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Material History and Engineering Students

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Résumé

Même si cela peut présenter des difficultés, il existe plusieurs excellentes raisons pour lesquelles certains historiens de la culture matérielle auraient avantage à s'adresser à des auditoires d'étudiants en génie. Cet article fait valoir ce point de vue en examinant principalement l'évolution des exigences associées aux programmes des écoles de génie accréditées au Canada ainsi que les liens et intérêts communs qui unissent certains historiens de la culture matérielle aux étudiants en génie. L'article évoque aussi la nécessité pour toute discipline de s'autocritiquer. Il s'appuie largement sur les conclusions que l'auteur a tirées de son expérience chez Northern Telecom, où il a enseigné les répercussions du génie dans la société.

Abstract

While it may not be easy, there are compelling reasons why some material historians might wish to consider trying to reach engineering student audiences. This essay advances this view primarily by looking at changing curriculum requirements for accredited Canadian engineering schools and the bonds and interests shared by some material historians and engineering students. It also deals with any discipline's need for self-examination. The essay draws heavily on the author's findings from his perspective as Northern Telecom Professor of Engineering Impact on Society.

There are many approaches to history. Even among the subset of material historians and historians of technology, some are more interested than others in having close contact with, and learning directly from, those who design, manufacture, build, operate or maintain the things and processes that figure so prominently in their studies.[1] This essay presents the view that the combined impact of the nature of material history plus certain trends and requirements in Canadian engineering education presents opportunities for material historians to reach a wider audience. Realizing this potential will require initiative, some understanding of the nature of engineering education and licensing, as well as attention to some of the impediments and aids to successful interdisciplinary teaching.

This essay reflects two of my long-standing areas of research plus my findings during three years of research as Northern Telecom Professor of Engineering Impact on Society. The first research area is understanding the nature, origins and impacts of technological change particularly in the earliest and often most confusing stages.[2] The second is the awareness and perceptions that engineers and the engineering profession have of the mutual interaction between technology and society and their responses to these types of issues. This combination of elements has made me aware of a number of both seized and missed opportunities and has helped clarify some of the fundamental issues that seem to be influential in promoting engineering students' interest in technology and society issues.

What Is a Northern Telecom Professor of Engineering Impact on Society?

This position is a most unusual one on a number of counts. First, it is multi-sponsored. The technical sponsors are Northern Telecom Canada Inc., Association of Professional Engineers of Ontario (APEO), Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA) and Alberta Government Telephones (AGT).[3] Second, although the sponsors are all engineering or high-tech organizations, the role of the Northern Telecom Professor is clearly defined as non-technical. A major function of the position during its initial stages was to research and provide assistance in the field of teaching engineering students about the mutual interaction between engineering and society. In engineering schools and faculties this is usually referred to as the impact of technology on society.

The Canadian Studies Directorate of the Department of the Secretary of State of Canada is another very significant partner in the total Northern Telecom Professor package. Through a normal competitive process it awarded a major research grant to support the research and writing of a university and professional training-level textbook, which is now in its final stage. Tentatively titled *Partners: Technology and Canadian Society*, it draws from and combines historical and contemporary material to present a number of principles and cases dealing with the mutual interaction of engineering technology and Canadian society.

Heavy investment in non-technical education by technically oriented organizations struck some people as surprising, if not wholly incomprehensible. However, it reflected a major concern within industry and the engineering profession. As a result of workplace and societal changes within the past few decades, which have not been matched by educational or training changes, the effectiveness of many engineers is unnecessarily below potential. Too often there is a failure to consider, understand or even regard as legitimate, such factors as public or personal perceptions as distinct from the so-called hard data or facts. Too often there is too little consideration of broad implications and personal impacts that seemingly neutral or natural technical decisions might have. There is growing industrial awareness of the need to consider actively the shifting power structures that make it far more necessary to consult and work with other professions and members of the work force and public rather than dictating.

