Teaching, learning and the undergraduate experience: THE HEART OF QUEEN’S ENGINEERING

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Welcome to the Spring/Summer 2011 issue of The Complete Engineer.

Our focus in this issue is on teaching, learning and the undergraduate experience, which together are the heart and soul of our Faculty.

We chose this theme because the education and experiences our graduates leave with will form the basis for their future lives and careers. We know this, because our alumni tell us so. This is why providing our students with innovative learning experiences is at the top of our Faculty’s agenda. Our ability to continue to do so is central to the success of our students and, indeed, our own. We constantly examine and refine our curriculum with this in mind.

In this issue, you’ll read about some of our innovative programs and courses, and about the learning that occurs outside the classroom in competitive design teams, the TEAM program and at conferences like Inquiry@Queen’s. These are all part of what makes our undergraduate experience – and in turn, our graduates – so special. Our Faculty’s mission has always been to offer a well-rounded, balanced and complete education that enables our graduates to take their place as leaders in their respective fields and positive contributors to society.

Thank you everyone who provided feedback on the Winter 2011 issue of The Complete Engineer. Many of you appreciated the timeline and history of the Faculty, and I very much enjoyed receiving your comments, ideas and suggestions.

Kimberly A. Woodhouse
PhD, PEng, FCAE, FBSE
Dean, Faculty of Engineering and Applied Science
First-year engineering gets an upgrade

Just as bridges, buildings and towers need a solid foundation, so do engineering students training for careers in the profession. The Faculty of Engineering and Applied Science begins building that solid base right from the start—in part through APSC 100, a course that all 650 engineering students take in their first year.

Dr. Jim Mason, Former Associate Dean (Program Development), PhD’75, Dr. Lynann Clapham, PhD’87, current Associate Dean (Academic) and Dr. Peter Gallant, PhD’01, co-developed this award-winning course in 1997 to encourage and enhance students’ creativity and open-ended problem-solving skills. This year, the Faculty has revised the course to expose students to a broader set of engineering tools, methods and working scenarios earlier than ever before.

“The goal is to teach students how to solve open-ended engineering problems using the same approaches and tools that professional engineers use,” says Dr. Brian Frank, Sc’97, MSc’99, PhD’02, who is APSC 100’s course coordinator and also Director (Program Development) & DuPont Canada Chair in Engineering Education, Research and Development.

Until this year, APSC 100 was divided into two sections, or modules. One focused on developing students’ ability to design an experiment and analyze uncertainties in measurements. This year, the Faculty has revised the course to expose students to a broader set of engineering tools, methods and working scenarios earlier than ever before.

“This year, APSC 100 has added a year-long module on complex problem solving and modeling. Students explore open-ended problems while learning the fundamentals of Matlab, a computer program that helps users perform complex numerical calculations and model design scenarios. It’s a valuable tool for professional scientists, mathematicians, and engineers, but until this year its use in the engineering school was limited mainly to upper-year students.

The new module isn’t an A-to-Z how-to course in Matlab, but students learn enough about the program to help them solve a myriad of problems of increasing complexity, using a model of some physical system to describe their solutions. The module encourages students to use their imagination to develop approaches to open-ended engineering problems.

“You want to give students a sense of freedom to be creative and fix problems in their own way,” says Henry Sukardi, a third-year Mechanical Engineering student who was one of several students hired by the Faculty as a Problem Analysis Mentor, a resource for first-year students taking the module. “We don’t want to restrain them.”

Last semester, for example, students completed an exercise based on an actual event—the failure in 1999 of a cargo elevator aboard the Mersey Venture, a Nova Scotia fishing vessel. A physics problem at the heart of the failure required students to call upon their understanding of Newton’s Second Law—but it was only part of the solution.

“They had to find the information to figure out what approximations and assumptions to make, and then apply it,” says Frank. “It provided a way for students to apply their science and math skills to a broader problem that complements the closed-end problems they solve in science and mathematics courses.”

In another, more complex assignment, student teams assessed the viability of installing rooftop solar panels at Queen’s (which the university is already doing). The objective was to estimate how much electricity the panels would generate over a given period. That’s easy to figure out when you have solar panels that are 100 per cent efficient and receive predictable daylight—but, unfortunately, these conditions don’t apply in reality. Thus, the students used Matlab to account for real-life considerations such as cloud cover and the varying intensity of sunlight according to the season and time of day.

To determine the accuracy of their model, the students compared their estimates of electrical output with actual data acquired from a set of solar panels on the roof of Goodwin Hall. Finally, the students calculated the revenue Queen’s would generate by selling electricity back to the provincial grid at the heavily subsidized rates specified in Ontario’s Feed-in Tariff program.

In another project, students modeled the diffusion of a chemical through the skin for an imaginary company hoping to commercialize a
work together to solve a single open-ended problem for a client, typically a Kingston community service organization or a Queen's faculty member or student group.

There’s no shortage of problems, because the Faculty has developed more than 200 projects. This year one of them involved Clark Hall Pub. The pub needed a simpler way to transport 54-kilogram kegs of beer from the street-level loading dock to the pub’s location on the second floor. Typically the kegs are physically hauled up two flights of stairs. The students had to design a device or system to transport the kegs to their destination without blocking the staircase, which is the fire exit for the building.

In another project, students had to design and build a model of a ship that demonstrates how filling and emptying the ballast tanks on a vessel affects its stability. The client, the Marine Museum of the Great Lakes at Kingston, now displays this model in its galleries.

Each project is assigned a Project Manager (PM). These are upper-year engineering students who guide the student teams through their project’s initial technical and design steps, and critique budgets and written and oral client presentations before the client sees or hears them. Like any project manager, the PMs ensure that the team is running smoothly and accomplishing tasks on time.

Helping students hone their communication abilities is something the faculty and PMs pay a lot of attention to, which comes as a surprise to beginning engineers who expect to learn mainly technical skills.

“There is a lot of talking about talking, and lessons on communicating that I hadn’t thought would be a large part of the engineering curriculum,” says first-year student Jess Nicksy.

“One of the reasons why APSC 100 is such a great course is because of this realistic model,” says PM Rob Lee, a fourth-year Mechanical Engineering student. “You have four groups all assigned to the same problem, but they each break off to tackle a different part of the problem, which is the way it happens in industry.”

