ADVANCED COMPETENCIES TRAINING FOR ENGINEERS

SERIES 1: BACKGROUND WORKSHOPS

Workshop 1.1: Understanding Evolving knowledge and skills "Gaps" in Engineering

The Engineering Profession in the 21st Century

At present there is one certainty about engineering – that in the coming years engineering will continually evolve and change because everything else will also change. The rapid growth of technology will result in rapid product obsolescence. This means that the need for engineers to perform narrowly defined the tasks that occupied most of them over much of the last hundred years will rapidly decrease. Driven by growth of nontraditional job markets for engineers, those who choose not to adapt and change to shifting markets and new technologies will not survive.

How Engineering is Changing

According to Armando Rugarcia et al [1] seven features of the coming century that pose challenges to future engineers include:

1. Rapid changes of a magnitude that not long ago would have taken years now occur on a time scale of months
2. Increasing globalized markets in which industries cannot compete to survive in the domestic market only so that cultural and economic understanding is as important as technological expertise.
3. Increasing focus on sustainability a cross-cutting issue, to combat threats to quality of life resulting from unrestrained environmental degradations and the depletion of nonrenewable resources and the corresponding need for engineers to incorporate sustainability principles into their work.
4. Increasingly multidisciplinary nature of their work, as engineers find themselves having to work in cooperation with previously separate disciplines to attack problems that have no recognizable disciplinary boundaries.
5. Emerging need for social responsibility as technology takes on more value in our society and our way of life so that engineers have to take on expanded roles to ensure that threats to public health and life are mitigated.

[1] Armando Rugarcia, Iberoamericana University–Puebla (Mexico), Richard M. Felder, North Carolina State University, Donald R. Woods, McMaster University, James E. Stice, University of Texas–Austin (2006) The Future Of Engineering Education I. A Vision for A New Century *Chem. Engr. Education*, *34*(1), 16–25 (2000).

6. Increasingly participatory nature of companies in different societies as they restructure to engage individuals in the decision-making process through quality circles and small group planning and troubleshooting sessions with joint participation by management, technical, and operational staff eliminating middle management so that much of the decision-making power is transferred downward to a broader spectrum of the corporate body
7. Proliferating information as exemplified by the fact that in 1989, 10,000 volumes were required just to list the titles of all the books that had been published in engineering and roughly 6,000 scientific articles were published every day.[2] In 2000 the number of documents available had since tripled. Moreover, the flood of information is available at the engineer's fingertips through the internet, virtual environments, and storage discs that can each hold up to one million pages of text.

Synchronizing Change and Skills Development

Given the rapidity and magnitude of changes means that the ways in which engineers learn, apply and gather knowledge will also need to change. Curricula that attempts only to remain current with industrial practice while courses in the "new technology" are being provided on a continual basis will not be effective in this change driven environment. By the time the need is identified, the courses developed, and the students trained, the new technology will already have started to become outdated at the current level of change. The education that will succeed in the future will have to be one that is modeled change management as an integral part of learning.

Measuring trends in the engineering labour market can often be a delayed and tedious process. Currently, labour market data is only available after gathering statistical information within a specific time frame. The ability to capture the changes on the ground as they happen can greatly enhance the engagement of engineers in continual learning and knowledge update geared to change management. Advanced competencies training workshops offered through this platform are based on this principle. Through our growing global community of engineers drawn from all engineering disciplines and over 110 countries around the world we capture competencies that exist in this group in real-time and compare these in real-time with engineering jobs that are being posted at a particular time. The results from this comparison establishes the 'gaps' between the employee market and employer demands creating an end –to-end curricula development and training process that is employer driven and employment focussed.

How are Engineering Skills Categorized?

Traditionally specific attributes of engineers have been categorized in terms of narrowly defined functions, education and specific engineering disciplines and/or sub-disciplines

[2] E. Meneses (1989) "El Sistema UIA en el Umbral del Siglo XXI," *Umbral XXI*(1), 2-9 (Oct. 1989).

With engineering now focusing on change management, innovation, communications and technology the profession is evolving globally so that certain aspects of engineering talent are becoming a commodity. Engineers of the future, in addition to practicing narrowly defined engineering tasks, such as research, interpreting, investigating, designing, analysing, evaluating, implementing, and problem solving, will constantly need to gather new information and decide on a course of action, including what tools are needed for a given task. [3]. The technical skills, the people skills, and the innovation required of engineers of the future means that they will need to:

1. Understand the engineering basics to the degree that they can quickly assess what needs to be done, can acquire the technology and tools needed, and can use these proficiently.
2. Have the communication skills, team skills, and understanding of global and current issues necessary to work effectively with people from other disciplines , professions and cultures
3. Be able to find information about anything quickly and know how to evaluate and transform this into working knowledge.
4. Have the capacity and managerial skills to identify needs, come up with new solutions, and see them through.

