Combating Obsolence – Redefining the Ever-Evolving Engineering Profession

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Without continuous updating one becomes obsolete and unable to function in the professions. Technological advances occur rapidly and engineers who are not continuously acquiring new skills lack currency two-and-a half years upon graduation while the "technical half life" of engineering knowledge is today less then ten years. Preparation for this upgrading must occur at the universities where the engineers are taught to be current, capable to perform well and acquire contemporary problem solving skills as well as function in multidisciplinary and multilingual situations. Addition of interpersonal relationship skills and technical communication abilities must augment technical skills. Projects combining different engineering and other disciplines mandate broader educational backgrounds. In France employers are required to budget 2% for employee development while in the USA some states require periodic review of registered professional engineers. This paper deals with approaches through which currency is improved and engineers become better adaptable to global forces and trends.

Keywords: *education of engineers, professional updating, obsolescence of skills, assessment, updating, technological change*

1. INTRODUCTION

Twenty-first century engineering is at the epicenter of an explosion in new knowledge. New and revolutionary discoveries in science, engineering, medicine, mathematics and the social sciences have influenced the way in which we view and interact with the world around us and have also contributed towards erasure of borders among academic disciplines. Engineering is the catalyst that unites the disciplines and advances the progress enabled by such collaborations [2, 3]. This contemporary approach requires ability to transcend one's own background and be able to communicate with professionals from different and divergent disciplines. Fields like medicine, veterinary science, geology, atmospheric science, chemistry, biology and other life sciences move in a synergistic manner with help of engineers. Technical professionals employed in a variety of industries have to read up on what the advances in the fields are, to learn of the new approaches in dealing with the traditional problems as well as identify the new issues which arise over the time and how to deal with those [6]. It was easy to follow technical journals 300 years ago as the level of knowledge increased at a slower pace and there were very few journals in existence [8]. Once the publishing expanded, scientific journals began multiplying exponentially and doubling in numbers every 15 years. It was estimated in 1987 that in the US scientific journals then totaled about 5000.

Some current estimates are that the current world production of papers "amount to over two million technical papers a day, or a daily output that would fill seven sets of *Encyclopedia Britannica*". Current approaches involve computer abstracting and computer searches of massive national and international data bases which help the increasingly fertile explosion of knowledge. However, no single technical professional can know or locate all relevant information even in a fairly narrow field of specialization.

It was reported that engineers as professionals make much less use of the published technical literature than do scientists and other professionals because major indexing is done by subjects which lends itself nicely to be used by scientists but is not too helpful to practicing engineer who is dealing with complex design situations in changing conditions [3]. Professional engineers recommend that engineers compile their own data bases dealing with issues relevant to their own work. Experienced engineers advocate that one keep files filled with articles of relevant information. It is also recommended that engineers collaborate with vendors who have their own relevant information while carefully scrutinizing what was obtained.

Quite obviously the requirement for lifelong learning is as old as humanity. Hsun Tzu (298-238 B.C.) wrote:

"Learning continues until death and only then does it ceas. The objective of learning must never for an instant be given up. To pursue it is to be a human; to give it up is to become a beast"

Without continuing learning engineers not unlike other professionals become obsolescent. While there are

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many definitions of obsolescence this writer finds the following ones to be most precise and descriptive:

"Obsolescence is the degree to which organizational professionals lack the up-to-date knowledge and skills necessary to maintain effective performance in either their current or future work roles", Dr. Harold Kaufman [5]

and

"Obsolescence occurs when the person's requirements of a job which are demanded by its tasks, duties and responsibilities become incongruent with the stock of knowledge, skills, and abilities currently possessed by the individual; given that the knowledge, skills, and abilities were previously congruent with job demands", J. Fossum, R. Arvey, C. Paradise and N. Robins.