Lee speaks from experience. His summer job last year was at Boston Consulting Group (BCG), where he was a junior associate on a consulting project for a major U.S. corporation. He worked in a team overseen by a middle manager, and rarely met with the client. When Lee returned to Queen’s, he was struck by the close parallels between his summer job and his Queen’s project-management work.

“The consulting models at BCG aren’t that different from the way APSC 100 is set up,” says Lee. “In the design module there’s a client you work for, the Project Manager is the middle manager, and the first-year students are the junior analysts who do much of the work. I’m guessing that was not a mistake.”

While APSC 100’s new curriculum is off to a promising start, Professor Frank says some kinks still need to be worked out. Prime among them is its workload: the new module needs to be adjusted such that it can be completed in a realistic amount of time. “Finding an appropriate balance between the problem complexity and the time required to solve is challenging,” says Frank. “Like most curricular initiatives, it will take a couple of years to fine-tune the experience.”

And faculty are still working on a way to replicate the pedagogy of APSC 100 in more second- and third-year courses, to help students become better prepared for their fourth-year “capstone” project – a comprehensive, sophisticated design assignment that is the culmination of their undergraduate engineering education.
When Thomas Jackson began studying at Queen's University two years ago, he wasn’t sure whether Mechanical or Computer Engineering was the right path for him. His first semester didn’t steer him one way or the other. But he took a second-semester course called Introduction to Computer Programming for Engineers, in which students learn programming by building functional robots out of Lego®, and that course helped him make up his mind. “I was leaning more toward Mechanical, but second semester brought me back,” says Jackson, now a second-year Computer Engineering student.

Introduction to Computer Programming for Engineers involves three types of classes: lectures in theory, studio sessions where students program virtual robots to perform tasks on their computer screens, and the Lego® labs where students practice what they’ve learned on the robots.

Unlike Jackson, many of his classmates had no programming experience or interest in Computer Engineering, but they became engaged once they realized that the programming they were learning would go beyond their computer screens.

“You really have to be creative in the course,” says Jackson, whose final project was a jukebox program. It consisted of a robot that could move around, dance and change songs when certain sensors on the robot were activated.

At the end of the semester, students complete an open-ended project to program the robots to do whatever they want.

“Having fun and playing around with these robots was a factor in choosing Computer Engineering,” says Valerie Sugarman, a third-year Computer Engineering student who had been wavering between the Computer and Chemical Engineering programs.

“You really got to see the result of what you were doing – it’s much more exciting than just seeing stuff happen on the screen,” Sugarman says.

This was one of the main goals for Dr. Stanley Simmons, Sc’76, MSc’82, PhD’86, when he developed the course three years ago. Introduction to Computer Programming for Engineers is a necessary introductory first-year course, so it had to stay. But it desperately needed a redesign.

“The course was redesigned to appeal to a wide range of students – those with some programming experience but also those with little or no experience and little interest. With this in mind, the department purchased the prepackaged sensor-equipped Lego® robots, and Simmons configured them for use in the labs.

The first year was an exciting test. Would students become more engaged and interested if they could do something more tangible with the programming skills they had acquired? They did – in a big way.

“We found that the course average went up and lab attendance went way up,” Simmons says. In previous years, attendance at the labs could be as low as 50 percent, but that figure rose to nearly 100 percent.

Jackson says the course material is great, but the “fun factor” provided by the robots shouldn’t be underestimated.

“They keep everyone interested,” he says. “Once people saw what they were going to get to do with them, they were far more interested in learning.”
Inquiry@Queen’s: 
TEACHING STUDENTS TO TEACH THEMSELVES

Annual conference highlights inquiry-based learning

D r. Vicki Remenda vividly remembers two summers during her undergraduate education. Instead of lying on a beach or toiling at a fast-food restaurant, she worked in the field with an engineering geologist who was investigating ancient landslides in the North and South Saskatchewan River basins and the potential hazards they posed to modern-day road and bridge building. It was hot, hands-on work that taught Remenda much about the value of learning by doing.

Today Remenda is a teacher and researcher at Queen’s who works to embed the same type of experiences – known as inquiry-based learning – across all Faculties at the University. An annual highlight of her work is the Inquiry@Queen’s conference.

Dr. Remenda joined Queen’s in 1993 after graduating with a doctorate from the University of Waterloo. Her research focuses on hydrogeology and the interaction between groundwater and wetlands. A professional engineer and an accomplished educator, she has won the Queen’s Golden Apple award for teaching, been nominated for the Frank Knox award and received a 2010 Ontario undergraduate Student Alliance (OUSA) Award for Excellence in Teaching.

The latter distinction recognized her work in inquiry-based learning, a concept she was introduced to during those Saskatchewan summers.

“Most of my undergraduate engineering courses at Waterloo were fairly uninspiring,” she says. “Classes were based on the model of a professor at the front lecturing while students listened. It was definitely a one-way, passive learning experience. In contrast, my work with my undergraduate mentor taught me critical thinking and problem-solving skills that I could apply to all of my coursework.”

Based on American philosopher John Dewey’s theory that education begins with the curiosity of the learner, inquiry-based learning teaches students to be more responsible for determining what they need to know about a problem or subject and to discover the resources they need to achieve success.

Dr. Remenda says that while students certainly need to learn the basics, much of the information they need is available in many formats beyond the classroom – which is one reason why she doesn’t use textbooks in her teaching. “Our role is to augment lectures with activities and discussions that teach students to think critically and to ask questions,” she says. In her third-year hydrogeology course, for example, she asks students to choose an article in an academic science journal, write a review of the article and participate in themed discussion groups.

In 2006, Dr. Remenda was awarded the Queen’s Chair in Teaching and Learning – and soon afterwards, she established Inquiry@Queen’s, a program designed to integrate inquiry-based learning into University curriculum. One of the program’s highlights is an annual conference that showcases independent or course-based undergraduate research from all Faculties.

Now in its fifth year, the conference features two days of concurrent presentations by nearly 100 students facilitated by faculty members from across Queen’s. Most presentations are delivered orally, but each year has seen more students – this year, the number was 24 – present their work on posters. Several professors now ask students to participate in or attend the conference as a course requirement.

The conference is well supported by the Queen’s administration. Principal Daniel Woolf, Arts’80, gave the keynote address last year, and Vice Principal Steven Liss took part in the opening panel discussion this year.