The following categories of traditional and emerging skill-sets, education and competencies have been identified and analyzed through this research:

1. Field of experience by engineering discipline, sub-discipline and/or field of specialization
2. Education (by length of full-time education, degree, discipline/sub-discipline , country and university from which degree was awarded)
3. Technical competencies in terms of engineering functions performed and tasks carried out
4. Computing abilities in terms of essential computing, collaborative computing and engineering knowledge-based software packages.
5. Communications, levels of responsibility, teamwork and leadership abilities
6. Language competencies based on languages spoken, length of time over which the language was learnt, self assessment as regards speaking, listening, reading, understanding and pronunciation and certifications obtained)

Emerging Engineering Skills 'Gaps' in Ontario

In today's engineering, real-time information about emerging competency requirements is not only desirable, it is crucial. Through a real-time analysis of job data against competencies of engineering workers a more efficient and helpful data analysis of the Ontario engineering labour market is obtained by immediately interpreting data from jobs listed in our database.

[3] Diran Apelian (2007) The Engineering Profession in the 21st Century –educational needs and societal challenges facing the profession

In this lesson we are presenting data obtained from a significant sample of nearly 400 jobs listed from March – September of 2009. As newer jobs are added to this list information is automatically updated in this reporting mechanism.

This real-time information is beneficial to employers, engineers, and trainers alike. With our innovative approach to engineering labour market data, employers can review current and emerging skills trends in the engineering job market when it matters most: now! Job seekers in the engineering field can access direct information that will let them know what skills are in demand and how they measure up to the industry standards. The graphs at the end of this paper give an illustration of the type of data that is generated from this technology.

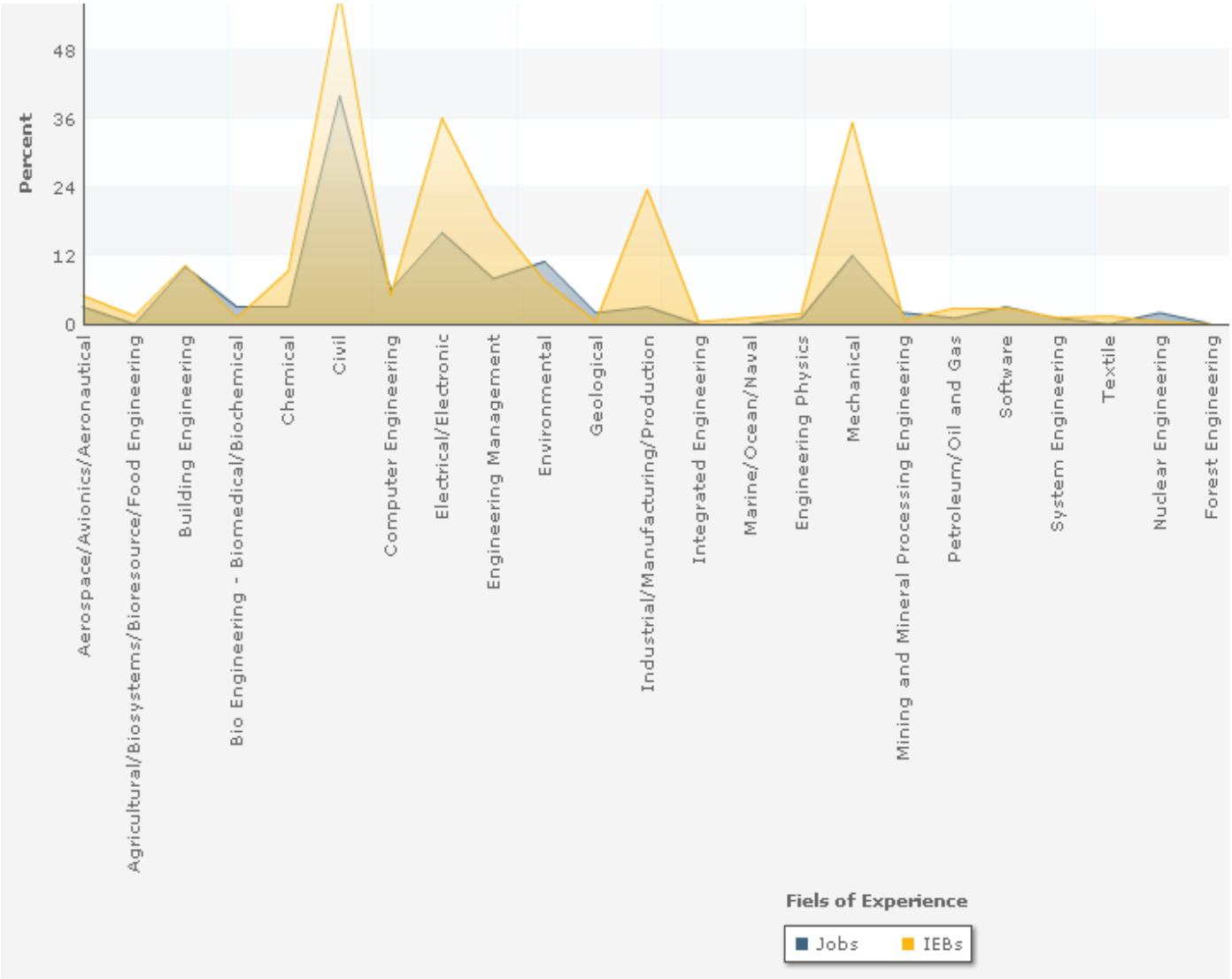
Translating identified 'Gaps' into Professional Development