Quite understandably the major interest of engineering schools is dealing with the content of engineering. However, as numerous scholars and observers have pointed out, human activities, such as engineering or the practice of any profession, operate within a context. For Marshall McLuhan the content was "figure," the context "ground" and the study of the relationship "figure-ground" analysis.[4] But whether one used scholarly references or simple interview techniques and observation of industrial and engineering practice and perceived weaknesses, it seemed to the sponsors and me that perhaps not enough attention was being paid to understanding the context of engineering as distinct from the content. Moreover, it seemed, with some exceptions, that while great visible emphasis was placed on the content of engineering, there seemed to be less visible activity in preparing students for their immersion in the context of engineering. One way of expressing the reason for the position of Northern Telecom Professor is that it was to learn more about, and contribute to, the context area of engineering education. As a major sponsor, and as a corporation with strong views and a vested interest in understanding context within a sophisticated manufacturing environment, Northern Telecom was concerned that this not be a single-university activity nor even a single-province activity. Consequently I worked with many universities. As a result of APEGGA and AGT support, Alberta, notably the University of Alberta Faculty of Engineering, was the major focus of activity outside Ontario. With APEO assistance I lectured to students and met informally with students and faculty at every engineering school in Ontario.

Because the primary purpose of the research was first to understand and then try to make realistic recommendations, or offer assistance as needed or wanted, I benefited from much frank discussion, which went far beyond official, carefully worded statements. Open and exceedingly helpful discussion covered areas such as resentment over curriculum control wielded by the Canadian Engineering Accreditation Board (CEAB), frustrated plans to do quality work in technology and society studies, cores of indifference or hostility, and in some cases clear statements that engineers need only be technically competent and society had to learn how to deal with its own problems. Most of the discussions uncovered genuine concern and very often a sense of confusion over how to improve engineering education in an area that seemed acceptable to discuss in private but not to talk about too frankly or enthusiastically in public department or faculty meetings. For some people the whole question of engineers and society was too touchy to confront in anything but a most defensive manner. Out of all of this came a greater appreciation of just how widespread the hidden concern is. Moreover, I came to believe even more strongly that improved interdisciplinary understanding, or improved technology-society interaction, desperately needs genuine interdisciplinary action and initiative. But the experience brought even greater appreciation of how difficult it is to bring about open and mutually respectful interdisciplinary discussion and action in a university. Repeatedly I was told that universities are organized and run on disciplinary lines as expressed by faculty and department.

When discussions turned to the prospects of change an unavoidable component was the CEAB: a sometimes touchy subject and a frequently misunderstood and misrepresented body.

The Canadian Engineering Accreditation Board and Life in a Closed Self-Regulating Monopoly Profession

Many historians are professionals in the common meaning of rigorous training and standards in areas such as research and quality work but not by legal definition; anyone may call herself or himself a historian. Life is very different in closed, self-regulating monopoly professions. For example, with professional engineers, architects, medical doctors, lawyers, accountants, dentists and veterinarians, the right to call oneself a member of the profession is legally reserved for those who have applied for and been admitted to membership in a legally recognized licensing body. Moreover, only those who are recognized by the appropriate body as licensed professionals have the legal right to engage in certain activities.

The subject of professionalism has spawned vast literature and disciplinary subspecializations. Self-regulation is one of the more controversial parts of the study of professionalism and much has been written about the inherent logic, or illogic, of self-regulation. However, for the purposes of this essay it is important to deal only with two aspects of self-regulating professions in Canada. First, under the terms of the British North America Act, licensing and regulating of professions is a provincial rather than federal responsibility. Second, professional engineers are members of a self-regulating profession, which by definition and statute has collective responsibility for setting and enforcing licensing standards and education. While each provincial and territorial engineering association is independent, they have a joint representative body to deal with university-level education. The CEAB was founded in 1965. It is a standing committee of the Canadian Council of Professional Engineers (CCPE), which in turn represents all of the provincial and territorial licensing associations such as APEO and APEGGA. The CEAB defines curriculum requirements and also sends visitation teams to every accredited engineering faculty in Canada. "Accreditation was implemented by the profession to test and evaluate undergraduate engineering degree programs offered at Canadian universities and to award recognition to programs which meet the required standards."[5]

The existence of CEAB and the fact that engineering faculties must keep CEAB accreditation if their graduates are to be licensed without undue complication and delay opens the doors to potentially rapid change in curriculum and educational practices at the university level.