A key component to the event’s success is the participation of the students across many disciplines. Amy Buitenhuis, who is in her final year of a combined degree in Engineering Mathematics and Geography, presented her work entitled A Sense of Belonging: The Undergraduate Experience in Engineering this year. Amy has presented in the last three Inquiry@Queen’s conferences, and while this year she presented on work she has been completing for her courses, in other years she has tackled material beyond the assigned curriculum.

“It’s a wonderful opportunity to explore issues and topics that might not come up inside the engineering classroom,” Amy says. “I always make a point of inviting my friends to come. It is a great way to start a dialogue.”

Dr. Remenda notes that inquiry-based learning benefits both students and professors. “When we invite students to participate in discussion and debate, we’re building a foundation for thoughtful analysis in the future, but we’re also making the classroom a much more vibrant and engaged environment for faculty,” she says. “Someday, just like I remember my summer experiences, these students will remember who helped them learn the integral critical thinking skills that prepared them to be true leaders in their fields.”
Since opening its doors in May 2006, the Integrated Learning Centre (ILC) at Beamish-Munro Hall has served as the physical embodiment of the Integrated Learning concept that is central to the unique education that Queen's Engineers receive.

That education consists of an enhanced curriculum that retains the rigorous lectures Queen's engineering is known for, while providing students with time to learn and practice the additional professional skills they will need to contribute to today’s society.

The ILC is essential to the successful implementation of that curriculum. A multi-disciplinary workplace with offices, meeting rooms, design and project space, and manufacturing and multimedia facilities, the ILC helps students integrate theoretical material from different sources and apply and enhance their design, team and communication skills.

**BEAMISH-MUNRO HALL:**
- Received a Four Green Leaf rating on the BRE Environmental Assessment Method (BREEAM)
- Received the 2005 Award of Excellence in Innovation in Architecture from the Royal Architectural Institute of Canada
- Was presented as one of Canada’s greenest buildings at the 2005 World Sustainable Buildings Conference in Tokyo, Japan
- Was presented as a Natural Resources Canada case study at the 14th UN Commission on Sustainable Development and at the 2006 World Urban Forum in Vancouver
- Received a Commercial Building Incentive Program grant from Natural Resources Canada (The ILC was 25.9% more efficient than the reference building)
- The ILC’s photovoltaic array received 50% funding from the Canadian Natural Sciences and Engineering Research Council (NSERC)

**INTEGRATING FUN AND LEARNING**

**ROBERT BEAMISH**

on Queen’s, the ILC and finding joy in what you do

“The trick,” says Robert Beamish, “is to find out what you love to do and to have fun doing it.” It certainly appears that Mr. Beamish, a Queen’s Sc’60 Mechanical Engineering grad and one of the benefactors of the Integrated Learning Centre (ILC), has figured out how to do both.

Beamish was born in Winnipeg, but spent his youth in Montreal and Toronto. After graduating from Etobicoke High School in 1956, he headed east to attend Queen’s.

“I had a great time at Queen’s, but it...
was a very different experience at that time,” he says. “There were no women in engineering then, and there was a lot more pressure. In my first year, our professors told us to look to our right and left. ‘Those people won’t graduate with you,’ they said. And they were right: only one in three people graduated from engineering at that time.”

One of the most significant differences to Beamish, however, is the lab experience. During his time at Queen’s, labs were restricted to work within each specific program. “Labs were less than fulfilling,” he says. “They weren’t very challenging, and there wasn’t much innovation or collaboration involved. The main objective was just to get through it.”

His memory of these disappointing lab experiences provided the impetus for donating funding for the completion of the iILC. Early on in the development of the project, Vice Principal of Advancement Tom Harris, then Dean of Applied Science, approached Beamish to ask if he’d like to be involved. “It was a tough sell,” says Beamish. “Tom was introducing a revolutionary idea, but I began to listen after realizing how improved the learning experience would be compared to what I had.”

Once Beamish saw that much of that learning experience would involve teamwork, he got on board. “I felt that it would allow students to work with others in different engineering disciplines and learn how to work as a team, a necessary skill in the real world,” he says.

If anyone understands the skill set required of a successful engineer, it’s Beamish. In 1978, he founded the Woodbridge Group, a private company that employs 7,000 people in 19 countries. The company provides urethane and bead foam technologies used primarily in the automotive industry.

Though Beamish is retired, he’s still involved with the company he founded. For Queen’s students, his love of engineering and support for the profession’s next generation lives on in his role as a key benefactor of the Integrated Learning Centre.

DEDICATED TO SUCCESS
From Queen’s to Gaspé to Bermuda and back,
DONALD MUNRO
has built a career on lasting partnerships and loyalty
It was the spring of 1952, and Donald Munro had just received his Civil Engineering degree from Queen’s University. His interest in construction soon led him to Gaspé, Quebec, to work for The Foundation Company of Canada, a firm that built everything from steel freighters to radar stations.

Munro was employed in his desired field, but the working conditions in Gaspé were poor and after a short period as a field engineer he left the company and returned to Ontario to work for the Robertson-Yates Corporation (ryco), a Hamilton-based construction company that he would remain with for the rest of his career.

Munro held various positions with ryco and completed small contracts and heavy engineering jobs throughout Ontario, Quebec and Bermuda. In 1960, an opportunity arose for him to purchase a quarter of the company’s shares. In 1971, he purchased the remaining shares – and eventually became company president and general manager.

With ryco, Munro helped to complete a number of significant and unique projects, including the Princess and Castle Harbour hotels in Bermuda, the Robarts Library at the University of Toronto, the Niagara Parks Butterfly Conservatory, Mohawk College in Hamilton and McMaster University’s Library and Student Centre. In 1990, ryco entered into a joint venture with Alberici Constructors of St. Louis, Missouri, to handle a number of large automotive projects for Chrysler and the Ford Motor Company. ryco is now an Alberici subsidiary.

“Our company was very successful,” says Munro, “and I think it was because everyone was completely trustworthy and got along well with each other.”

Although he no longer works with the company he helped build, Munro is still creating lasting partnerships – most notably with his alma mater. Soon after his retirement in 2000, he made a significant donation toward the completion of the Queen’s Integrated Learning Centre. “I wanted to donate because I really enjoyed my time at Queen’s, and I’ve always been faithful to the school,” he says.

Munro is impressed with the result of his support. “It’s a beautiful building and a great environment for students from different disciplines who want to collaborate and put their learning into practice.”

