TEACHING WISDOM AND OTHER SOFT SKILLS WITHIN ENGINEERING CURRICULA

Michael Piczak McMaster University B. Tech. Management Program Chair Hamilton, Ontario, Canada piczakm@mcmaster.ca

Abstract – Engineering accreditation bodies routinely examine the state of university engineering programs to ensure currency and relevance. Accreditation by the Canadian Engineering Accreditation Board (CEAB) focuses largely on the development of technical skills and competencies. While required graduate attributes acknowledge the inclusion of selected "soft skills", e.g. communications and teamwork, curricular emphasis leans decidedly in the direction of achieving technical skills implying that soft skill development is squeezed in as an afterthought rather than being afforded deliberate recognition. Indeed, rapid growth of technological development as well as including content required by regulatory agencies (e.g. health and safety), points toward even greater pressure to marginalize soft skills, which paradoxically, seasoned engineering managers look for in their hires and those considered for promotion.

In addition to basic communications and teamwork, important soft skills and competencies include: creativity, collaboration, instilment of a sense of wonder/curiosity, learning to learn, lifelong learning, reading with comprehension, thinking skills, and the infusion of wisdom to design, problem solving and decision making.

Including soft skills development presents a challenge for most engineering professors, often because their own education was focused almost exclusively on technical material. Given this situation and evolving curricular pressures, the challenge becomes identifying ways and means of introducing the teaching of wisdom to engineering students.

This paper focuses on one particular soft skill: wisdom, a concept which can be difficult even to define, let alone convey/teach. Engineering professors must think through what is meant by wisdom, structure opportunities for the consideration of wisdom in design/decision making situations and develop methods for evaluating the application of wisdom – all within existing curricular constraints. Practical suggestions are advanced to help engineering professors infuse wisdom into their lectures, tutorials and labs as a matter of accelerating the learning and maturation of their students.

Keywords: curriculum, decision making, infusion, professional skills, soft skills, wisdom

Arthur Heidebrecht McMaster University Director, Booth School of Eng. Practice Hamilton, Ontario, Canada heidebr@mcmaster.ca

1. INTRODUCTION

Engineering curricula are recognized as consistently preparing graduates for the technical aspects of their discipline through the selection of engineering science courses that constitute the bulk of such programs of study. Considerably less curriculum time and resources are devoted to contextual competencies including professional and soft skills. Those skills are increasingly being seen by industry as being an essential component of an engineer's skill-set. Considering also that upwards of 40% of graduating engineers assume employment in nonengineering related jobs [1], there may be a mismatch between what is taught and what students/employers are seeking in an engineering graduate.

This is an opportune time to revisit the technical/professional skill balance to ensure that graduates are prepared for what employers require in an increasingly complex world. Society might well be better served by providing graduates with a different mix of competencies that include listening, collaboration, decision making, thinking, teamwork and the even wisdom, much as these may be difficult to define and operationalize.

This paper examines the role of wisdom and provides suggestions for infusing wisdom into the curriculum of engineering programs to prepare graduates for the realities, subtleties and nuances of the real world. Two primary curriculum design approaches for injecting wisdom into the competency set of graduating engineers are described: embedment and competency-based.

2. ENGINEERING CURRICULA

Engineering curricula traditionally emphasize technical, quantitative and design competencies to equip graduates to assume responsible, leadership oriented positions early in their careers. Curricular content is typically mandated by accrediting bodies to ensure that society is protected from poorly prepared or uninformed practitioners that could impart harm on an unsuspecting and trusting citizenry.

A review of virtually any engineering curriculum will reveal a decided emphasis in favour of technical knowledge including mathematical methods, scientific, engineering, phenomenological theories, fundamental design concepts, use of quantitative data and procedures for achieving some specified aim whether that involves designing a product or service or solving a problem. Resultant programs of study represent the triumph of content over all other topics or concepts and curricula being increasingly stuffed with ever more content.

