# Leaders of Tomorrow - A Leadership Development Program for Engineering Students at the University of Toronto

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## Abstract

Leadership development is an important, emerging component of student experience in the Faculty of Engineering and Applied Science at the University of Toronto. Leaders of Tomorrow started in 2002 in the Department of Chemical Engineering and Applied Chemistry and was funded to be implemented Faculty-wide in 2006. The program includes department-based co-curricular activities, a new senior-level course on leadership and support for leadership development in extra-curricular clubs and student government. As an example of Leaders of Tomorrow co-curricular activity, the thirteen-week, Friday-afternoon summer program is described. The Vision, Mission, Values, and Beliefs for Leaders of Tomorrow were developed through extensive discussion and debate, incorporating the perspectives of faculty, staff and students. Our Vision: An engineering education that is a lifelong foundation for transformational leaders and outstanding citizens.

## Introduction

Leaders of Tomorrow, The University of Toronto Faculty of Applied Science and Engineering's Leadership Development Program has three main objectives: first, it strengthens and enriches the experience of engineering students by providing coherent, structured and intentional learning opportunities to enhance their leadership development. Second, through leadership development in engineering education, it will enhance the ability of its graduates to make significant contributions in their work place, their community and society. Third, leadership development can enhance the connection between the field of engineering, with all its technical, analytical and problem solving capability, and the realm of public policy, enabling graduates to contribute more fully to technologically sound public policies.

The program integrates leadership development through all facets of the engineering student experience: curricular, co-curricular and extra-curricular. Pioneering work of the Department of Chemical Engineering starting in 2002 is being extended through co-curricular leadership development training, workshops, summer experiences, community service projects and other opportunities in departments and divisions across the Faculty. The Faculty has already adopted two “columns of integration” in the engineering curriculum, communication and design, and will now move to implement a third, namely leadership. In July 2006, the Faculty appointed its first Leadership Development Professor who has developed a new senior-level course, "Leadership and Leading in Groups and Organizations"; the course is being piloted in the fall of 2007. Building on the robust tradition of student activity, the Faculty will support student leadership development through programming for leaders involved in student government and a wide range of clubs and groups involved in outreach, orientation, publications, and culture.

This paper will introduce Leaders of Tomorrow - its origins, vision, mission, values and beliefs - and describe one of its important components, the summer program. Other elements that await future presentation are: programming during the academic year, the leadership development course, mobilizing student leaders through working groups, and the leadership development certificate.

**Background**

The scholarship of leadership teaches us that advances in technology combined with the increasing globalization, complexity and interconnectedness of the post-industrial economy demand new approaches to leadership. A definition of leadership as a set of traits or behaviours is no longer sufficient. Rather, leadership is defined as “a relational process of people together attempting to accomplish change or make a difference” (Komives, Lucas, & McMahon, 1998). New ways of leading include collaboration, teamwork and the ability to transform followers into leaders themselves. This is especially true in the field of engineering, where groups and teams have the potential to bring multiple approaches to a single problem or challenge. In order to succeed in this new paradigm, professionals need leadership tools of inclusiveness, empowerment, ethics, purposefulness and process.

The skills of good leadership are not innate; they can be learned. In her recent study on the development of leadership identity among students, Susan Komives (Komives, et al., 2005) identified four key developmental influences: *adult influences*, through external affirmation and as role models; *peer influences*, as role models and collaborators; *meaningful involvement* -- experiences that help students experience diverse peers and develop new skills; and *reflective learning* -- structured opportunities to allow students to uncover their passions, integrity, and commitment.

At the same time as we are learning about the demands of leadership in the 21$^{st}$ century, the Faculty is learning more about its students, their experiences and their development.

The National Survey on Student Engagement (NSSE) provided concrete evidence of what many of us have come to understand about our students by observation:

- While more than half of our students participate in the robust array of student clubs and organizations in engineering and the wider campus, more than 48% report spending no time involved in what NSSE calls co-curricular activities.
- Despite the cultural diversity of our student population – almost 64% identify as a member of a visible minority group – a large proportion (34%) say the University does "very little" to encourage interaction across economic, social, racial and ethnic backgrounds and 29% say their experience has done "very little" to contribute to their understanding of people of other racial and ethnic backgrounds.
- Engineering students are more likely to say the University emphasizes learning effectively on your own than working effectively with others.