When Donald Munro was working in Gaspé, he probably didn’t imagine that a Queen’s building would one day bear his name. Today, however, the structure is a fitting tribute to a successful and fulfilling career.

WHAT IS Integrated Learning?
Members of all departments in the Faculty – and some outside of it – collaborate to offer courses that are relevant across programs and give students a broader understanding of engineering principles and practice than any single department can provide.

INTEGRATED LEARNING MEANS:
- Knowledge integration – modularised laboratories allow for flexible projects that challenge students to combine theoretical material from different courses.
- Integration across disciplines – jointly offered, multidisciplinary projects give students a wider understanding of how theory is applied, as well as insight into other science and engineering fields.
- Industry integration – Integrated Learning strengthens the bridge between Queen’s and the external community, giving students more projects that mirror professional practice.
- Integration across years – Upper-year mentors and collaborative projects allow students to enrich each other’s educational experiences.
- Integration of theory and practice – Open-ended, real-world engineering design problems all have social components that must be understood and considered when designing a solution.
Close to 160 Engineering alumni, Faculty members and students joined Dean Woodhouse at the *Engineering at Queen’s Calgary Reception* on March 15, 2011.

Audrie and Harry Rankin with Branch President Josephine Tsang

Dean Woodhouse with alumni Dave Van Vliet and Clyde Fulton

Kim Sturgess and Jeff van Steenbergen

Kent Novakowski, Head of Civil Engineering, talks with Calgary alumni Kaitlin Palmer Ford and Johnathon Ford

Principal Woolf met with a group of San Francisco area alumni at a private reception hosted by Diana Liu and William Yu, Sc’84, MBA’87. The event took place in Atherton, CA on March 29, 2011.

Hosts William Yu and Diana Liu are joined by Principal Woolf and alumni guests

Donald and Carolyn Clendenning with Dean Woodhouse

Principal Woolf thanks William Yu and addresses guests

Dan Trepanier, James Verner and Scott Bonham

Scott Bonham talks with Principal Woolf
DESIGN TEAMS OFFER REAL-WORLD CHALLENGES FOR QUEEN’S STUDENTS

The 12 student design teams at the Faculty of Engineering and Applied Science offer students at all levels a chance to apply their budding academic and practical knowledge to a variety of challenging real-world projects.

We are pleased to announce the formation of two new teams. Beginning in September of 2011 students will be able to hone their engineering skills in the AUTOMATED POKER and the BRIDGE BUILDING teams.

QUEEN’S GENETICALLY ENGINEERED MACHINE (QGEM)

QGEM combines engineering with biology to design a biological system capable of performing a programmed function, with applications ranging from medicine to industry. The team competes annually with more than 130 teams in the International Genetically Engineered Machine Competition. Last year, the team assembled a toolkit for the efficient engineering of the nematode C. elegans. This year’s squad hopes to apply QGEM’s previous work to solve real-world problems with the engineered worm.

http://home.qgemteam.com
apply@qgemteam.com
As its name suggests, the Queen’s University Concrete Canoe Team is a student-run team whose purpose is to design, develop, and create a canoe made of concrete. The team competes annually in the Canadian National Concrete Canoe Competition with other Canadian universities and colleges. The team’s key objective is to provide a learning opportunity for students in all years that promotes a creative, innovative, and fun activity and fosters leadership, teamwork, communication, project management, and problem-solving skills.

For more than a decade, participation on the Concrete Canoe Team has been an excellent way for students to get involved in the Queen’s community and meet peers with similar interests. The team interacts primarily with local engineering companies to attract team sponsorship. The team is involved in all open-house sessions for prospective students. Many former members have said that their participation on the team left them with some of their fondest memories of Queen’s. The Concrete Canoe Team has appeared several times on the Discovery Channel, Queen’s TV, and CBC National News.

http://engsoc.queensu.ca/canoe

canoe@engsoc.queensu.ca
Tobogganing down a snow-covered hill never gets old, especially when you’re riding a slab of frozen concrete at 60km/h! That’s just what the Queen’s Concrete Toboggan Team does annually at the Great Northern Concrete Toboggan Race. This innovative and entirely student-run team offers hands-on experience unmatched by the classroom. Team members not only design and build the toboggan, but also network with industry members and plan campus events. In 2010, the team took second place overall in the competition against nineteen other competing universities.

http://engsoc.queensu.ca/index.php/content/queens-concrete-toboggan-team-0
toboggan@engsoc.queensu.ca
The Queen's University Baja SAE Design Team is a group of dedicated students who work together to create an off-road racing vehicle to compete in the North American Baja Society of Automotive Engineers (SAE) competition series. The team is comprised of engineering students ranging from first-year to the graduate level. Every year the team designs, constructs, tests and races a completely new vehicle.

Participants enjoy a unique learning experience. Members of the team gain hands-on experience solving practical engineering problems. Furthermore, due to the student-run nature of the team, new members learn many key concepts and skills from senior members.

www.queensbaja.com
minibaja@me.queensu.ca
QUEEN'S FORMULA SAE TEAM

Queen's Formula SAE is a group of dedicated engineering students who come together each year to design and build a custom, Formula-style racing car and then use it to compete against other cars built by student teams from other universities around the world. Students gain a wide range of skills ranging from design and manufacturing to project management and business. The end result is a car capable of accelerating from 0-100 km/h in 3.5 seconds and cornering at 1.6G's!

www.qfsae.com
formula@me.queensu.ca
QUEEN’S FUEL CELL TEAM (QFCT)

The Queen’s Fuel Cell Team is an undergraduate engineering design team consisting of about 40 members. The team provides students with hands-on experience in real engineering projects involving the application of fuel cell technology. QFCT was founded in 2005 and began with the modification of a golf cart to enable it to be powered by hydrogen fuel cells. The team successfully completed that project in 2009 and is now in the design phase of a new project: the production of the world’s first fuel cell-powered snowmobile.

The team plans to showcase its design at the 2013 SAE Clean Snowmobile Challenge, an annual design competition for undergraduate students to reengineer snowmobiles to reduce emissions. Bombardier Recreational Products generously sponsored the Queen’s team with a snowmobile in early 2010. The team is now designing parts and systems that it will use to convert the vehicle to fuel cell power later this year, and is raising funds for the project from donations and corporate sponsorship.

