-based filter integrated into the HVAC system. This 'green wall' also contributes aesthetically, and is located at the main entrance to the building. Low energy TFT-LCD monitors will be used throughout the building to reduce heat loads. The lighting system is automatically adjusted, room-by-room, so that natural light is supplemented by only the minimum amount of fluorescent light needed to achieve the desired lighting levels. And, of course, care has been taken in the selection of glazing and other building components to reduce environmental impacts.

To evaluate the building's 'greenness', and to provide information usable in teaching, a BREEAM [5] evaluation has been carried out by external consultants. Results to date are encouraging, but the evaluation cannot be completed until later in the building process.

AESTHETICS AND OTHER INTANGIBLES

Key objectives were to make the building exceptionally functional, yielding as many benefits to learning as could be devised and to make the building warm and attractive and exciting for students, a place where they would feel ownership and want to spend time. In order to preserve these qualities in the design, the Faculty always said that it would cut facilities rather than building quality if one or the other were necessary in order to meet our budget and we did so; eliminating a teaching studio of different design from that which survived, reducing the first year studios from three to two, and reducing the competitive team space by about 15%.

There is a café/lounge on the ground floor at the west end and a student lounge on the second floor at the east end. Both of these will encourage evening and weekend use and contribute to the liveliness of the building. The café will be student operated, and will provide opportunities for learning business and communication skills, and for introducing environmentally responsible methods.

MUCH MORE THAN THE SUM OF ITS PARTS

Each of the facilities described above supports specific activities that contribute to one or more of the objectives of integrated learning. Their individual value would be great if they were distributed among existing departmental buildings.

However, grouping them in one structure increases the benefits. This is particularly true with regard to our objective of developing in each engineering student some awareness of other engineering disciplines. In our current instructional mode, a student of, say, civil engineering receives most of his or her education in the Civil Engineering building. The student of civil engineering therefore has few if any chances to observe the activities of mechanical engineers, chemical engineers, computer engineers and so on. He or she is only rarely made conscious of the fact that civil engineering is a part of a continuum of engineering disciplines, and that engineering is importantly linked to the social and natural environment in very many ways. And the same is true for students in each of the other engineering disciplines. These problems are reduced in engineering schools which have a single engineering building or complex, although even there departments usually claim areas of the complex, and opportunities to share space and activities with other engineers may not be many.

In the Integrated Learning Centre, students from every discipline spend significant time there. If they work in an instrumented plaza, they are likely to see people from other programs performing quite different work nearby. They will also often be working in teams with students from other disciplines, exploring applications of theory that someone in their discipline might not normally encounter. Furthermore, they become aware of the sustainable energy sources, or the energy-efficient building envelope, even where such technology is not a normal part of their field. Even in moving through the building, they pass windows and overlooks giving them views of other activities. They experience engineering as an integrated subject, and indeed one that is linked to business, to science, to urban and regional planning, and to society generally. This holistic view of engineering, in which the various engineering disciplines are seen to be related, and in which the connections of engineering to the environment and to society are always evident, is very important to our objectives.

SPECIALISED STAFF

Master practitioners

The academic staff of most universities are primarily successful research scholars in their field of study. They have pursued graduate studies in their discipline, usually to the doctoral level, and have published extensively in research journals and at conferences in their research areas.

This is not the career path of most engineering graduates. Most of them will pursue careers as entrepreneurs or as managers, as consultants, as designers, as members of government agencies, or in production or research roles in industry. Relatively few academic staff have substantial experience in most of these roles. Since Integrated Learning is designed to develop competence in professional practice, its staff must include people who have themselves been very successful in a variety of engineering roles, a group we refer to as *master practitioners.*

The most important among these is the *Director*. The Director has responsibility for the maintenance and operation of the Integrated Learning Centre: its equipment, its facilities, its systems, and its live building capabilities. Equally important though, the Director has a responsibility for maintaining the vision of the Integrated Learning Centre, where the highest standards of professional practice are demonstrated in teamwork, in safety, in equity issues, in ethical issues and so on. The first director was appointed in the spring of 2001 and plays a major role in shaping the building and its program. His background is as a consultant in civil and geological engineering, where he was a partner in a medium-sized firm. His daily reminders of how practice in industry differs from practice in academia are invaluable to achieving the goals of the ILC.

The master practitioners play a major role in developing the 'elevating theory to practice' part of the ILC's role. We anticipate that practitioner positions will encompass a wide range of appointment conditions: recent retirees willing to share their experience with university students; active engineers volunteering a few days; engineers seconded from industry for perhaps one term; tenured appointments (as in the Construction Engineering Chair at the University of Melbourne). Without knowing what avenues will open, we expect to utilise any and all of these types of appointment in order to accommodate the wide range of practitioners who can contribute to the ILC operation. In the main, however, it is hoped that the practitioners will be engineers made available by industry, with a major part of their function on campus being supervision of projects put forward by their firms and/or collaborative research with university faculty. This is similar to the very successful pattern at Aalborg University, which has a large contingent of industrial engineers working on campus in project supervision and collaborative research. In the case of Queen's University, which is within a three-hour drive of three major engineering centres and several smaller ones, it is hoped that a combination of electronic communication and day-long visits will allow us to utilise a large contingent of practising engineers without many of them taking up residence. These practitioners will act as team advisors, as mentors, as instructors, and as role models.

Managing a large contingent of practising engineers, most of whom come to the University for only a day at a time, will require some considerable administrative organisation. Such an organisation must be capable of handling, in an integrated manner, all of our interactions with industry:

- project selection and supervision;
- research collaborations;
- continuing education;
- internships;
- permanent and summer job placement.