The NSSE results have served to strengthen the Faculty's commitment to the goals set out in the Faculty's strategic plan. The Faculty's Mission Statement includes: *"To ensure that our students are equipped with the academic, leadership, and communication skills required by the engineering profession and society in general"*. A more explicit statement regarding leadership development can be found in the undergraduate section of the plan: *"Provide opportunities for soft skills development and professional training in areas such as team building, leadership, citizenship, ethics and social awareness in order to produce graduates fully prepared to embark into leadership roles in corporate, entrepreneurial, or future research careers in a global environment."* The Faculty's record in leadership development is strong. We have integrated collaboration, community outreach and communication skills into the curriculum through such initiatives as the first-year Engineering Strategies and Practice course (McCahan, et al 2004).

The University of Toronto's Academic Initiatives Fund, in early 2006, granted $1 million over five years to implement a Leadership Development Program across the engineering faculty. The mandate of Leaders of Tomorrow is to create intentional, structured and meaningful leadership development programming through the curriculum, the co-curriculum and extra-curricular activities providing, for our students, an experience that integrates theory and application, formal and informal learning. Funding has permitted hiring of two full-time leadership development program staff members and a part-time leadership development professor.

**Vision, Mission, Values and Beliefs**

The Vision, Mission, Values and Beliefs for Leaders of Tomorrow were developed through extensive discussion and debate, incorporating the perspectives of faculty, staff and students.

<u>Vision</u>
An engineering education that is a lifelong foundation for transformational leaders and outstanding citizens.

<u>Mission</u>

To design, develop, implement, and evaluate the concepts, strategies, and components of a world-class engineering leadership development program that:

- Enables students to gain knowledge, skills, and experience that increase their ability and motivation to effect positive change and benefit society;
- Provides students with opportunities to develop their leadership ability by observing, experiencing and reflecting on the leadership process within their groups and communities;
- Provides extra-curricular, co-curricular and curricular components for students throughout their undergraduate and graduate experience;
- Engages faculty, staff, and alumni

so that it promotes development of exemplary local, national and global citizenship and provides a foundation that will inspire and guide students throughout their lifetimes.

Values

Leaders of Tomorrow will be built on a foundation of values, drawn from the Faculty, the University, and the engineering profession, specifically:

- Citizenship, service to society, and public stewardship
- Personal and professional integrity
- Social responsibility and responsible use of technology
- Productivity and added value
- Creation of infrastructure and organized processes
- Creativity, innovation, and design
- Pursuit of excellence
- Recognition of the benefits of diverse views and backgrounds
- Education, continuous learning and intellectual pursuit
- Creation, transmission and preservation of knowledge

Beliefs

- Leadership can be learned; therefore it can be taught.
- Engineers with significant leadership ability contribute more value than those without.
- Global and local issues are increasing the need for engineers to realize their full potential to contribute to society.
- Engineers already make enormous contributions to society but are often not appropriately positioned or equipped to achieve their full potential.
- The engineering thought process involves moving from identifying general needs to producing specific outcomes (analysis, problem definition, design, realization, and iterative optimization). This thought process is a natural fit with leadership.
- Current engineering education places inadequate emphasis on the development of the whole individual and human interactions, which should be integrated into an engineering education.

- Many competencies currently emphasized in engineering education, such as communication, teamwork, and social impact, are aligned with leadership competencies.
- Increased leadership ability will broaden the perspective of engineers, making them more receptive to diverse views and more sensitive to the relevance of matters outside the engineering discipline.
- Engineering students need to appreciate that enhanced leadership ability will increase their value to their organizations, communities, and society.
- Some engineering students enhance their leadership ability through self-study, volunteering, and participation in extracurricular activities.
- Students who are more engaged will have a better university experience; students who feel they are part of a community will be more engaged. Hence there is a need to help students learn how to build communities.

Further, we believe that a leadership development component in the student experience will be an important distinguishing feature at the University of Toronto that will attract students with an interest in leadership and thereby reshape and strengthen the candidate pool.

**The Leaders of Tomorrow Summer Program**

The Leaders of Tomorrow summer program began in 2002. The program was initiated to enrich the experience of undergraduate students conducting summer research projects in the Department of Chemical Engineering and Applied Chemistry. The program provided sessions on current research in the Department, industrial tours and leadership development training. Since the summer of 2002 more than two hundred students have enrolled in the program. Sessions are held on Friday afternoons from May to late August. Students who wish to participate, must get approval for release time from their supervisors. Students who attend 80% of the program receive a non-credit, Leaders of Tomorrow Summer Program Certificate.

