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Viewpoint: Teaching Engineering as a Second Career

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Teaching engineering as a second career refers to the movement of successful professional engineers from the 'real world' of practicing engineering to the world of education. Unless forced to do so, in normal economic conditions very few professional engineers will even consider such a move, especially if it is associated with a pay cut as is very often the case. So why would anybody accept such sacrifices by turning to the teaching of engineering in mid-career? Many reasons can motivate this drastic move, and the advantages and disadvantages of a second career in teaching engineering are presented and discussed in some detail.

INTRODUCTION

IN THE last two decades, professional engineering associations in several provinces in Canada have been calling for wider co-operation on engineering education between universities, and industry and engineering practice. A similar situation applies in the USA. Suggestions for an industrial organization to adopt a university department and to increase the direct and indirect interactions between the parties are regularly proposed. The rationale is obviously to improve the quality of engineering education. Despite these repeated calls, the gap between the two parties, if not widening, seems to be maintained, and the communication, if not shrinking, is going nowhere.

One way of dealing with the above situation is to facilitate some exchange between the parties. Hiring practitioner engineers to teach aspects of engineering would be one option to increase and improve the dialogue. Unfortunately, this proposition has not been seriously considered, and the situation in real life is completely different. The number of professional engineers who consider university teaching as a second career, and actually make the move, is very small in Canada.

The aim of this paper is to explore this phenomenon, to provide some arguments about hiring practitioner engineers, and to discuss the advantages and disadvantages of university teaching as a second career.

First, the implied requirements to become a full professor, and the qualifications for teaching are presented in some detail, since the rank of full professor is seen as a key factor for the whole process. Then, three basic arguments for hiring practitioner engineers are discussed. The first of these is the design factor, the second one is the capabilities of the students for analysis versus problem-solving, and the third factor is the engineering approach. Finally, some advice is given on what it takes if one is considering the move.

QUALIFICATIONS AND REQUIREMENTS FOR TEACHING

What skills does it take to teach engineering? In particular, this question relates to teaching courses on engineering design and practice, or to teaching design rules and regulations using the engineering method, heuristics and approaches to solving real-life problems. Two completely different and opposing views are offered: the practitioner's view and the university one.

Most practitioner engineers would assume that a doctorate in an appropriate field, and solid practical and relevant experience, would be enough to teach not only this particular field of engineering design, but also all the related subjects in the same domain, provided the candidate shows a willingness to teach. The past and practical experience of a potential candidate should provide him/her with the minimum requirements for teaching, particularly teaching the design courses. The fact that many practitioners find difficulties in explaining what they do, and particularly how they go about doing it, is a constraint.

Unfortunately, many professors and university managers do not agree that engineering practice is a valid basis for teaching. They do not recognize the different procedures, nor the comprehensive and cross-disciplinary awareness and knowledge required for engineering practice, compared to those for university activities. They consider their own work, with its fairly narrow but deep specialization, as a prestigious and essential profession in itself, and think that the only way to pursue it is to follow the conventional path. This path can be summarized as follows: a candidate starts teaching directly after receiving a doctorate, or after a post-doctoral period pursuing and improving his/her research capability. With a few publications, and after a few years as an assistant professor, the promotion to associate professor seems to be straightforward, if the candidate has demonstrated

satisfactory teaching and research effectiveness. That these teachers have received little, if any, instruction in teaching methods seems to be irrelevant.

Promotion to full professor differs from the previous promotional stages: it is more difficult and less straightforward. The candidate must, on the one hand, demonstrate an effective teaching performance and a very high achievement in his/her discipline; and, on the other hand, must have attained a reputation for research in the field. For the research aspect, a minimum number of papers published in refereed journals is an absolutely essential requirement for this promotion. The minimum number differs from one institution to another, and comparisons are made between departments in an effort to maintain academic standards and the reputation of the university. If, as stated above, there are some rules to 'evaluate' the research performance of a candidate, very few exist to 'measure' the effectiveness and performance of the teaching part: it is done in a very subjective way, helped in part by student evaluations of courses and instructors.