A number of Ontario universities have set out degree level expectations which call for a selection of competencies to be achieved by graduates beyond technical skill. Typically, these degree level expectations call for graduates to emerge with [2]:

- Depth and breadth of knowledge
- Knowledge of methodologies
- Application of knowledge
- Communication skills
- Awareness of limits of knowledge
- Autonomy and professional capacity

While standard engineering curricula, with their technical bent have served society well over the years, there are increasing calls suggesting that contemporary engineering work is evolving and demands a more sophisticated command and understanding of the interplay between the natural and the contextual, human influenced world [3].

Engineering schools produce graduates that are considered to be technically competent. The issue becomes whether engineering schools can provide graduates with more value added by introducing professional skills, including wisdom, to complement their technical skills enabling graduates to be even more effective for the good of society.

3. PROFESSIONAL SKILLS AND WISDOM DEFINED

Engineering principles and theory will inform to a point, at which time humans must make choices that carry the engineering forward into the real world. Such choices are flavoured by knowledge, stakeholder needs, long term considerations, beliefs, values, experience, ethics and wisdom, among other things.

Soft or professional skills can provide guidance as to 'what is the right thing to do' in a given situation. Wisdom and experience are needed to inform technical options that have been developed using sound engineering principles so that decisions can be made drawing on factors well beyond technical engineering considerations.

Wisdom, as a concept, can be described in any number of different ways including [4]:

- Knowing how to improvise, balance conflicting aims and interpreting rules and principles in light of the particularities of each context
- The exercise of perception, knowing how to read a social context and moving beyond the black-and-white to see the gray of a situation
- Taking on the perspective of another to see a situation as the other person does and to understand how the other person feels

- Knowing how to make emotion an ally of reason relying upon emotion to inform judgment without distorting it
- A wise person is an experienced person
- An acknowledgement that the world is gray demanding a consideration of similarities, differences, subtleties, nuance, weighing and perspective

Proceeding from the above descriptions, the question becomes: How can students be exposed to and inculcated with academic experiences that will permit them to hasten the acquisition of the wisdom competency?

4. WHY WISDOM IS NOT TAUGHT

If, within the engineering community, there is acceptance that wisdom, and related professional skills (e.g. creativity, innovation and leadership) are admirable and important attributes/proficiencies, the challenge to be addressed relates to finding the time and resources necessary to instill students with these qualities. There are some identifiable reasons as to why wisdom and related professional skills are normally not given much prominence in the development of engineering curricula. Some of those reasons and the authors' counter-arguments are:

- Cannot risk accreditation not valid; accreditation does not prescribe the context in which engineering attributes are developed
- Institutional factors in the form of curricular pressures to the contrary, increasingly universities are in fact recognizing non-cognitive dimensions of learning in their degree level expectations
- No time to 'digress' from technical content often this is just an excuse for an instructor to sidestep dealing with the more intangible dimensions of learning
- Large class sizes instructors have found ways to deal with this issue for courses in which the focus is primarily technical
- Professional practice and ethics course will catch it developing professional skills should not be compartmentalized into a corner of the curriculum
- Passage of time will take care of it this is akin to hoping that a problem will go away if not dealt with
- "It's not my job" the engineering profession expects graduates to be equipped with the foundations of professional skills to enable further development during an engineer's career
- Assumption that good analysis will adequately inform number crunching will not necessarily reveal the obvious or 'right' answer
- Cannot test professional skills non-technical competencies can be tested

CEEA15; Paper 70 McMaster University; May 31 – June 3, 2015 • Don't know how to teach it – the statement itself portrays a misunderstanding of the nature of professional skills; largely, they are gained or learned through mentorship and example rather than through direct instruction

The list above demonstrates that the reasons or excuses for engineering curricula de-emphasizing professional skills are largely invalid. In particular, the responses also lead to some suggestions as to how wisdom might be included, which are presented and discussed later in the paper.

5. WISDOMS WORTH TEACHING

Every profession and human endeavour has evolved truisms and wisdoms that are often passed down orally with engineering being no different. Timeless and universal engineering wisdoms might include:

- Every design represents a compromise
- Keep it simple
- Less is more
- Form follows function or vice versa
- Plan for the worst, hope for the best
- Build in redundant systems
- Always leave options, Plan B
- Work with nature, not against it
- Least cost alternative is not always best
- What happens if we do nothing?