The team of program organizers has changed over time and now includes the Department Chair, the Faculty lead, Department staff, and staff members from the Faculty's Leadership Office. As student feedback has been incorporated into the planning, and our ability to deliver programming has grown, the program has evolved to intensify leadership development. In the summer of 2007, the leadership development part of the program had three segments: 1) 'Personal Development' - emphasizing the importance of self-awareness to effective leadership; 2)'Group Leadership' - the skills that are needed to contribute to, and lead, teams; and 3) 'Leadership in Society,' promoting the notion of engineers as active citizens and change agents in the world. As well as seminars, speakers and workshops, students participated in design/research project teams and went on tours of industry facilities.

<u>The Leaders of Tomorrow Summer Schedule, 2007</u>
Segment 1 – Personal Development
- Myers-Briggs Type Indicators- External Instructor

- How to Build a Strong and Successful team Atmosphere- Leadership Office Staff
- Tour #1
- An Introduction to Leadership- Leadership Professor

Segment 2 – Group Leadership

- Leadership Styles and Myers-Briggs- External Instructor
- Transforming Conflict: Skills for Resolving Conflict While Strengthening Relationships- Leadership Office Staff
- Tour #2
- Part 1: Team Tune –Up (Reflections on Group Project Teams)- Leadership Office Staff
  Part 2: Debate #1

Segment 3 – Leadership in Society

- Engineering and Public Policy- Internal Instructor
- Tour #3
- Ethics and Leadership- Student Affairs Office Staff
- Debate #2
- Team Reflection- Leadership Office Staff
- Networking lunch with Alumni and Final Team Presentations

The 'Personal Development' segment of the program included a number of workshops where students were given opportunities to reflect more on themselves and on their particular leadership styles and strengths. Students completed the Myers-Briggs questionnaire and an instructor was hired to give in-depth discussion on personality types according to Myers-Briggs Type Indicators. Students learned about the characteristics of their own and others' types. By starting the program with this workshop, students and organizers shared a common language that could be used throughout the summer when exploring team dynamics and differing leadership strengths. Following the Myers-Briggs session was a workshop on team dynamics. Students learned about the stages that teams usually go through. Students discussed group values such as inclusivity, accountability, and transparency and how groups express these values in their behavior. Finally there was a session given by the Leadership Professor on leadership styles, ethical leadership and the attributes of successful leaders.

The second segment focused on skills for working and leading in groups. The Myers-Briggs instructor held another session and Myers-Briggs personality theory was revisited in the context of leadership. Students learned about the leadership styles that corresponded to their personality preferences, and were encouraged to consider the potential blind-spots of their types or potential challenges when leading individuals of different types. The next workshop focused on conflict resolution. This workshop was very experiential and focused on two skills; active listening and how to raise a concern. Students were encouraged to practice these skills in their project teams. The next workshop involved a team challenge where groups were asked to complete a project in a short time and then reflect on their group process. Discussion focused on the difference between task-oriented and process-oriented roles of members of the group. We hoped to

instill in students an appreciation of the need for both, in order to have an effective and satisfying group process. The "Leading in Groups" segment ended with a debate experience. Students were taught a debate format and engaged in a debate on whether the internet diminishes personal communication skills. This experience offered an opportunity for students, in teams, to assemble an argument in a brief time, engage in a healthy intellectual debate regarding the impact of technology on individuals and society, and practice public speaking skills.

The final segment focused on ‘Leadership in Society’. It began with a talk on ‘Engineers and Public Policy’ addressing the leadership role that engineers play in the issues of the day, particularly concerning policy formulation where technology was at the heart of the matter. A session on ethics and leadership challenged students to think about the ethics of their everyday decisions and gave students a framework to use when faced with an ethical dilemma. There was a second debate on the question: "Who is responsible for the current state of science journalism - journalists or scientists?" In the final workshop students were asked to reflect on their progress in understanding themselves and understanding others. Students were guided through a process that focused on their group project experience and drew out the meaningful skills and knowledge that they acquired over the course of the summer.
Another component of the summer program is project work in small groups. Groups are given a design challenge or a research challenge. In 2007, group projects included: green roof design, designing green chemistry labs, designing a compost system for an apartment building, developing a website for recruiting future chemical engineering students, designing an energy efficient home insulation plan, designing a bio-engineering facility, harnessing bio-methane, and organizing student tours. In 2007 the tours visited a municipal waste incinerator, a refinery and a steel mill. The rationale for the projects was to allow students to apply their newly acquired knowledge, self-awareness, and team skills.

As a capstone to the summer program, students presented their group project work to invited alumni and industry leaders. This was a formal event, where students presented and were asked questions about their research and design work. Alumni voted on presentations and the winning presenters were invited to present at the Department Board of Advisors meeting. The opportunity to present to distinguished alumni added an element of excitement and significance to the group projects.