Protection of society is the theoretical reason behind the legal recognition of professionals and the accompanying conferral of monopoly powers.[6] The potentially harmful consequences of having anyone engage in certain activities such as brain surgery or designing highway bridges are simply too great to allow unhampered or uncontrolled entry and practice. The public must be reassured that anyone using the title of the particular profession meets a certain minimum qualification. One view of the essence of professional licensure is one of its functions, which is to assure that none sink beneath a certain point; beyond that it is buyer beware. There are certainly no restrictions on how good one becomes. The legal position of closed self-regulating professions and the philosophy underlying the concept have a number of implications.

First, there is the constant need to monitor effectiveness and question assumptions regarding desirable characteristics for a given profession and requisite areas of minimum knowledge. Second, a licence may be revoked. It is inherent in self-regulation that there will be disagreement over whether this power is exercised as frequently and as judiciously as it should be. From this doubt flows suspicions or charges of cronyism, tightly-knit clubs and old-boy networks looking after their own, which often bedevil closed, self-regulating professions. The educational institution equivalent to an individual losing her or his licence to practise is loss of accreditation. Possible imperfections notwithstanding, the theoretical obligation to protect society remains and has important implications in a third area, namely curriculum and teaching.

The Paradox of Limited Curriculum Choice

The need to assure the public that all members of a profession have met certain minimum standards has an impact on curriculum in professional faculties preparing students for careers requiring professional registration. Students in professional faculties tend to have far less freedom in their choice of courses than students in non-professional faculties or departments. Similarly, professional faculties are far more constrained in the courses they offer and changes they make than non-professional faculties. The detailed mechanism varies from profession to profession but all are variations on a theme: a curriculum statement, which each faculty or school must interpret, and an accrediting body, which monitors performance. Failure to appear to meet expectations elicits an official advisory that a particular department or faculty fails to meet standards and must make appropriate changes within a given time. Failure to comply may lead to loss of accreditation, an extremely serious matter. Students graduating from an unaccredited school, department, or programme are not eligible for professional licensure and, as a result, are ineligible to practise as professionals until they have taken additional courses and/or exams. Understandably, there is considerable incentive to adhere to accreditation requirements, or appear to do so.

The implied contractual relationship between society and self-regulating professions gives accrediting bodies wide jurisdiction. In addition to technical or core subject-matter content, there is room to prescribe and look for instruction, training, or heightened awareness in issues relating to relationships between the profession or its members and society at large, or individuals such as patients and clients. Within professional education there is great variety in both prescription and compliance. The fact that some schools do far more than required is consistent with the theory of self-regulating professions: legislation and regulations cover minimums. Moreover, while it may appear professional faculties have little freedom of choice, there is far more than one might expect.

Interpretation and Custom Give Meaning to Policy Guidelines

The past is littered with examples of ineffective – even counterproductive – legislation, which was either poorly enforced or unenforceable. Anyone wishing to understand the impact of a particular piece of legislation or regulation must look to areas such as enforcement and perception.

For several decades all, or most, engineering students in Canada have had to take a course in engineering economics. Some understanding of economics as related to engineering was seen as desirable because many engineers moved into management within a few years of graduation. As Northern Telecom Professor of Engineering Impact on Society, I met with many professors and administrators in Canadian engineering faculties and on many occasions was told that CEAB guidelines required a course in engineering economics. But no such policy statement could be found. This came as quite a surprise to many individuals. There is only a vaguely worded policy statement that lumps economics in with a number of other requirements.

The CEAB policy statement defines the engineering curriculum as consisting of 4 years of instruction, each of 26 weeks. There are 8 academic terms, each of 13 weeks, exclusive of time devoted to examinations. The main areas include the following: "Mathematics: A minimum of one half year ... Basic Sciences: A minimum of one half year and ... Engineering Sciences and Engineering Design: A minimum of two years of a combination of engineering sciences and engineering design." Each of these is further defined and elaborated on. The section of potential interest to material historians is the fourth area, which is quoted here in full:

> *2.2.4 Complementary Studies: A minimum of one half year of studies in humanities, social sciences, arts, management, engineering economics and communication that complement the technical content of the curriculum.*
>
> *While considerable latitude is provided with the choice of suitable courses for the complementary studies component of the cur-*

riculum, some areas of study are considered to be essential in the education of an engineer. Accordingly, the curriculum must include studies in engineering economics and on the impact of technology on society, and subject matter that deals with central issues, methodologies and thought processes of the humanities and social sciences. Provision must also be made to develop each student's capability to communicate adequately, both orally and in writing.[7]

Several observations are in order. First, there is no statement of relative amounts of time to be devoted to the various intellectual components identified. There is no defined requirement for a course on, say, engineering economics or the impact of technology on society, only inclusion in the curriculum. However, interpretation gives meaning to the letter of the law. Traditionally, engineering economics – or some variation thereof – has received a one-term course, and it might be very difficult to change that custom. The second observation is that "impact of technology on society" is not defined in terms of a subject or discipline approach. There is absolutely no statement on how students should acquire this knowledge or area of understanding. The guidelines are very imprecise and ambiguous.