It is likely that some of the basic truths embedded in the homilies are considered and mentioned in class or lab settings by professors attempting to punctuate lessons/take-aways in a short, memorable phrase. It may also be that such wisdoms are rarely mentioned with the assumption that graduates will somehow acquire such knowledge when connections and realizations are made during the progress of their careers. Instead of hoping and assuming that time and experience will present engineers with wisdoms, it is possible to include them in a curriculum to accelerate the process of acquiring wisdom.

6. TOWARDS A WISDOM MODEL

This section describes a number of approaches for developing wisdom, the combination of which will be referred to as a "wisdom model". They are intended to provide a set of options which engineering departments and faculty members may choose to use within courses and their relationships to their students. Possible curricular options are described in the next section.

Before describing these approaches, it is important to highlight the key dimensions of wisdom which can be acquired by engineering students, based on the different definitions which were given earlier in the paper:

- Balancing conflicting constraints or rules
- Recognizing that judgement is required and that decision-making is not based only or primarily on analysis
- Knowing the importance of the social dimension or context of a problem
- Acknowledging that stakeholder perspectives, which may be gained from a different process, can be as valid as those gained from a technical analysis
- Realizing the role of uncertainties
- Accepting that both emotion and reason play roles in decision-making

The above dimensions are distinctive in that they are all "non-content", i.e. they don't lend themselves to being identified as items in a course outline or syllabus. For example, while there are technical ways of describing and analyzing uncertainties, that dimension in the wisdompicture is more concerned with their role when it is not easy or even feasible to do such an analysis. It has been suggested that engineers resort to their own personal and evolved heuristic to deal with a given situation [5].

Given the nature of the wisdom dimensions, our suggested approaches have largely to do with the "how" of teaching rather than with the "what": Professors might reconsider augmenting their content with ways of appealing to that which will amount to injecting wisdom into a lab, assignment or project.

Figure 1 implies that the engineer must be both smart and wise. It is contended that the engineer must be smart first and that intelligence must be flavoured and imbued with wisdom such that the knowledge-equipped and wisdom-infused engineer is able to adapt to unique and emerging situations drawing on their knowledge, personal heuristics and accumulated wisdom.

UNCERTAIN SITUATION



Given that there is some broad acceptance as to the value of injecting wisdom into the curriculum, the issue becomes identification of a 'natural home' for this concept aside, perhaps, from the professional practice and ethics examination. Table 1 presents strategies in relation to places within a curriculum where wisdom can be introduced.

	CURRICULUM OPPORTUNITY				
WISDOM STRATEGY	Design Courses	Lab	Projects	Summative Ass'ts.	
Early Stakeholder Involvement	~		~	~	
1 on 1/Mentoring	✓	✓	✓	✓	
Real Client/World Exposure	~		~	~	
'War Stories'	✓	✓	√	✓	
Common Sense	✓	✓	✓	✓	
Experience	✓	✓	√	✓	
Intuition	✓			~	
Personal Heuristic			~	~	
Emotion			√	✓	
Open Ended Problems	~		~	~	
Case Studies	✓		√	~	
Roads Not Taken	✓		√	\checkmark	
Capstone Projects				~	

Table 1: Wisdom	Building	Strategies
-----------------	----------	------------

The table illustrates a number of wisdom injecting and building opportunities across the typical engineering curriculum. Professors should consider employing selected strategies as a reflection of what would/could work in their course given the learning outcome in question. Professors should review what they teach and how they teach with particular emphasis on curricular places where wisdom could be introduced including design courses, assignments, labs, projects and summative projects. Where possible, wisdoms could be built into these tasks accelerating the process of wisdom acquisition. The following selection of strategies would be illustrative of the wisdom infusing interventions educators could consider:

Early Stakeholder Involvement: make clear the multiplicity and competing interests of all parties to the engineering problem/situation

1 on 1 Mentoring: professor makes self available for individual or small group/coaching individualizing the learning experience based on student needs, interests, aptitudes and aspirations

Real Clients: locating real world problems and permitting students to deal with situations

'War Stories': such anecdotes can be taken from personal experience, online video, educational programming, guest speakers

Common Sense: providing illustrations where the application of common sense prevails over 'smart' engineering