Faculty chairs

Until recently, all academic appointments in the Faculty of Applied Science at Queen's University have been made by departments. Where this is the only route to hiring, it is sometimes difficult to hire a faculty member whose presence would benefit several departments, but whose field is not central to that of any one department. Such a person can assist every department, but a department head in, say, civil engineering, will usually prefer to hire a civil engineer, someone whose scholarship and teaching will strengthen the reputation of civil engineering in the institution. This outlook can and does reduce the chances of hiring candidates with exceptionally broad interests. An environmental engineer may have published in civil engineering, chemical engineering, biology, urban and regional planning and other fields. His or her strengths may include an unusual knowledge of the connections among these fields. But even where the quality of the scholarship is beyond dispute, such a person may be not enough of a civil engineer for the civil engineering department, not enough of a biologist for the biology department, and so on.

Since Integrated Learning seeks to make connections among different disciplines, people of undoubted quality and broad interests are invaluable. The Faculty has therefore put in place the machinery needed to make Faculty appointments as well as departmental appointments. A Faculty Chair may be cross-appointed into one or more departments, and may have an office and/or graduate students in those departments, but his or her responsibility is to develop faculty-wide activities. The appointment, promotion, tenure and salary decisions for a Faculty Chair will be made by the Dean and/or a Faculty-wide committee, not by any single department.

The first such Faculty Chair is a Chair in Engineering Education. The existence of such a Chair is critical to the success of the ILC. Its mission is to provide a mechanism for continuous quality improvement. The Chair provides research into the effectiveness of engineering education methods, and guidance to faculty on how to improve learning in any situation. The Chair also has a mandate to study continuing education for engineers, and to develop more effective ways of delivering continuing education. It is important that the Education Chair maintain the vision of Integrated Learning, and apply himself or herself to assessing how well graduates absorb the broad education central to integrated learning as well as the rigorous engineering core education that must be maintained and improved upon. The Education Chair has been endowed by Du Pont Canada, which has professional values in safety and many other areas that align well with the Integrated Learning program.

The second Faculty Chair will be in engineering design. Few engineering schools have enough engineering faculty with design experience to teach all of the design courses offered. The Chair in Design Engineering ensures that this vital area of instruction is constantly addressed. Moreover, as a Faculty Chair rather than a departmental appointment, the Chair has both the mandate and the freedom to develop design on a multi-disciplinary basis.

Although further Faculty Chairs are not imminent, it is expected that more such appointments will be made. They will be in areas of research which cut across traditional departmental boundaries, and will serve an integrating and leadership function.

Outreach coordinator

One aspect of Integrated Learning is about the role of engineers in society. That requires engineers having a sensitivity to societal needs, but it also requires that people outside of engineering have an accurate sense of the possibilities and limitations of technology. The position of outreach coordinator will take responsibility for this latter aspect of integrated learning. He or she will also support outreach activities designed to attract young people to engineering, and to showcase new technologies to the public generally. In both of these tasks, it is anticipated that the outreach coordinator will make extensive use of the 'live building' capability.

As mentioned earlier, the Integrated Learning Centre contains an office for Science Quest. Various activities are being considered that would bring arts students, business students, elementary and high school students, government officials and others from outside the profession into the building and into contact with its web pages. All of this will be the responsibility of the Outreach Coordinator.

SERVING MANY ROLES

The Integrated Learning Centre, with its specialised staff and broad objectives, is a complex building serving many roles. Whereas much of engineering education is devoted to isolating a particular topic so that it can be analysed and understood in detail, engineering education must also be about putting all the parts together and using them in any context. The Integrated Learning Centre is a building designed to accommodate putting the pieces together—to *integrating*. Work in one area of engineering is done in the same space as work in other areas, in collaboration where appropriate. Theory is integrated with practice in the same space. Skills development is integrated with the acquisition of a deeper understanding of theory. Integrated Learning is intended to create situations in which technology is understood in a relationship with other technologies, and in relation to its societal, environmental and economic context. The building is designed to support such experiential learning, both structured and unstructured,

Beyond all that, the building must be versatile and flexible. New learning approaches will develop, and new technologies will emerge. The building, if it is to succeed, must accommodate and, indeed, facilitate, continuous improvement.

Because of its many objectives, the building is seen quite differently from different perspectives.

- *For the student*, the Integrated Learning Centre provides many aspects of the professional work place, complementing the classroom experience by providing the offices, meeting rooms, design space, project space, prototyping facilities and multimedia facilities in which a student integrates material from different sources, practises the skills needed to elevate theory to practice, and learns to deal productively with fellow professionals in other fields.
- *For the instructor*, the ILC is a place to try other ways of teaching and learning, a place where flexible teaching spaces, work spaces and presentation spaces can be reconfigured to suit the needs of the class, where professional help is available to assist in developing innovative learning and in monitoring and evaluating its results, and in which constraints imposed by timetabling are as few as is possible.
- *For the Faculty of Applied Science*, the Integrated Learning Centre integrates the faculty's teaching in those areas where it is beneficial to do so. It is the space where members of all departments in the Faculty (and some outside it) collaborate in offering courses of relevance to several programs, and in providing students with a broader understanding of engineering principles and practice than any one department can provide.
- *For employers*, the Integrated Learning Centre offers opportunities to work with, supervise and evaluate a broad range of students in project supervision, and to work with Queen's in developing steadily more effective educational facilities and methods, particularly in developing improved communication skills, team-skills and lifelong learning skills.
- *For society*, the ILC offers an opportunity for outreach, for showcasing technology, and for attracting young people to careers in engineering. Through visits and via the web, it offers opportunities to anyone to learn something of green technologies, of building technologies, and of the role of engineers in society.

All of these aspects of the ILC interact in a most constructive way, each in some way helped by the others and each contributing, in turn, to the success of the others. The Integrated Learning Centre is integrated in many ways.

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