We Cannot Tell You What It Is, but We Know When We See It or When It Is Not There

The ambiguity is so complete – the level of imprecision so high – that both the CEAB and the CCPE are unable to supply a definition or description of what they mean by understanding the impact of technology on society. Moreover, the CEAB does not have a publicly available statement of necessary elements or yardsticks useful in determining if the requirement has been met. Definitions seem to be operational: we cannot define it, but we know when we see it and we know when it is not there. Now that the CEAB appears to be taking the impact of technology on society requirement more seriously than in the past, this ambiguity has led to a certain amount of confusion and, sometimes, hard feelings. For example, it makes planning very difficult and in some instances raises the suspicion that perhaps not all engineering faculties are treated equally by the CEAB visitation teams.

The imprecision is a reminder of another fact of engineering education; while more prescribed than in arts, social sciences and humanities, there is considerable variation. Engineering education is far from the monolithic block often imagined by non-engineers. Freedom and variation are important and should be prized and protected but must not compromise the contractual relationship between society and professional engineering as a closed, self-regulating monopoly profession. This means that in addition to societal protection, maintaining public confidence is an element of professional self-regulation. If the profession states that an area of instruction is important but it is not possible to determine what constitutes satisfactory instruction, or even some vague idea of what the subject covers, then motives might be questioned.

One might ask whether the regulations or guidelines are more concerned with appearance, public relations, and window dressing than with substance. The question might be perceived as entirely unfair but given the trust implied in self-regulation and the fact that some view it as an inherently illogical mechanism, it is not enough to be good, one must be perceived as good. It is a modern application of the oft-quoted "Caesar's wife must be above suspicion." For an example of this line of criticism one might look to the *Financial Post* article "OSC Needs Power To Punish Pros" in which Diane Francis writes in "The Insiders" column:

Self-regulation is a privilege that society extends to certain professionals .... But this system has often failed in the past as one would expect when monkeys are allowed to guard other monkeys.... Self-discipline is a privilege, not a right, and the professions have blown it often enough to convince me that regulators must move in, if only to be able to perform their jobs properly.[8]

Within a given engineering faculty there is variation from department to department on how complementary studies are approached and what students are encouraged, or allowed, to do. Similarly, there is variation as to when they are allowed to take complementary studies courses or complementary studies electives. While initially the issue of timing may seem inconsequential it may influence how a student views the role of technology-society interaction. Are we looking at add-ons and afterthoughts or a foundation that should be an integral part of engineering planning, design and decision-making? If 60 per cent of the non-technical courses are relegated to the final 25 per cent of the students' undergradu-

Table I: Scheduling of Complementary Studies Electives, University of Waterloo

Term	*Chemical*	*Civil*	*Electrical*	*Computer*	*Geological**	*Mechanical*	*Systems*
1A	-	-	-	-	-	-	-
1B	1 CSE	-	-	-	-	1 CSE	-
2A	-	1 CSE	1 CSE	1 CSE	1 CSE	1 CSE	-
2B	1 CSE	1 CSE	1 CSE	1 CSE	1 CSE	-	1 CSE
3A	-	1 CSE	1 CSE	-	1 CSE	-	-
3B	1 CSE	1 CSE	1 CSE	1 CSE	1 CSE	-	1 CSE
4A	1 CSE	-	1 CSE	1 CSE	1 CSE	2 CSE	2 CSE
4B	1 CSE	1 CSE (usually Law)	1 free elective	1 CSE	1 CSE	1 CSE	1 CSE

CSE = complementary studies elective
* Geological engineering students have six opportunities to take CSEs although only five are required for graduation.

ate careers, are these courses likely to influence strongly their ideas on how one defines the nature of engineering and formulates questions appropriate for inclusion in fundamental rather than peripheral planning and problem solving?