The complex and multidisciplinary nature of the current project rewards the team members with a diverse and challenging learning experience. Chemical, Mechanical and Electrical Engineering students work together to design components and systems that must integrate together and operate seamlessly. This helps team members develop a varied technical background, communication skills, and a fuller understanding of the engineering design process. They also gain experience in the business world through the pursuit of sponsorship.

qfct.ca
info@qfct.ca
Since 1988, the Queen's Solar Design Team’s solar vehicles have brought Queen’s to the forefront of innovation. Now the team has a new mission: to build a net-zero, solar-powered home for the U.S. Department of Energy’s 2013 Solar Decathlon in Washington, D.C., which showcases the world’s most energy-efficient and affordable homes. The event is unparalleled in scope and excitement - 20 teams from around the world bring their homes to Washington, and more than 300,000 visitors tour the dwellings. The Solar Design Team will compete against teams from Germany, Spain, Puerto Rico and New Zealand. In light of consumer trends towards green building, the Solar Design Team is determined to make net-zero homes a reality.

www.qsdt.ca
info@qsdt.org
QUEEN’S SPACE ENGINEERING TEAM (QSET)

The goal of the Queen's Space Engineering Team (QSET) is to provide an environment where students can develop industry transferable skills through hands-on experience. From mechanical and electrical, to chemical and financial, the competitions that QSET participates in offer a wide range of challenges. Operating as an independently run team offers members the flexibility and freedom required to plan, research, and implement successful solutions to open-ended design problems.

QSET is defined by its competitions. In 2010, QSET placed second at the International CanSat Competition in Texas, an event sponsored by NASA. The competition involves designing a rocket payload that meets the constraints designated by the CanSat guidelines. In 2011 QSET re-entered the CanSat Competition and joined the Canadian Satellite Design Challenge (CSDC) organized by GeoCentrix Technologies Ltd. Both competitions require extensive planning, dedicated teamwork, creativity, and resourcefulness. The team is responsible for all aspects of both design competitions and receives advice from public- and private-sector mentors.

http://qset.ca/
qset@engsoc.queensu.ca
QUEEN'S SAE AERO DESIGN TEAM

The Queen's Aero Design team comprises undergraduate students from all engineering disciplines, and each spring since 1994 has represented Queen's University internationally at the SAE Aero Design Competition in the southern United States. The goal of the competition is to design and build a remote controlled heavy-lift aircraft, and the winner must be able to carry the most weight, maintain control in flight and land successfully. Typical challenges of designing and building the plane include wing design, stability control, structural support and weight reduction.

The design of the plane for this year’s competition in Fort Worth, Texas, has a three-meter wing span, weighs less than 5kg and is capable of lifting over 10kg of additional weight. The team hopes to improve on its 18th place finish at last year’s competition in Los Angeles, California.

http://engsoc.queensu.ca/index.php/content/aero
aero@engsoc.queensu.ca
MOSTLY AUTONOMOUS SAILBOAT TEAM (MAST)

Queen’s Mostly Autonomous Sailboat Team (MAST) is an undergraduate student team that designs and builds two-metre robotic boats that sail without human intervention using on-board computer controls and sensors. It was the first Canadian team of its kind.

MAST has represented both Queen’s and Canada at international conferences and competitions, and team members have earned many awards for their performance. The most recent World Robotic Sailing Championship and Sailbot were hosted in Kingston in the summer of 2010. MAST is one of several teams from around the world that is preparing to build the first fully autonomous sailing vessel to cross the Atlantic. Currently, MAST is constructing a four-metre vessel for the trans-Atlantic competition and a new two-metre boat for the upcoming Sailbot competition.

www.qmast.ca
sailboat@engsoc.queensu.ca
The Living Energy Lab was founded in 2006 to retrofit two campus houses with various green technologies and to determine the subsequent energy savings for its occupants. Today, the club’s mission remains the same: to devise new and improved energy- and water-saving retrofits for existing homes and systems. The members actively design and test their creations. If the results are positive, the designs are marketed to Kingston-area interest groups. The ultimate goal is to sell the ideas and creations on the open market.

The group is one of the few engineering sustainability clubs at Queen’s. It meets with the AMS Sustainability forum to provide an engineering perspective for environmental policy at Queen’s and also researches and provides advice to the AMS Greenovations group, which focuses on retrofitting student homes for free and helps students reduce their utility bills.

The LEL combines all steps in the engineering process: concept development, research, design, prototyping, testing and working with the School of Business. Current and past projects include dual toilet retrofits, grey-water recovery systems, urban gardening systems and thermal windows.

www.livingenergylab.ca
admin@livingenergylab.ca
QUEEN’S BIOFUELS ENGINEERING DESIGN (QBED)

Queen’s Biofuels Engineering Design (QBED) team is the first and only design team available specifically for Chemical Engineering and Engineering Chemistry students. Now in its second year, QBED is a 10-member team that hopes to introduce a sustainable fuel blend capable of powering diesel engines in vehicles used by Queen’s (such as the shuttle bus). QBED is also estimating the capital costs of equipment that will help make Queen’s a green campus. As funding for QBED increases as a result of this initiative, the team hopes to enter into international competitions.

http://engsoc.queensu.ca/index.php/content/qbed
biofuels@engsoc.queensu.ca
If you’re ever near the town of Tamworth, Ontario in early September and spot a flotilla of young people furiously paddling cardboard canoes down the Salmon River, don’t be alarmed. It’s all part of Civil Week, a course taken by upper-year Queen’s Civil Engineering students at the start of the semester to help them gain valuable skills to support their learning throughout the year.

Civil Week was introduced by Dr. Andy Take in 2006 as a way to immerse students in engineering design and professional skills development. During the five-day course, students practice team-building, leadership, effective written and oral communication, problem solving and technical writing.

Ryley Beddoe, Sc’05, MSc’09, is a PhD candidate in Civil Engineering and has been involved with the course for four of the past five years, this year as part of the Adjunct faculty. She sees Civil Week as an invaluable component of a student’s education. “It helps to develop skills such as communication and teamwork, which they’ll use throughout their time at Queen’s.”

Second-year students spend the week in lectures and in small groups working on designs for cardboard canoes and water-balloon launchers, which are then tested in a competition on the fourth day at the Kennedy Field Site, a 65-hectare property on the Salmon River north of Tamworth. The property was donated to the Department of Civil Engineering by the late Professor Emeritus and former Queen’s Vice-Principal Russell Kennedy, Sc’41, LLD’93.

