THE LEADER-ENGINEER – CAPABILITIES, COMPETENCIES, AND ATTRIBUTES

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INTRODUCTION

There is an urgent need for engineers to participate more fully in debate and decision-making to address the many challenges, local, national and global, that society faces (1). Engineering education provides graduates with technical competence but there are relatively few engineering programs that directly address development of leadership capability. At the University of Toronto, we have been developing leadership education since 2002 and presently offer wide-ranging curricular and co-curricular programming through Engineering Leaders of Tomorrow (LOT) (2).

Leadership can be defined as “a relational and ethical process of people together attempting to accomplish positive change” (3). Adding leadership capability to an engineer creates a powerful combined capability. A leader-engineer has the capability to leverage and empower engineering competence with leadership competence.

ENGINEERING COMPETENCIES

Engineering competencies are defined with some precision by professional accreditation processes, and, more recently, in Ontario, by degree level expectations. Leadership competencies, on the other hand, have a much wider range of understanding and definition. There are similarities and differences between the competencies and behaviors of engineers and of leaders and there are characteristics we can ascribe to the “leader-engineer”.

Universities in Ontario, at the direction of the Ontario government, have undertaken to articulate “Undergraduate Degree Level Expectations” (UDLEs). In 2008, the Faculty of Applied Science and Engineering at the University of Toronto (UoT) defined the UDLEs for those receiving the UoT Bachelor of Applied Science (4). The overall learning objective as: “...an education that will allow them to be leaders in society in developing solutions to its most pressing problems.” There is a clear and explicit expectation that engineering graduates develop the capability to be “leaders in society.”

The UoT engineering UDLEs describe six categories of expectations: 1) Depth and Breadth of Knowledge; 2) Knowledge of Methodologies; 3) Application of Knowledge; 4) Communication Skills; 5) Awareness of Limits of Knowledge; and 6) Autonomy and Professional Capacity. Most of these expectations, when examined in detail, refer to engineering/technical competency. Communication skills are described as being able to “...communicate information, arguments and analysis accurately and reliably, orally and in writing, to specialist and non-specialists audiences.” “Autonomy and Professional Capacity” refer to students understanding of professional practice, working in teams, being self-directed in learning and practicing ethical behavior.

The Canadian Engineering Accreditation Board has also recently defined graduate attributes for engineers (5). Most of these attributes also refer to engineering/technical competency. Several of the attributes of the graduating engineer also describe attributes of leaders or leader-engineers, for instance: with respect to team work – “An ability to work effectively as a member and leader in teams”; with respect to communication – “... reading, writing, speaking and listening...” also “...to give and effectively respond to clear instructions”; and with respect to life-long learning – “An ability to identify and to address their own educational needs in a changing world...” There is also correspondence between engineering and leadership attributes in the areas of professionalism, impact on society, ethics, and project management.

In the United States, ABET defines the outcomes necessary for engineering programs to be accredited (6). As with Canadian accreditation there is a natural predominance of engineering/technical competencies. Broadly speaking, the required competencies of engineers that are also competencies of leaders include communications, teamwork, ethics, understanding the context of work, and life-long learning.

In summary, as stated at the outset, engineering programs seek to graduate engineers that have skills, competencies and behaviours that aid them in technical work but the leader-engineer must be capable of

connecting technical output to teams, systems and organizations. Capable leader-engineers must be technically proficient but they must also have competencies beyond the technical. Further relative to engineers, we would expect leader-engineers to have higher-level performance in communications and teamwork and a broader appreciation of ethics and context.

LEADERSHIP COMPETENCIES

Leadership learning begins with individuals coming to know themselves, their values, their strengths and weaknesses, their talents and their passions. Self-knowledge increases personal capability, which is further enhanced through the creation of a personal vision of the future, growth in emotional intelligence, and the ability to make decisions that are congruent with personal values. The second level of development involves relational leadership where students grow as collaborators and team members, learn how to communicate effectively, resolve conflict and become astute in team dynamics. This level of skill empowers students to inspire others and to build strong teams and groups. The third level of development is organizational leadership, which manifests itself in organizations of all types, including businesses, institutions, governmental and non-governmental entities. This level of leadership includes creating organizational vision, setting direction, embracing ambiguity, reconciling organizational aspirations and constraints, and empowering others. The last level of development, societal leadership, involves creating change beyond the organization. Leading in society requires understanding the issues of the day and acting as citizens and catalysts of change. Individuals who participate in political change, contribute to social movements and deeply engage other citizens demonstrate societal leadership. Programming at these four levels (Self, Relational, Organizational and Societal Leadership) will enhance engineering education and empower our graduates to make greater contributions.

Teaching leadership has special challenges. It cannot be taught by lecture alone; it requires a number of different strategies to engage students in concepts, experiment, experience and reflection. A recently completed Dean’s Task Force on Engineering Leadership Education (7) explores these questions and presents a framework for education of the leader-engineer.

The leader-engineer can be a powerful instrument for positive change, combining the capability of the engineer for problem solving, designing and building to the capability of the leader for personal growth, envisioning the future, and for motivating others.

REFERENCES

1. Reeve, Doug Engineering Leadership Review, Vol 1, No. 1, pp 1-6. May 2010 <http://lot.utoronto.ca/elr>.
2. Engineering Leaders of Tomorrow Website: <http://lot.engineering.utoronto.ca>.
3. Komives, Lucas & McMahon, *Exploring Leadership*, 2nd Ed., San Francisco: Jossey-Bass, 2007.
4. Faculty of Applied Science and Engineering, University of Toronto 2008. “Degree Level Expectations for Graduates Receiving the Degree of Bachelor of Applied Science” Revised: May 28, 2008).
5. The Canadian Engineering Accreditation Board (CEAB) Engineers Canada 2008, “Accreditation Criteria and Procedures”.
6. ABET, 2009 “CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS” Engineering Accreditation Commission, ABET, Inc. Baltimore, MD October 31, 2009.
7. Reeve, Doug, et al, Dean’s Task Force on Engineering Leadership Education, May 5, 2010, <http://www.engineering.utoronto.ca/Assets/AppSci+Digital+Assets/pdf/Memos/Leadership+Task+Force+May+11+2010.pdf>

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