Table I, based on university calendar information, indicates when University of Waterloo engineering undergraduates are scheduled to take complementary studies or non-technical electives. Under the heading "Term" the numeral indicates year of study and the letter A or B, first or second term respectively.

Teaching ethics is another area of variation. Although I have heard the contrary many times, there is no CEAB policy guideline statement requiring that a course in ethics be taught. However, before being licensed as a P.Eng. one must write a professional practice exam, which includes ethics. Consequently, some engineering undergraduates take an engineering ethics course. There are other areas of significant variation in undergraduate curriculum but they are less germane to this essay.[9] Having established that perhaps there is need and opportunity for increased technology-society understanding in which historians play a part, one should now turn to strategy considerations.

Promoting Material History or History of Technology

Whether one is inside or outside a university, certain common steps would be advisable. One must begin by accepting that at an operational level there is not a one-shoe-fits-all description of the curriculum of engineering schools. For complementary studies, there is rarely even uniformity between departments.

A blanket canvas of all engineering schools is unlikely to attract much attention. At any university one must determine whether delivery of complementary studies electives is largely internal or external to the department or faculty. One must also determine whether students have any choice in selecting a course for technology and society; some schools or departments are far more regimented than others. It might also be wise to determine if there are other perceived needs such as oral and written communication skills that might become part of a custom-made course. Moreover, and this is perhaps most difficult, one must determine how seriously the requirement is being taken either by the faculty as a whole or by individual departments.

One of my major research findings on the teaching of impact-of-technology-on-society courses to engineering undergraduates is that variation is the key word. Some institutions are doing a fine job with a good resource base dedicated to the subject. Others are doing their best under very difficult circumstances and some seem more intent on skirting the issue and generating more appearance than substance. Another finding deals with courses noted for friction and lack of student satisfaction. Individual complaints were quite varied but some types recurred too often. These negative findings have been reversed to positive recommendations.

Avoiding Pitfalls and Charting Toward Success

The first is to build on one's strengths and areas of expertise. This might seem obvious but it needs to be said. While one may have to stay within broad guidelines one must bring, build on and adapt some areas of deep knowledge. The Centre for Society, Technology and Values (CSTV) at the University of Waterloo was founded in 1984. Sessional lecturers have come from a range of disciplines including philosophy, history, music and engineering. In addition to interest in the work of the Centre, a primary concern in hiring is the extent to which people appear willing and able to build on their total knowledge. It is not always easy to find such people.

During the course of the past three years' research, one of the worst cases I learned about at other universities involved a course given with considerable satisfaction by two different professors from outside the field of engineering. As a result of some other hidden agendas being played out, the Chair of the department allowed both professors to go on sabbatical at the same time, and then assigned the large course to a Ph.D. student who had no specialized knowledge of the field. The situation deteriorated quickly and the students formally petitioned to protest the quality of teaching. Things were back to normal the following year but much good will had been lost. In another conflict centring on relevance in which I was asked to provide some observations and input, a course was described as a custom-tailored history of technology and environment for engineering students. It was in fact a very conventional course on twentieth-century political history. It was also compulsory. Complaints from students plus official requests for reasonable change from the engineering faculty brought no significant alteration despite the fact that delivery of this course brought financial benefit to the history department. After two years of conflict with no relief in sight the engineering faculty approved a new technology and society course to be offered internally. Students had to take one of the two courses. The history course changed radically so as to fit its description. Both courses co-exist peacefully, both draw approximately equal numbers of students and students in each course feel they are learning much that helps their understanding of the interaction between technology and society.

Willingness to adapt to engineering student audiences is very important. This does not mean lowering standards. Usually it means thinking about and acting on fundamental communication needs. Consider what might happen if a philosopher or historian of modern science and technology asked a computer-engineering professor to talk about computers to a class of arts students with little or no pre-existing knowledge of the subject. Imagine the consternation, confusion and complaints about poor communication skills if that guest professor addressed the class as if it had the same level of interest, pre-existing knowledge and mastery of technical language and concepts that one would find in a class of third-year computer-engineering students. The guest lecturer who had not taken into account, or started, where the audience was, would have made a grave error in teaching and intellectual salesmanship. Everyone would recognize the error made by the engineering professor. There is, however, another side to the specialist/non-specialist communication challenge. Arts professors may commit equally serious communication errors. People from the arts may easily underestimate the extent to which their knowledge, assumptions, language and belief in the importance of a particular subject are quite incomprehensible to people from significantly different disciplines, backgrounds or interests. While the hoped for final destination might be the same for all audiences, one must pay particular attention to the starting point so as to build on and show respect for pre-existing knowledge lest, to the consternation of all, the audience be lost irretrievably in the first few classes or even the first few minutes.