By examining closely most of the classified advertisements for teaching positions printed in the engineering newspapers and magazines, it is clear that the recruiting agents (universities, colleges, etc.) expect the candidates to have followed closely the above described pattern in their careers, meaning the conventional path. The actual hiring is done primarily at the assistant professor level, sometimes at the associate level, and in very exceptional circumstances at the full professor level.

That is one reason why, for an outsider, the perception is that universities are a very closed and isolated world, very hard to get into at the academic staff levels; and it is very difficult to understand how and why they operate the way they do.

A practitioner engineer who wants to teach engineering has to overcome this perception, and fight to prove to the academic community that a different experience and career path might be as valuable and effective as the conventional path, especially to become an engineering teacher even at the top level of appointment.

ARGUMENTS FOR EMPLOYING THE PRACTITIONER ENGINEER

The three basic arguments for hiring practitioner engineers are concerned with the design factor, the analysis versus problem-solving capability factor and the engineering approach.

The design factor

If the engineering curriculum of many universities is carefully examined, 'teaching design' seems to be the weak part of the program. Usually, the administrators do not like to discuss this subject. In the absence of practical industry experience of their own, they use a lot of imagination and 'creative thinking' to add a minimal 'design dimension' to many courses, in order to satisfy the stated minimum requirements for design to be accepted and approved by accreditation committees or boards. In every national or international conference, congress, seminar or workshop on education held in North America (e.g. [1,2]), there is a least one session or panel discussion dealing with the teaching of design and its importance for the engineering profession. After the conventional and usual display of new and old techniques, approaches and/or models on the art of design, the discussion ends by asking 'Who is better prepared and qualified to teach design?' The consensus reached in the majority of the cases is that the 'ideal' teacher should have a substantial practical background in industry, having preferably designed some products [3]. But the conventional career path does not supply teachers with any experience or appreciation of the role of design [4]. So, two options are available:

1. The first option is to ask practitioner engineers to act as adjunct professors in all the fields where design instruction is required. Consequently, the majority of the final-year courses may be taught by adjunct professors. It seems that the university administrators do not like this approach, and very few, if any, adjunct professors are currently teaching design in universities.
2. The second option is to hire practitioner engineers onto the academic staff, and ask them to teach design, i.e. teaching engineering as a second career. Here, the real problem is found. What type of tenure, status, rank and promotion prospects should these practitioner engineers be allowed to have?

Many of these practitioners have a very limited number of publications. These publications, if any, are mostly of technical and professional nature, not research oriented. In many cases, private corporations and companies will not even allow any corporate knowledge to be published. Moreover, if these practitioners have been heavily involved in practical design cases, as expected, they definitely did not have the opportunity or the time to follow the forefront of research in the field, neither in their domain speciality, nor in the developments of engineering design theory. Consequently, not only do they not have the 'right' type of publications to start with, but they are not sufficiently up to date on research details to be able to publish in a constructive way. If, as is now the case, the main criterion for promotion to a full professorial position is the number of publications and the reputation of being an accomplished researcher, it is going to be very difficult, if not impossible, for these practitioners to be promoted and attain the highest professorial rank, with all its financial and professional advantages and prestige.

It is very revealing to see how the academic community discusses this question and it is very interesting to hear all the suggested solutions, e.g. these practitioners should stay at the associate professor

level; how about creating a special status for them?; etc. All this means one simple fact: the academic community has a very hard time accepting an outsider who did not follow the conventional path. Consequently, overcoming the initial resistance is the main disadvantage of considering teaching engineering as a second career.

One way to avoid all the above trouble is for the practitioner engineer to be appointed directly at the level of full professor, with tenure in one of the prestigious or endowed chair positions. Theoretically, these chair positions are available to all. Unfortunately, in practice, the successful candidates are very often already full professors! On very rare occasions, the chosen candidate is a successful practitioner engineer who succeeds in convincing the administration. In two cases known to the writer, the professional engineers returned to their engineering practice after a very short time!

The design factor thus presents a very good reason for hiring practitioner engineers to teach engineering.