**Pre- and Post-program Survey Results**

Pre-program and post-program surveys were designed and administered to gather feedback from students and to measure new learning. Students in the 2007 summer program were surveyed before and after the program. There were 43 responses to the pre-survey and 31 to the post survey. All were undergraduate engineering students, who had completed one, two or three years of a four-year program. Just over 50% of the participants in the pre-and post-program groups were women; approximately the same as the general undergraduate student body in Chemical Engineering.

Students were asked:

1. "On a scale of 1-5, how strongly do you value Personality Theory in your group interactions?" in the pre-program survey and "To what extent has your appreciation of Personality Theory, and its impact on group interaction, advanced as a result of completing the summer program?" in the post-program survey.
(1=very little, 3=somewhat, 5=very much)

The average response to the pre-program question was 2.9 whereas the post-program average response was 3.7 indicating a significant increase in appreciation over the summer.

2. "Rate your capacity/skill level for each of the following skills:" in the pre-survey and "Please rate how your capacity/skill level for each of the following skills has changed as a result of the LOT summer program" in the post-survey. The shift in the question complicates interpretation when comparing before and after but does provide useful assessment of the program impact.
(1=don't have strong capacity, 3=have some capacity, 5=feel very capable)

| | AVERAGE RESPONSE | |
|---|---|---|
| | Pre-program | Post-program |
| Listening | 3.5 | 4.1 |
| Conflict resolution | 2.8 | 3.8 |
| Being ethical | 3.6 | 3.9 |
| Acknowledging the contribution of others | 3.5 | 4.3 |
| Consensus-building in decisions | 3.3 | 3.9 |
| Delegating tasks | 3.2 | 4.0 |
| Self-awareness | 3.3 | 4.3 |
| Interpersonal skills | 2.9 | 3.8 |
| Clearly articulating your views | 3.1 | 3.8 |
| Critical thinking | 3.4 | 3.9 |

None of the pre-program skills was rated above 3.6 indicating only modest self-assessed skill level. All of the responses to the post-program question were above 3.8 with four skills rated above 4.0 indicating significant improvement in the students' perception of their own overall skill set.

The lowest rated pre-program skills were Conflict Resolution and Interpersonal Skills. Students indicated significant improvement in these skills over the summer. They also indicated significant improvement in Self-awareness. All other skills increased in rating over the summer.

3. "Please rate the importance of the following leadership values:"
(1=not very important, 3=somewhat important, 5=very important)

| | AVERAGE RESPONSE | |
|---|---|---|
| | Pre-program | Post-program |
| Empowerment | 3.5 | 3.9 |
| Inclusivity | 3.7 | 4.1 |
| Participation | 4.4 | 4.6 |
| Empathy | 3.8 | 3.7 |
| Integrity | 4.5 | 4.8 |

The results did not change much from pre- to post-program. It is interesting to note that Integrity and Participation were ranked most highly and Empathy and Empowerment ranked lowest.

4. "Please rate from 1-5 the following statements"
(1=not responsible, 3=feel somewhat responsible, 5=strong responsibility)

| | AVERAGE RESPONSE | |
|---|---|---|
| | Pre-program | Post-program |
| As an engineer I have a responsibility to: | | |
| a) Be technologically innovative | 4.0 | 4.1 |
| b) Contribute to the development of public policy | 4.1 | 4.5 |
| c) Communicate the impact of advances in science and engineering to the general public | 4.3 | 4.5 |

It is interesting to note how solidly the students see their responsibility to contribute to public policy and communication of science and engineering to the general public.

## Concluding Remarks

Leaders of Tomorrow offers an enriched experience for engineering students at the University of Toronto and, although it is early in its development, we have made significant progress. Our aspirations are guided by our Vision: An engineering education that is a lifelong foundation for transformational leaders and outstanding citizens.

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**Biographies**

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Dave Colcleugh, retired in 2003, as Chairman, President and CEO of DuPont Canada Inc. after a distinguished career serving the company in Canada, USA and Asia. He was named the first Leadership Development Professor in engineering at the University of Toronto in 2006. He holds a BASc, an MASc and a PhD (Toronto).

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Veena Kumar is the Leadership Development Officer for Leaders of Tomorrow. She studied engineering at Queen's University, where she participated in leadership development activities through community service, international exchange, professional experience, residence life and clubs. She holds a BASc? (Queens).

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Emma Master is an Assistant Professor of Chemical Engineering and Applied Chemistry at the University of Toronto. Her research applies microbial catalysts for the production of renewable bioproducts. She is the Faculty Lead of the Department's Leaders of Tomorrow Program. She holds a BSc (McGill) and a PhD (UBC).

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