iLead UT Signature CMYK P655 PC 2010.tif

**Research Projects on Engineering Leadership**

Since 2011 ILead has been conducting research on engineering leadership in university and the workplace. The purpose of ILead research is to facilitate the production of knowledge in the field of engineering leadership and to inform the development of curricular and co-curricular activities for engineering students and professionals.

**Engineering Leadership Project I**

The first Engineering Leadership Project (ELP I) drew on qualitative and quantitative data gathered across four companies to explore how engineers think and talk about leadership in the workplace. The study revealed three distinct orientations to leadership in engineering: technical mastery (insightful problem-solving, analytical and detail-oriented skills), collaborative optimization (exceptional team skills balancing quality work with efficiency and engagement), and organizational innovation (visionary and entrepreneurial thinking). The study also found that while engineers demonstrate skills and traits relating closely to the competencies outlined by the Canadian Engineering Accreditation Board, they tend to struggle with self-awareness, conflict resolution, ethics, and equity issues. Lastly, the study provided the first evidence-based model of engineering leadership that was tested with a self-developed engineering leadership survey. The study was funded by the the Faculty of Applied Science and Engineering Dean’s Strategic Fund and by a consortium of companies (Hatch, Vale, ERCO Worldwide, and Google Canada).

*Selected ELP I Publications and Presentations:*

Rottmann, C., Sacks, R., & Reeve, D. (2015). Engineering leadership: Grounding leadership theory in engineers' professional identities. *Leadership*, *11*(3), 351-373.

Rottmann, C., Sacks, R., Simpson, A., & Reeve, D. (2015). *Gendering engineering leadership: Aspirations vs. shoulder tapping.* American Society of Engineering Education Annual Conference and Exposition, Seattle, WA.

Reeve, D., Rottmann, C., & Sacks, R. (2015). *The ebb and flow of engineering leadership orientations.* American Society of Engineering Education Annual Conference and Exposition, Seattle, WA.

Rottmann, C., Reeve, D., Sacks, R., & Klassen, M. (In print). An inter-subjective analysis of engineering leadership across organizational locations: Implications for higher education. *Canadian Journal of Higher Education.*

**Engineering Leadership Project II**

The second Engineering Leadership Project (ELP II), which consists of four phases, investigates how engineers learn to lead in university and the workplace. *Phase One* explored how co-curricular and extra-curricular activities facilitate the development of leadership and engineering skills and identities among students during their undergraduate studies. The results of the large-scale survey suggest that work, design competitions, and professional development activities are most effective at helping students build their engineering skills. In contrast, leadership programming, student government, and industry placement are most effective at helping them develop their leadership skills. *Phase Two*, on which we are currently working, focuses on the university-to-work transition of engineering graduates. We are studying the ways in which engineering graduates navigate the job market and adjust to the workplace and the opportunities for leadership development that are available to them at this stage of their careers. *Phases Three* and *Four* will examine, respectively, the transitions of engineers from technical to formal leadership and the career trajectories of senior engineering leaders. This multi-phase study is funded by the Faculty of Applied Science and Engineering Dean’s Strategic Fund and by a consortium of companies (to date: Hatch, ERCO Worldwide, Chemtrade Logistics, Independent Electricity System Operator (IESO), Toronto Hydro, and Accenture).

*Selected ELP II Publications and Presentations:*

Rottmann, C., Sacks, R., Reeve, D., & Klassen, M. (2016). *Sports, arts and concrete canoes: Engineers learning to lead outside the formal curriculum.* American Society of Engineering Education Conference and Exposition, New Orleans, LA.

Reeve, D., Evans, G., Simpson, A., Sacks, R., Oliva-Fisher, E., Rottmann, C., & Sheridan, P. (2015). Curricular and co-curricular leadership learning for engineering students. *Collected Essays on Learning and Teaching*, *8*, 1-16.

**Engineering Ethics Education Project**

ILead is currently working on the Engineering Ethics Education Project, which aims to collect information about ethical challenges faced by engineers across the career trajectory and to engage engineering students in an analysis of these challenges. The project consists of three phases. *Phase One* conducted career history interviews with professional engineers and engineering students with industry experience and generated case studies on the basis of these interviews. *Phase Two* will test these case studies by teaching a course in Engineering Ethics and Equity. As a part of Phase Two, we conducted pilot workshops at which we presented and discussed selected case studies with engineering students. Pre- and post-surveys administered during the workshops revealed that while engineering students have a wide range of views about the effectiveness of their formal ethics instruction, a significant proportion of them view ethics as an important aspect of their engineering education. *Phase Three* will provide professional development support to faculty members interested in infusing the case studies into their existing coursework. The project has been conducted with support from the Engineering Instructional Innovation Program at the Faculty of Applied Science and Engineering.