Analysis know-how versus problem-solving

One aspect of modern engineering education discussed heavily in all the meetings on education is the capability and know-how for analysis, versus the problem-solving and design capability of the graduate. It is summarized by the following statement [5]: 'Many engineering graduates today have no feel for engineering problems. They can analyse anything but solve nothing.' If the majority of the engineering teachers have followed the conventional career route, it is not surprising that as role models they are producing too many graduates who know a great deal about analysis and almost nothing about real industrial-level problem-solving. It is very difficult, if not impossible, for instructors to teach problem-solving techniques when they have not themselves experimented with a few, preferably under industrial constraints and pressures. Dealing with human and financial constraints, and pressures of time, to solve a real-life problem, as well as delivering an appropriate solution selected and developed from one of many alternatives, is not a range of experience that can be acquired in the university as a teacher, unless that person is seriously involved in an engineering consulting practice going beyond analytical techniques. Conversely, it is much easier for practitioners to develop a wide expertise in all analytical techniques when in a university environment. Consequently, students are much more exposed to the analysis expertise of their teachers than to their problem-solving ability.

One way to deal with this deficiency is to hire practitioner engineers who have already spent part of their life solving problems in an industrial setting.

The engineering approach

It is now well accepted by both professional engineering associations and by university administrations that an engineering graduate should go through a period—generally of two or more years—of supervised activity as a junior engineer before reaching the status of senior (or professional) engineer. The purpose of this period is to allow the junior engineer to learn, under the guidance of a senior engineer, how to tackle 'real-life' problems and to see and appreciate how a senior engineer deals with them, i.e. learning, understanding and mastering the engineering method [6], in contrast to the scientific method the student has been acquainted with at university. If the required previous practice for this advancement is well accepted by everybody, then why not expose the students, during their stay in the universities where the level of threat is relatively lower, to the engineering method of the practitioner engineers?

With practitioner engineers being hired as full-time faculty members, the students can be exposed, in a balanced way, to the viewpoints of both the engineering method and the scientific method. They will probably finish by learning 'more and better'.

FINANCIAL ASPECTS

It is very hard to compare, in a systematic and effective way, the financial compensation in industry versus academia. In general, the average pay of the mid-career newcomer to teaching is lower than the average pay of a practitioner in industry with the same number of years of experience. Moreover, the potential loss of acquired additional non-monetary benefits increases the pressure not to move to a university.

TEACHING AS A SECOND CAREER

To an outsider, a university has its own environment, which appears a closed and isolated world, very hard to get into and very hard to understand. The perception is that many, if not all, engineering professors consider their work to be a prestigious and essential profession, and that the only way to pursue it is to follow their way, which is the conventional path. They do not always give the mid-career newcomer a warm welcome.

So why would anybody take a potential pay cut and accept sacrifices by turning to engineering teaching in mid-career? The first and strongest motivation has to be that the newcomer must not only love teaching, but must also enjoy it day after day.

A second reason is control over one's own work situation. Besides the requirement for teaching and a moderate amount of administrative work, professors have almost complete autonomy over their time, work and destiny. This freedom is unique in the workplace and may have an enormous implication on a career as a professor.

A third reason is the theoretical opportunity to

perform some consulting work, which may increase personal satisfaction and remuneration.

Finally, as the author has experienced, if you are considering the move, you will be on your own. Get ready to overcome all the above obstacles. It is not easy, but it can be done.

CONCLUSION

Despite all the above logical arguments in favour of hiring practitioner engineers as professors, university communities have a hard time accepting them. Universities have not changed their traditional attitudes and still prefer to hire someone who has followed the conventional path. A mid-career newcomer as engineering professor is still considered an outsider and he/she may well not be given a warm welcome. It seems to be very hard, if not impossible, to change the conservative belief that the only way to pursue any academic career is to follow the conventional path.

These comments may sound extreme, and many engineering professors and administrators will probably claim that they are incorrect, citing the few exceptions that exist, and then dismiss the whole issue. Unfortunately, this reflects the reality, and voicing unpopular views is never welcome. The intent here is to expose the situation and hope that the academic community will deal with it, not ignore it.

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