In the workplace one can establish presence of engineers that meat the definitions of obsolescence via the following symptoms established by Samuel Dublin:

1. *They are less and less inclined to solve engineering problems with contemporary techniques*
2. *They find it increasingly difficult and frustrating to read current technical papers because they cannot follow the mathematics or unfamiliar with the algorithms used or do not comprehend the fabricating technique*
3. *New technical concepts are confusing*
4. *New engineering assignments appear to look too difficult and/or impractical*
5. *Colleagues no longer seek their advice*

2. THE DECREASED DURABILITY OF THE INITIAL ENGINEERING EDUCATION

The broad foundation of the engineer's background is supposed to enable acquiring skills as one practices the profession. But sooner or later one must focus on problem solving skills inherent in the environment of the workplace [4]. And as the time advances some of the fundamental knowledge is forgotten and the skills become rustier and less efficient. And if the engineer has a role in management issues the technical proficiency decreases even more. Hence the need for revitalizing old skills and acquiring new ones becomes more acute and a matter of professional survival. Also, with the increased competitiveness in the job market this need is emphasized. Pursuit of this learning can take many forms: many engineers maintain their currency by taking a series of educational programs either leading to a postgraduate degree or certificate or just to advance their knowledge in a given domain. These may be courses offered by universities or any other institutions of learning. Some courses may be offered through professional societies or via long distance learning programs while some may be offered at the place of the employer and are generally specifically designed to enhance the productivity and sophistication of the employee's contribution in the workplace.

Expertise needed in the workplace involve the following [1,2]:

1. *Awareness of what other engineers are doing in the engineer's own or related fields*
2. *Knowledge of specialized technologies and techniques not covered in the original professional preparation*
3. *Knowledge of new technologies and techniques, new processes and materials which have been introduced since the original professional preparation ended*
4. *Details of new requirements imposed on the engineering profession such as health and safety, regulatory requirements, product liability laws, environmental considerations, ethical considerations*
5. *Management skills connected with the projects i.e. financial control, marketing, outsourcing, maintenance, warranties*

Studies of the professionals within larger industrial organizations indicated that career advancements of engineering professionals were accelerated if the persons possessed graduate degrees. Also, that their levels of performance were above and beyond those who only had a BS degree. It was also noted that the contributions of holders of postgraduate degrees were maintained ten years after the performance of BS holders begun to decline. That strongly suggests that a "heavy dosage of graduate courses can push obsolescence back by ten years….". Courses conducted at the employer's premises are mostly appealing to older professionals who are more comfortable in settings lacking formal examinations and grading and who feel less pressured than in competitive environments of institutions of higher learning. Personal initiatives are less needed in large metropolitan areas where a larger number of engineering professionals want to pursue growth in their fields. These are, of course, more needed in small townships and cities with one or two industrial plants. There reliance on distant learning modes seems to be the obvious way to seek out the additional educational training and upgrading of the skills.

Interaction with colleagues represents a powerful mode for expansion of knowledge. Rubbing shoulders with professionals who are truly immersed in their practice has a strong motivational influence, particularly when the on the job experience is at the cutting edge of the field. And when this is coupled with mentoring on the job, the learning is genuinely enhanced. When the management of the industrial outfit is supportive of the learning experience and provides adequate support to advance the professional skills and challenging job assignments through enabling attendance at professional meetings and conventions, short courses, industrial fairs and exhibitions this brings about an improved intellectual climate and a vigorously creative and progressive workplace.

Of special interest is the role of professional societies [1]. There are numerous professional societies seeking membership, support and involvement of engineers. The Directory of Engineering Societies and Related Organizations lists close to 300 national

organizations in the US and Canada as well as over 150 foreign and international ones as well as close to 150 state, local and regional organizations. While various efforts to organize most of these into a structure similar to the one of the American Medical Association did not materialize, the individual societies have made gigantic strides in advancing the mission and goals of the profession. This was particularly true in the case of dissemination of knowledge which most societies identified as the pre-eminent task. Most of their activities were focused on continuing education and advancement of knowledge and implementation of contemporary standards. Some divide US organizations into four major groupings which are cited for illustration purposes only. The listings are by no means comprehensive:

Engineering disciplines: American Society of Civil Engineers, American Society of Mechanical Engineers, Institute of Electrical and Electronic Engineers, Society for Advancement of Material and Process Engineering,

Occupational fields: Society of Automotive Engineers, Society of Petroleum Engineers, Society of Military Engineers, Society of Plastic Engineers, Institute of Transportation Engineers.

Fields of Technology: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Society of Manufacturing Engineers, American Welding Society

Task Oriented: Accreditation Board for Engineering and Technology, National Society of Professional Engineers, American Society for Engineering Education.