*Selected Presentations:*

Rottmann, C., Reeve, D., Sacks, R., & Klassen, M. (2015). *Engineering ethics education: More than a CEAB requirement.* Canadian Engineering Education Association Conference, Hamilton, ON.

**Integrating Explicit Team-effectiveness Instruction in Large Classes**

Over the past five years, ILead has worked to improve students’ understanding of, and ability to engage in, effective teamwork. This research project has focused on integrating intra-team self- and peer-feedback into first-year, team-based design courses to help students understand how they behave in their teams and to provide them with the scaffolding to improve their behaviour. The project consists of three phases. *Phase One*, funded by the Higher Education Quality Council of Ontario, involved analysing how inventory-based and freeform feedback affected students’ efforts to improve their behaviour in teams. It found that peer feedback needs to combine inventory-based feedback, which discusses the strengths and weaknesses of each team member, with some personally written feedback in order to show that team members care about each other’s improvement. *Phase Two* consisted of implementing our inventory in an online *Team-effectiveness Learning System*. The systemcombines students’ self- and peer-feedback with teamwork lessons and exercises. The *Team-effectiveness Learning System* has been successful in developing student and instructor awareness of, and support for, team learning. It will be used in nine courses from first through fourth year in the 2016-2017 academic year. *Phase Three*, funded through a Social Sciences and Humanities Research Council scholarship, involves following several teams through their first-year design course to determine how students leverage the behaviours in the inventory to make their teams effective or ineffective.

*Selected Publications and Presentations:*

Kinnear, P., Sheridan, P.K., Evans, G., & Reeve, D. (2016). *The role of shared physical space in affording the creation of shared conceptual spaces in design project teams*. American Society of Engineering Education Annual Conference and Exposition, New Orleans, LA.

Sheridan, P.K., Evans G., & Reeve, D. (2015). *Teaching team-effectiveness in large classes*. Toronto, Ontario, Canada: Higher Education Quality Council of Ontario (available online)

Sheridan, P.K., Malone, A., Reeve, D., & Evans G. (2015). *Seeing into your teams: An instructor interface to support team learning*. Canadian Engineering Education Association, Hamilton, ON. 2015.

Sheridan, P.K., Reeve, D. & Evans G. (2014). *Understanding teaching assistants’ assessment of individual teamwork performance*. American Society of Engineering Education Annual Conference and Exposition, Indianapolis, IN.

**Institutional Aspects of Engineering Leadership Education**

ILead conducted a study to examine the meanings of, and approaches to, leadership education in engineering across selected universities in the USA and Canada. The study was based on interviews with senior leaders of engineering leadership initiatives and on a content analysis of program websites and publicly available materials. It revealed that engineering leadership education programs and initiatives differ vastly in their goals, the content taught, and the pedagogical approaches deployed. The study developed and utilized a seven-dimensional conceptual model to analyze the goals, leadership definitions, program structures, content, and student participation in the programs studied. The model can be used to examine and evaluate engineering leadership education programs from different perspectives and should be of benefit to university administrators and faculty, curriculum designers, and accreditation agencies. The study revealed three clusters of programs and initiatives: technical integration (where leadership learning is embedded in technical engineering courses), social impact focus (engineers applying their problem solving to societal problems), and influencing core curriculum (infusing leadership learning across the undergraduate engineering curriculum). Another related study analyzed the historical growth and evolution of a single engineering leadership program using ILead as a case study. The study used the framework of institutional entrepreneurship to illuminate key strategies used by the program founders to evolve from a small co-curricular program to a full-fledged institute.

*Selected Presentations:*

Klassen, M., Reeve, D., Rottmann, C., Sacks, R., Simpson, A., & Huynh, A. (2016). *Charting the landscape of engineering leadership education in North American universities*. American Society of Engineering Education Conference and Exposition, New Orleans, LA.

Klassen, M., Reeve, D., Simpson, A., Sacks, R., & Evans, G. (2016). *Using institutional entrepreneurship to ‘reverse engineer’ a large engineering leadership institute*. Canadian Engineering Education Association Conference, Halifax, NS.

If you are interested in learning more about ILead’s research or wish to receive copies of our publications, please contact us at info.ilead@utoronto.ca or 416-978-3018.