At various institutions and in numerous discussions with students about the complementary studies courses and professors they liked and felt they learned something from, light workload or guaranteed annual pass was not a factor. In fact, professors for so-called "bird" courses were often spoken of quite scornfully. This does not mean that no students found such courses attractive. Praise often was associated with professors who "showed us how to look at the same stuff differently" or helped students see "how things really get screwed up when you don't pay attention to society and things other than just technology." The latter came from a fourth-year engineering student at the University of Alberta who, in second year, had taken Anthropology 230: Technology in Culture. Earlier in the day he had attended a lecture I had given on the role of technology in raising societal expectations, which often inspires ill-conceived or poorly executed projects, which lead to further calls for technological rescues. He was well acquainted with the idea that technology operates in a social context and has ramifications beyond those envisioned by those who created, introduced or sought the new technology. When asked for an example he cited the case of the snowmobile. He described the anthropology course as interesting and useful. When asked what useful meant he explained that his deeper understanding of technology and society interactions had helped him in school projects and in a summer job when he had to decide which technological solution seemed to be most appropriate. He felt he had gained an important decision-making tool.

While the order "take no prisoners" is a chilling and inhumane one in a military context, it perhaps has a desirable meaning in the context of complementary studies and engineering students. If one has any control over the matter, it is best to be involved in courses students have chosen to enter voluntarily or semi-voluntarily rather than as prisoners. The best students in terms of openness to learning new ways of looking at engineering are most likely to come from those who feel some element of freedom. Engineering students are often frustrated by the lack of choice in their core courses but at least most of them have some faith in, or see the point of, these courses. It may be a very different matter with complementary studies courses. A number of students look forward to complementary studies because of the variety and freedom from equations. Others regard the courses as an unwarranted, useless and totally unnecessary burden added to an already heavy workload. Students allowed to choose one from a number of courses are invariably more positively predisposed to contribute to, and get something out of, the course than hostile, or neutral, conscripts who were given absolutely no choice.

To meet the technology and society requirement at the University of Alberta it is suggested that engineering students pick one of General Engineering 505 (Engg 505): Business in Society, or Sociology 366 (Soc 366): People in Industry. Both courses are given first and second terms. Engg 505 was created for business or engineering students in their last two years of study; others are admitted only if space allows. Soc 366 is for engineering students exclusively. Students are allowed to take other courses to meet the technology and society requirement. Anthropology 230: Technology in Culture is one such course for which students have high praise.

Information gathered at the CSTV certainly supports the view that teaching and learning are more effective, and more enjoyable with volunteers than with prisoners. Experience at CSTV has also revealed another interesting fact about class composition. CSTV classes are normally a mix of engineering, science and arts students. Students from all faculties have consistently identified working with students from other faculties and learning how they view and analyze problems as a major plus and an eye opener.[10]

Giving Multidisciplinary and Interdisciplinary a Chance to Work

Material history and history of technology are truly multidisciplinary and interdisciplinary. An increasing amount of professional work involves multidisciplinary teams and problem definitions. Yet it is still rare to find university teaching geared towards consciously created multidisciplinary classes. Perhaps people currently teaching history to an exclusive, or near exclusive, arts audience might consider trying to add some engineering students to their classes. Similarly, those teaching, or planning for, non-technical courses for engineering students might consider trying for more varied class composition. In the same vein, administrators making decisions regarding complementary studies electives for engineering students would be well advised to try to encourage multidisciplinary learning conditions as much as possible. While perhaps more difficult to plan and administer, it is educationally and professionally much preferable to the no-choice monoculture actively promoted by some and passively promoted by others through default.

What Does All This Mean?

Is this essay nothing more than unparcelling nested Russian dolls of little or no real intellectual interest to material historians or historians of technology? I think not.