The discipline specific gap analysis clearly indicates that the major fields of engineering in demand in Ontario include structural, transportation, environmental and civil engineering. When this analysis is extended to investigate for instance what software skills are in demand in say structural engineering, it is clear that there are proportionately fewer numbers of engineers who are proficient users of STAADPro and Strucad*3D than the number of jobs that require this competency. When further extended to investigate the 'Gaps' in soft skills, it is clear that the proportionate demand for communication and inter-personal skills is high compared to the competencies that the engineers in the pool analyzed hold.

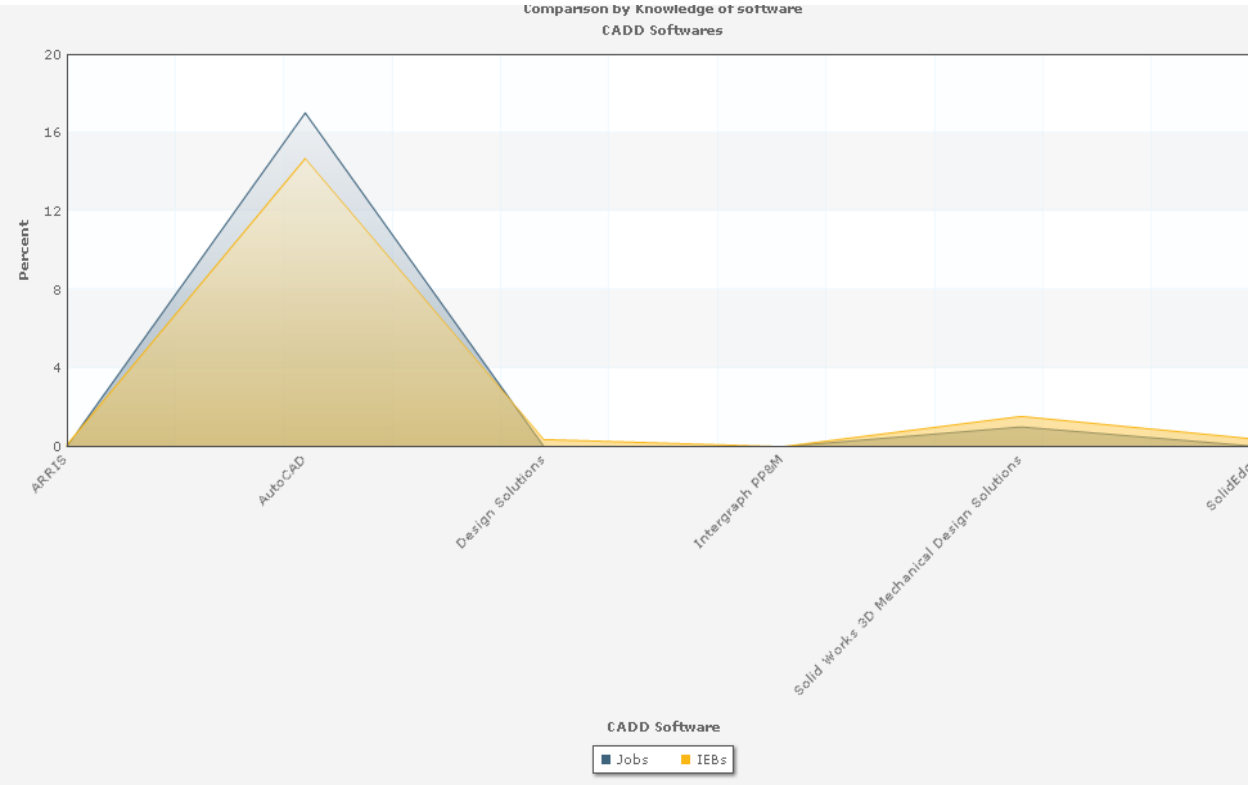
To learn more about how this information is being translated into professional development through our online learning platform try out Workshop 2.1: A free introductory workshop on Changing Nature of Communications in Engineering.

Sample Real-Time skills 'Gaps' Information

1. Sample discipline-specific gap analysis:



2. Sample software skills gap analysis:


Comparison by Knowledge of software
CADD Softwares
20
16
12
8
4
0
Percent
ARRIS
AutoCAD
Design Solutions
Intergraph PP&M
Solid Works 3D Mechanical Design Solutions
CADD Software
Jobs
IEBs