Students entering their third year spend Civil Week travelling to off-campus investigation sites to apply the fundamentals learned in second year to actual case studies. In the past, third-year field trips have included excursions to Ottawa to view the impact of sensitive clay on slope stability along the banks of creeks and rivers.

Fourth-year students spend the week in small groups going through the bidding process for their top choice of the available capstone design projects. These are real-world projects supplied by the department’s industry partners, who work with student groups throughout the year to mentor them through the design process.

It’s not only fourth-year students who profit from mentors, however. During Civil Week, each member of the Civil Engineering faculty is also directly involved in activities for first-, second-, and third-year students. “This allows for a great deal of interaction between faculty and students, both formally and informally,” says Beddoe. “Both the students and faculty members have indicated that working so closely with each other right from that first day truly provides a unique environment in Ellis Hall.”

Though students have a lot of fun during Civil Week, it’s clear that the five days aren’t just about riding in a cardboard canoe, taking a field trip or bidding on a capstone design project. They’re about working together with fellow students and faculty. And, according to Beddoe, “they’re about bringing meaning and context to theory that’s learned in the classroom.”
A WINNING TEAM

left to right: Dan Chiu Sci’07, Justine Deloyer Sci’10, Elliott Collyer Comm’10, Andrew Kelly Sci’10, Holly Blair Sci’07, Jeff Kent Sci’10
Integrating industrial projects into the education of engineering students may seem like a leading-edge practice. But Queen’s has been doing it for 16 years, and it began with TEAM, a course like no other.

TEAM (Technology, Engineering And Management) is a year-long course that allows fourth-year students from Engineering, Commerce, Law, and Arts and Sciences to participate in an engineering project in which they engage, advise and learn from an actual client. It also gives companies a chance to tap into vigorous, bright minds that can help solve real industry problems and for Queen’s alumni to support the next generation of professionals at their alma mater.

In 1994, when TEAM was launched, bringing undergraduate engineering and commerce students together to serve a fee-paying client was a novel concept, but time proved it was a sound one. Four years later, one of the course’s first supervisors – Barrie Jackson, a former process designer and developer for the Shell Group who is now retired – won the 1998 Engineers Canada (formerly CCPA) Medal for Distinction in Engineering Education.

In 2005, Shell Canada revitalized the TEAM program with a $400,000 donation from its Campus Ambassador Program, and injected the same amount four years later. That kind of corporate backing from Shell and others has helped TEAM grow its enrollment and the number of projects that students can choose from each year. Cooperation from the Faculty of Law, the School of Business and students from Chemistry, Biology, Environmental Science and other Queen’s programs has also given TEAM great momentum.

“It’s the tremendous support from industry and the growth in our client base that has allowed us to meet the challenge of increasing enrollment,” says David Mody, Sc’88, an adjunct lecturer in Chemical Engineering who is TEAM’s current supervisor. “If it weren’t for Shell and longtime clients like DuPont, we couldn’t have provided these opportunities to the students.” The Province of Ontario, through the Ontario Centres of Excellence (OCE) program, has also been an important sponsor, providing $70,000 a year on average. In 2010, TEAM offered over 30 projects to students.

Much effort goes into ensuring that TEAM offers a broad range of experiences – from projects involving the environment, alternative energy, and business process improvement to the development of medical devices, manufacturing improvements and government policy. Because students work in teams, they can learn from each other as they tackle the technical, marketing, intellectual property, regulatory, and policy issues that crop up in a typical engineering project.

Companies that join the program and pay its $5,000 fee have their needs assessed by the TEAM faculty, who assign a student team to the project. Before the work begins, the team submits a proposal letter to the company outlining the project’s deliverables, a confidentiality agreement, a liability waiver and administrative arrangements. The group is also assigned an industrial advisor, typically an experienced engineer who can help guide the students through the challenges of integrating and working with industry.

Andrew Kelly, Sc’10, who last year worked with Agrium, a global fertilizer manufacturer based in Alberta, was in a team that examined how to recover inert gases – particularly helium and argon – from the production of ammonia at Agrium’s Redwater, Alberta site. In addition to inventing and modeling the process, the team investigated market demand and the requirements for shipping the materials.

“The course contributed a great deal to my organizational abilities,” says Kelly. “We had to juggle multiple meetings each week with our client, advisors and group members to ensure the project was completed on time and that it fulfilled the needs of the client.”

Matthew Ponsford, Artsci’10, participated in TEAM in his final year at Queen’s. “It’s a rare course,” he says. “It brings together networking, team building and project management, all with the intent of bridging science, problem solving and the law into a cohesive real-world challenge.”

Ponsford and his team – three engineers, a biologist, a lawyer and numerous affiliates, partners and advisors – were tasked with advising Agrium about how to reduce the amount of water and energy used in the company’s plant. The job involved conference calls and weekly advisor meetings, the distribution of professional memoranda and letters of intent, and two visits to the project site – one for a tour, and another to present the team’s findings in a lengthy final report.

The hard work paid off. Ponsford says the team made a set of solid recommendations to the company based on Alberta’s environmental codes. “As a result, they implemented an improved wastewater treatment process that reduced costs, helped the environment and emphasized Agrium’s commitment to socially responsible corporate objectives.”

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Holly Blair, Sc’07, who now works with Agrium, was the client for the 2010 TEAM projects at the company. As a former TEAM participant, Blair didn’t hesitate when, a couple of years after her graduation, Mody proposed to her that Agrium become a TEAM corporate partner. “I knew the strength and enthusiasm of the students and the quality of projects they would be capable of providing,” says Blair. “It’s a one-of-a-kind program in Canada, and something that Agrium and I are happy to be a part of.”

Success stories from TEAM’s 16 years of existence abound. For Mody, a particularly memorable one was in 2006, when Shell assembled a panel of geothermal energy experts to hear a final presentation from TEAM and one of the Shell people started asking a student some tough questions. Fortunately, the student was prepared. “He must have read every geothermal article he could lay his hands on,” recalls Mody. “He began to debate the issue, and the Shell engineers and I watched in amazement as this student defended his project with rock-solid technical knowledge. As the discussion continued, everyone forgot this student had only six months of intense knowledge-building in the subject. In the end, the audience was ready to applaud.”