First, societal trends and pressures, students' interests and a quality control body – the CEAB – with a theoretical but indirect responsibility to society are all pointing in the same direction: the need to help engineering students gain a better understanding of the mutual interaction between technology and society. Second, material historians and historians of technology know a great deal about technology and society interaction. Third, while it is exceedingly unlikely there will be anything resembling widespread uniformity, there will be increased activity in most engineering faculties. As discussed above, there will be little room for change and innovation in some institutions but in others the chances are greater. Fourth, while engineering students vary considerably they share a number of characteristics with many historians of technology and material historians. Powerful common bonds offer an excellent foundation for building. It is my experience that teaching engineering students is both satisfying and enjoyable. Moreover, I think it makes me a better historian. It forces me to try to understand how others see my work, and in trying to help others understand more about the merits of what my fields of research have to offer, I am forced to think more about what it really should be about. It is my great privilege to work and teach in a sometimes frustrating but always enriching environment, namely an engineering student and professional milieu.

Building on Common Bonds

What are the readily identifiable elements on which to build? To begin, most engineering students share a belief that technology is an important and worthwhile pursuit; it is an important part of their value system. In common with many other population groups, they vary in their estimation of the current perfection and appropriateness of many technological elements. Historians of technology and material historians also believe the material production of society merits study. Again, there is variation amongst historians in secondary factors such as relative balance, time periods, type of objects and, again, how one feels about the role and nature of the technology studied. But there is a shared starting point: respect for the legitimacy and admirability of technology and engineering as important human endeavours.

Many engineering students are very idealistic, a factor one often finds in the writings of engineer and cultural critic Samuel Florman. Idealism might manifest itself differently than in arts students but it is there. While uncertain as to how it might happen, many engineering students speak of hoping that what they learn, and the careers they follow, will somehow make life better. Outsiders may often look down on engineering students as incapable of harbouring such thoughts and ambitions, or point derisively at technology-only solutions to what are in fact complex technology-society interaction problems. But if too many engineering students seem too naïve about where solutions might come from, that reflects current educational systems and priorities much more than it does some supposed defect of the minds of individuals who choose engineering as a field of study. Here is an opportunity, not a problem. The experience of the CSTV, as well as my research, clearly indicates that engineering students respond very positively to good teaching that respects their career choice and starts by helping them see technology as part of a larger socio-cultural system. It is this same desire to find connections that leads some students toward undergraduate courses in management or business; it is also what disillusions some if they do not find it there.

Who Will Accept the Challenge?

In terms of potential, material historians and historians of technology have much to offer engineering students. The need is not to teach history but how to think historically, that is to say, to think critically and creatively about change and the flow of time, be it past, present or future. I do not teach history courses but rather courses using history. They deal with change, design and society, technology and society, understanding how and why we get the technology we have, and learning about how others – the non-technical experts – look at technology and what there is to learn from other views and perspectives. We look and try to understand many of the things that are right as well as what needs improvement. I draw deeply and heavily from history but certainly not to the exclusion of present and future.

Clearly, there will be continuing significant change in engineering education in the area of interaction between technology and society. Equally clearly – if past and present are any indication of the future – the approach to teaching will not be uniform within the country, province or, in many cases, even in a given faculty of engineering. Consider the general nature of the assignment: working with students who already possess a pre-existing interest and belief in the importance of technology and helping them understand more about the mutual interaction between technology and society. Clearly this is a task where some material historians and historians of technology have the potential to do a fine job.

But pointing out potential might raise questions such as "Will historians be given a chance by the engineering education system?" or "Are historians encouraged to get involved with engineers and engineering faculties?" These are legitimate questions but one must beware that posing them must not look like naïveté or a temporary lapse in historical perspective. If by "encouraged" one means "courted," the answer is probably no. Most, if not all, engineering education decision makers, whose students might benefit from the work of material historians, are not acquainted with the field of material history, nor should that knowledge be expected. For many, their experience with more conventional history was probably of the sort that encouraged many readers of this journal to pursue non-traditional approaches to historical understanding. If material historians believe that their work leads to valuable insight and understanding, and I do, then they should let others know. They should take the initiative and both speak and write outside of their field to let others know and see what material historians might do for them.

Two groups of wallflowers at opposite ends of the dance floor, one of which might not know the other exists and with neither ready to make a move, hardly makes a recipe for social interaction let alone a revolution in teaching. I do not use the word "revolution" lightly or imprecisely. There is a revolution in engineering education circles if by revolution one means change occurring faster than the system's ability to cope smoothly. The engineering education system is such that historians could play a significant role, but to be invited, historians must first cease being strangers.