CEEA15; Paper 70 McMaster University; May 31 – June 3, 2015 **Personal Experience:** students possess considerable life, co-op, previous engineering experience that can be called upon as they evolve their personal heuristic

Emotion/Empathy: acknowledge that factors beyond reason and quantification play a role in engineering and decision making; placing one's self into another circumstance without becoming emotionally involved

Open Ended Problems: challenging students with unstructured problems

Case Studies: situations based on real circumstances presented as illustrative of circumstances likely to occur repeatedly should we not learn from history or the past **'Roads Not Taken':** having students articulate and defend why particular options were NOT considered or chosen **Capstone Projects:** summative, all inclusive undertakings which integrate learnings from across the curriculum where theory is blended with practical engineering

The addition of a single 'wisdom moment' across every engineering course in a given curriculum could introduce upwards of thirty to forty wisdom opportunities.

7. CURRICULAR OPTIONS

1. Embedment model: This approach can also be described as "bottoms-up". Instructors, based on their understanding, experience and commitment, proactively provide wisdom development opportunities in labs, courses, assignments, and projects. The role of the institution is to provide mentoring and development advice for faculty members to enable them to develop and use those opportunities. This approach relies heavily on the personal commitment of instructors, supported, but not formally mandated, by the institution.

2. Competency based model: This approach would recognize wisdom as one of the graduate attributes to be achieved in parallel with other attributes. Programs would be expected to develop and incorporate wisdom-oriented competencies in a manner which is analogous to what is being done for accreditation, i.e. ensuring that these competencies are being achieved in courses (and other learning experiences) throughout the curriculum. The main question about this model is whether wisdom-oriented competencies can be mandated, since they rely heavily on the personal commitment of instructors. Additionally, it can be anticipated that the addition of a single course in professional skills would imply the removal of a technical course.

8. CONCLUSIONS

Typically, the approach taken within most disciplines, engineering included, is to teach students in black and white, i.e. that problem solutions are either right or wrong. Students emerge from institutions of higher learning that this is how the world operates. However, when they graduate, they practice in world painted in gray, i.e. there are few rights and wrongs and quite subtle changes of "shading" between various possible solutions to a problem. Wisdom is definitely needed to practice in this world and preparing our graduates to develop and be informed by wisdom is important.

Such preparation can definitely be done, but it needs will, desire, commitment to include wisdom-development opportunities in the curriculum. Such commitment must derive from both faculty members and administrators. Stronger acknowledgement and acceptance from accrediting bodies would ease the introduction of professional skills into engineering curricula.

It is recognized that universities operate in a world of constraints: time, resources, accrediting body requirements, needs of society, skill limitations. Within that, ways and means of preparing engineering graduates for challenges that call for more than a knowledge of theory, formulas and concepts must be found. Professional skills must be conveyed along the journey to engineering status.

9. RECOMMENDATION

This paper has described two "models" (embedment and competency-based) which in fact represent ends of a continuum. An effective approach is likely to be somewhere in the middle of that continuum, i.e. having some combination of grass-roots commitment from instructors as well as a more formal commitment within the curricular or programmatic framework established by the institution. The key recommendation is that the matter of developing wisdom-oriented competencies (and other professional development skills) be taken seriously as an important commitment to the education of engineers. With that commitment, it will be feasible to develop an approach which is appropriate and workable within a particular institutional environment.

Acknowledgement

The authors wish to recognize Kevin Dunn for challenging our engineering faculty as to importance of teaching wisdom as a professional skill at a recent McMaster University Faculty of Engineering retreat.

References

- Benderly, B., Checkered Careers, ASEE Prism.org, January 2015
- [2] McMaster University Degree Level Expectations, http://cll.mcmaster.ca/COU/degree/undergraduate.html
- [3] Sheppard S., Macatangay, K., Colby, A., Sullivan, W., Educating Engineers – Designing for the Future of the Field, 2009.
- [4] Schwartz, B., Sharpe, K., Practical Wisdom, The Right Way to do the Right Thing, 2010.
- [5] Mar, A., 87 Soft Skills, The Big List, Simplicable, May 2013, <u>http://training.simplicable.com/training/new/87-soft-skills</u>