This year, two TEAM projects are racing to meet the deadlines of clients and partners in an effort to kick-start the bio-economy of rural Eastern Ontario. In another project, on behalf of a Kingston-area farm, three students from Engineering, Commerce and Law are working to see whether the farm’s owners might patent, produce, distribute, and sell an organic fertilizer produced as a by-product from their biogas-generation system. The team is performance testing the proposed product at the Queen’s greenhouse while they explore the regulatory and marketing aspects of the venture.

It’s a remarkable project, but the energy and enthusiasm that the students are devoting to it doesn’t surprise Mody. “When you look around, there are so many examples of students rising to the challenge of achieving excellence at Queen’s,” he says. “TEAM is just one of those great moments in the university experience, but it’s a special one.”

As its name suggests, making TEAM happen involves people from across the university; these include Steven Moore and Dr. Keith Rogers from the School of Business; Dr. Stan Corbet from the Faculty of Law; and a number of Engineering professors, including NSERC Design Chair David Strong, Sc’81, Dr. Victoria Remenda, Dale Dilmamter, and Dr. Jim McLellan, Sc’81, PhD’91, among many others.

One of the more interesting features of the Queen’s industrial design project courses is the support that teams receive from engineers across Canada who advise, mentor and guide students through the projects. The list of people helping as advisors is extensive. Long-time advisors such as DuPont Fellow Keith Marchildon provide incredible depth and breadth of experience and advice to the teams. Others, including Maureen Plunkett, Laurie Phillips and Lynn O’Malley from the Department of Chemical Engineering, provide administrative support. Jim Campbell, Queen’s Calgary-based representative for Western Canada, has played an important role in helping to identify and develop TEAM projects.

“When the stars all align, when the project is challenging but achievable, the students know it’s not just their reputation at stake,” says Mody. “They know it’s also the reputation of Engineering and Queen’s. They can make amazing things happen for our clients. For me, it’s inspiring to work with them, to see students succeed, and to hear our clients say how impressed they are by Queen’s.”

For more information about TEAM, or if your company might like to participate in one of Queen’s several industrial project courses, please contact Dave Mody in the Department of Chemical Engineering. More information about TEAM is available at http://team.appsci.queensu.ca.

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In 2008, Dave Mody, Sc’88, Lisa Maxwell, Sc’06, and Amar Kher, Sc’06, had a brainstorm: to bring Queen’s alumni working in the oil and gas industry back to campus to speak to current students about their careers and current industry trends. Their idea became a reality in 2009, and since then the Oil and Gas Speaker Series has become a popular annual occasion for students, alumni and industry professionals looking to learn, network and share ideas.

When they first conceived of the event, Mody, Maxwell and Kher hoped that Queen’s students from different backgrounds would attend to increase their knowledge of the oil and gas sectors. Meanwhile, Shell Canada was encouraging Queen’s to make students more aware of those sectors, partly through its generous support of the Technology Engineering and Management (TEAM) program (provided as part of Shell’s Campus Ambassador Program – see page 22).

The timing was perfect, and in January 2009 the inaugural Oil & Gas Speaker Series welcomed 100 students who attended presentations by 20 alumni on a variety of oil and gas topics including exploration, raising capital, production, refining, environmental monitoring and remediation, engineering consulting, trading, services, software, research, sustainability and distribution. Shell Canada provided key sponsorship. Other sponsors – including Imperial Oil, Provident Energy, Encana and Suncor – soon jumped on board.

The event wasn’t just about learning. Students and alumni got to know each other during breaks, meals, receptions and at a banquet dinner. “A great reunion was had by all,” says Mody. “The event was more successful than I ever imagined. Industry support was tremendous and the speakers gave inspiring, interesting and often surprising presentations to the students who attended.” In an exit survey conducted by the organizers, nearly 90 percent of the students said they discovered new career opportunities, and roughly the same proportion said they would return next year.

And they did. The 2010 speaker series included approximately 100 attendees, and more than 140 students attended the recent 2011 event held in late January. “It was a great way to meet people within the industry and to gain another perspective on important oil and gas issues,” said one student surveyed after the 2011 event. “I learned some valuable lessons, including the importance of taking risks when opportunities are presented to you.”

Roger Smith, Sc’71, addressed the same topic in his presentation “Finding Your Inner Entrepreneur.” Smith, the president of Big Muddy Exploration, a private company that generates and markets oil and gas exploration opportunities, spoke about how career surprises that appear to be crises can actually be catalysts for achieving personal and professional growth.

According to Smith, the Oil & Gas Speaker Series is also helping students achieve that growth. “When I graduated, I had little perspective on the industry,” he says. “This speaker series changes that for students. Taken together, the presentations shed light on an amazing cross-section of the industry.” This year’s speakers represented a number of companies including Shell Canada, Encana, Imperial Oil, Suncor, Provident Energy, Africa Oil Corporation and Borden Ladner Gervais LLP.

Attendees gathered in Ban Righ Hall over three days to listen to half-hour talks on topics ranging from oil sands mining and energy trading to sustainability and environmental protection. More informal evening sessions at Wallace Hall, Portsmouth Olympic Harbour and at a local Kingston restaurant gave students the opportunity to meet and network with the speakers.

The team effort that Jim Campbell, Dave Mody and students from Engineering, Geology and the Queen’s Energy and Commodity Association put into bringing such diverse guests was not lost on student attendees. “It was an amazing opportunity to meet leaders in the industry and to gain a new and improved perspective,” said one student.

Event Coordinator Maureen Plunkett of the Department of Chemical Engineering played an important role in organizing the venues and meals, and Queen’s Event Services provided a professional workshop environment. Several industry attendees observed that the venue and workshop were as good as any they had encountered in their professional careers.

Mody, Maxwell and Kher’s idea has grown into a significant annual event that has helped encourage more students to enter the oil and gas industry with greater knowledge and new contacts. Mody couldn’t be happier with that result. “It’s rewarding that an idea that seemed simple – to put alumni together with students to explain the industry – has been so successful with our students,” he says. “It’s win, win, win all around!”

For more information see:
http://oilandgas.chemeng.queensu.ca
RAPID PROTOTYPING: From design to reality at the speed of imagination

On the shelf is a white, 10-centimetre-high plastic figurine of what might be a jolly Great Dane, sitting upright. A few toothed cogwheels, seven centimeters in diameter and made of the same white plastic, lay atop a nearby table. Beside them are more plastic bits, girders for a miniature bridge.