Aims Oriented: National Society of Black Engineers, Society of Women Engineers, Society of Hispanic Professional Engineers

If engineers are to be truly appreciated for what they are and for what they do for the society they must be involved in the activities of at least some of these societies. This involvement may take many forms: following the technical literature in the field, serving on committees of societies, attending regional or national or international conferences, presenting papers on topics of current interest, sponsoring educational programs and/or attending short or longer courses, exchanging professional opinions on topics of contemporary interest, serving in leadership roles within local chapters of societies. As professional responsibilities change within one's career so does one's focus of what is the domain where one needs to learn. In the initial stages of one's career engineers most likely belong to the society of their undergraduate discipline, i.e. to which they usually belonged as students. They may keep that membership for the duration of their professional lives. In later stages of their career they may join the society which is primarily focused on the industry in which they work, i.e. NSPE, ASEE, ASHRAE, AWS etc. Some enlightened employers understand the benefits that result from their engineering staff belonging to professional societies and do underwrite part or entire cost of membership in these. Sharing one's professional experiences at meetings of these societies brings up the quality of the engineering profession which is a time treasured achievement for the engineer and the employer company [7]. This is, of course, of particular importance in academia where publications represent an index of achievement and recognition in the field. Professional registration is essential for progress in some engineering disciplines and very valuable in others while of marginal importance in some.

Academic profession has a vital responsibility of sensitizing undergraduate students about the importance of professional registration and about the career benefits that this brings by enhancing awareness about it. Much more can and should be done in this regard at many institutions of higher learning. However, a more important and indeed crucial task facing the academia is instilling the awareness and responsibility for the upcoming graduates that their first degree represents *only a license for continuing learning* throughout their professional career. Students frequently leave the University with the impression that they are equipped for life of practicing engineering and that their learning is over with granting of the degree. Nothing could be further from the truth. In order to combat trends towards obsolescence Universities must engage in the following:

1. *Create undergraduate programs which prepare undergraduates to be able to make contributions to a wide variety of fields within a short time. Create preparation which allows for quick adaptation to different fields of endeavors. Avoid narrow specializations on the undergraduate level and encourage interdisciplinary endeavors among departments by using capstone design projects as a vehicle to enable students to work in multidisciplinary environments early in their careers.*
2. *Engage in parallel continuing education program which are flexible in preparing the alumni or other engineers to acquire expertise needed in the profession. These programs are usually both expensive and narrow in focus. Find ways to create these in partnership with industry drawing on the specialized background of engineers in practice. Make use of on-line available nationwide or even world-wide programs. Expand the learning horizon of the profession.*
3. *Aggressively expand partnerships with different universities, professional societies, industry and governmental agencies in creating new learning opportunities. Create coalitions for learning specific know-how.*

Even governmental entities recognize the need for continuous updating of engineering skills, i.e. in France employers are required to budget 2% for employee development and enhancement of their professional skills while some states in the US require periodic reviews of registered professional engineers. The trend clearly recognizes updating of professional skills as a worthwhile and necessary endeavor.

3. CONCLUSIONS

Professional updating is of essence if one is to survive and thrive in the very competitive contemporary workplace and avoid obsolescence. The tasks involved are too complex to be solved individually by engineers themselves. This must be a shared responsibility of individuals, employers, professional societies and governmental agencies and pro-active approaches have to be developed and improved where these exist today. Incentives must be provided for both individuals who have to invest their time and energies above and beyond their regular responsibilities and for their employers in forms of tax benefits. Indeed, engineers must pursue their professional responsibilities and obligations:

1. *Engineering professionals are to maintain technical competence through continuing education programs and by expanding their experience.*
2. *Engineering professionals should belong to and participate in, the activities of appropriate professional societies in order to broaden their knowledge and experience. Such participation should include preparing professional and technical papers for publication and presentations at technical meetings.*
3. *Engineering professionals should achieve appropriate registration and/or certification as soon as they become eligible to do so.*
4. *Engineering professionals should participate in public service activities, including civic and political activities of both technical and non-technical nature. Such activities are encouraged in order for engineers to provide appropriate leadership in endeavors that have impact on the community and society at large. Few professionals, apart from engineers, are as professionally equipped to solve the problems that the society is facing.*

The continuing need to enhance competitiveness of any industry in the global economy through maintaining a competent professional workforce at the state of the art engineering knowledge is a matter of life and death for the society and its way of life. Proactive measures to accomplish that truly become not only necessary but also mandatory if the engineering profession is to perform its mission to improve life and society as well as to meet its social responsibilities.

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