These might be playthings in a child’s toy room, but the location is the basement of McLaughlin Hall, and the plastic bits in question are the products of student projects for a third-year machine-design course taught by Dr. Yongjun Lai.

Students in the course study Mechanical Engineering basics such as static and fa-
tigue failure, but this is the first year that they have learned how such theoretical principles apply in practice by turning their own engineering drawings into three-dimensional plastic models they can use to test their designs. Enabling all this is a piece of equipment called a rapid prototyping machine. There are about five at Queen’s, but the one in McLaughlin Hall, donated last year by the family of D.D.C. McGeachy Sc’40, is the newest.

Making a 3-D model involves some seriously sophisticated technology. It begins with Computer Aided Design (CAD) software, which the students use to draw a digital image of the object they wish to make. The program exports a file that is fed into another program called Catalyst, which digitally “slices” the CAD file into hundreds of micro-thin layers. This data is then fed into the rapid prototyping machine, or printer. The one in McLaughlin Hall – a Dimension 1200 about the size of a refrigerator – has internal jets that squirt out hair-like filaments of molten ABS plastic in progressive layers that conform to the precise contours of the desired object, a process called fused deposition. As the layers build up and cool, the object slowly takes shape. The machine even produces “support” material that supports projecting or delicate parts – like the floppy ears of the dog figurine.

Rapid prototyping has enabled each of the 180 students in MECH 323 to take their evolving knowledge of design to a new level. This year, for example, student groups were challenged to design a functioning gearbox capable of lifting a weight over a certain distance. The rapid protyper made all the difference.

“In the past, students would be able to design a gearbox in CAD, but they wouldn’t be able to actually test it physically,” says Geoff Lee, a third-year Mechanical Engineering student. “Now we can.”

“You can have zero machining experience and still make something, because you draw it yourself in CAD, send it off to the shop guys and out comes a printed part,” says Sam Roesch, another third-year student. “You don’t have to deal with machining your own parts.”

Andrew Bryson, the department’s machine shop supervisor, says that convenience is a real boon.

“If we had to make prototypes out of steel, it would take us months,” he says. “With the Dimension, the whole thing is automated and takes only a few hours, depending on the size of the part. Plus, plastic is a lot cheaper than steel or aluminum.”

A Growing GLOBAL Movement

Machines like the Dimension represent the low end of commercial rapid prototypers, but a small but growing community of engineer-tinkerers around the world, is developing and building do-it-yourself desktop 3-D printers. Costing under $1,500, they can produce small plastic items – coat hooks, simple toys and other small items – using recyclable waste plastic. The designs for the 3D printers, and designs for the items they can build, are shared for free on the Internet.

A goal of this so-called “raprep” – for rapid reproduction – movement is to build printers that can replicate the parts they are made from so that one machine can, in effect, give birth to others. You build your own machine, which you use to make parts for another machine.

A competition headed by Mechanical Engineering Professor Dr. Joshua Pearce is currently underway to challenge students, staff and faculty to create open-source designs for 3-D printers. It’s hoped that the experience will introduce the Queen’s community to this particular field of design and create an open exchange of raprep designs to meet human developmental needs.

Professor Pearce believes the homemade machines could change the way economies function.

“Today when something breaks, you go buy another one of whatever it was,” he says. “You pay a lot for it because of the predatory nature of intellectual property law. In the future, people will be able to replace broken objects by downloading open-source 3-D designs from websites and printing out the object in their own homes.”
Getting the Word Out

With a long and storied history and a promising future, the Faculty of Engineering and Applied Science has great stories to share, and we’re working hard to do a better job of telling them.

Over the last two years we’ve launched The Complete Engineer magazine, redesigned our Faculty web sites and begun to produce a series of videos.

Students thanking alumni for their support in the Sci’70 Class Giving video.

Professor Ian Moore is featured in the GeoEngineering Laboratory video.

The Complete Engineer

Published twice a year, the magazine reaches out to alumni and other stakeholder groups to bring them the fascinating stories of our students, faculty and alumni.

Please send your suggestions, comments, critiques or kudos to complete.engineer@queensu.ca.
Our Videos

A picture, they say, is worth a thousand words – and you can cram a lot of images into a three-minute video. Ours are shot by staff and edited by a second-year Engineering Physics student on a desktop computer in our Student Services office. Our videos highlight

- Our departments and programs
- Current research and facilities
- Student experience and campus life
- Our amazing alumni

View our library of videos at http://engineering.queensu.ca/Video-Library.html

In the coming months we will be exploring new media and formats to help us communicate. Stay tuned. The story of the Faculty of Engineering and Applied Science continues!

You can follow us on Twitter @QueensEngineer.

Our Website

Over the last 18 months, we have completely redesigned and re-launched our Faculty websites. Our goal is to provide our online audience with a satisfying experience. We want you to find the information you want as easily as possible. Each site is constantly evolving, and we welcome your feedback.
Renowned spirit, Unrivalled excellence

Without Queen’s, where would you be …?

where would Queen’s Engineering be without you?

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Teaching, Learning AND THE Undergraduate EXPERIENCE…

Wherever we go, our alumni tell us that their undergraduate Engineering experience at Queen’s was a defining part in shaping who they are today. It is our goal to ensure that the unique quality of a Queen’s Engineering education continues into the future – with your help.

Over 17,000 graduates now proudly call themselves engineering alumni of Queen’s university. They include industry leaders, outstanding entrepreneurs and award-winning contributors to society, both at home and around the globe. Many of these alumni have chosen to invest in future generations of Queen’s Engineers through their generous support to the Faculty of Engineering and Applied Science.

Join others in providing a distinctive learning experience to our future leaders of the 21st Century. There are many ways our alumni and friends can contribute to the present and future excellence of a Queen’s Engineering education.

Are you involved in an innovative or unique initiative? Do you have corporate insights that could benefit our students. Are you interested in providing support for our innovative programming, the student experience, excellence in teaching and research and/or revitalizing our infrastructure?

The Development Team in the Faculty of Engineering and Applied Science is a dedicated and experienced group eager to help our alumni remain connected to and involved with their alma mater.

We encourage you to ask us how you can make a difference for our engineering leaders of tomorrow.