As regards encouragement, articles such as this that try to promote awareness might be seen as encouragement. But perhaps most of the encouragement must come from within and from a sense of professional pride combined with honest self-interest. Insights from material history and the history of technology have much to offer, but they have to be publicized and offered; a little bit of honest but planned intellectual salesmanship is in order.

There are no guarantees and there are obstacles in various quarters. But to date the biggest problem in the historical community seems to be the lack of awareness of need, perhaps unwillingness to change, and disinclination to aggressively pursue mutually beneficial alliances with engineering faculties.

The history of Canadian history as a set of disciplines and the actions of historians is certainly not without its chronicles of lost opportunities, challenges unrecognized or untackled and, in some quarters, declining influence and effectiveness. Most historians have one or more articles they feel should be required reading. For the lesson it teaches, one of my favourites is "The Tradition of Public History In Canada" by John English.[11] It is best read and digested rather than summarized. It is a thoughtful reminder of what happens when a discipline stops thinking about what other disciplines are doing, stops thinking about how the professional knowledge it develops and delivers is used and perceived. As many historians failed to change with the times, insights for which people once looked to historians were supplied from elsewhere. I think that in many cases the change in the source of supply for insightful analysis and intellectual services was for the worse or, at least, not an improvement. But, as any good historian knows, a large part of reality is whatever is perceived and the perception was that there were better places to look.

This essay has dealt with a need. There are historians with the beginnings of the requisite knowledge needed to do a better job than any other group. Will they respond? Will they succeed? Or, in a few decades, will someone need to write a John English type article on opportunities not tackled by material historians and historians of technology?

There are three questions that any profession needs to consider regularly. How does it justify support and existence? How does it avoid intellectual isolation and its frequent companion, incestuous sterility? How does it learn to recognize and respond to opportunities? Looking at the relationship between material history and engineering students may help to put these questions in focus. Acting on them may lead to some beneficial and intellectually exciting answers.

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NOTES

1. For purposes of this essay the author will use the term material historian and historian of technology interchangeably. This is not to imply that they are alike in all respects or that either is in itself wholly uniform. Rather the usage and the issues addressed here draw most heavily on elements common to both of these interlapping approaches to understanding.
2. For early formative examples in a Canadian context see Norman R. Ball, "Petroleum Technology In Ontario During The 1860s" (Toronto: University of Toronto, unpublished M.A. thesis, 1972); Bruce Sinclair, Norman R. Ball and James O. Peterson, eds., *Let Us Be Honest And Modest: Technology And Canadian Society* (Toronto: Oxford University Press, 1974); Norman R. Ball, "The Technology Of Land Clearing And Settlement In Upper Canada Prior To 1840" (Toronto: University of Toronto, unpublished Ph.D. dissertation, 1978). For a more recent, succinct piece see Norman R. Ball, "Essential Connections: Past And Future; Technology And Society," in *Proceedings. Beyond The Printed Page: Online Documentation: Second Conference On Quality In Documentation* (Waterloo: University of Waterloo, Centre for Professional Writing, 1992), 11–28. For change over an extended period in a Canadian company see Norman R. Ball and John Vardalas, *Ferranti-Packard: Pioneer In Canadian Electrical Manufacturing* (Montreal: McGill-Queen's University Press, 1993).
3. There was also a contractual link with the Canadian Standards Association involving research on origins and perceptions of certain aspects of standards in Canada.
4. For a brief and actually very clear introduction to figure, ground, and figure-ground analysis see Marshall McLuhan et al., *City As Classroom. Understanding Language And Media* (Agincourt, Ontario: The Book Society of Canada Limited, 1977), 8–17. I am indebted to graduate student Trevor Garrett for bringing this unusually coherent explanation to my attention.
5. *Professionalism Performance Pride. P.Eng. APEO Career Information Series* (Toronto: Association of Professional Engineers of Ontario, n.d.), 4. For a readable introduction to the field of professionalism and its issues see Terence J. Johnson, *Professionals And Power* (London: MacMillan Education Ltd., for British Sociological Association, 1972).
6. For an introduction to self-regulating professional status for engineers as a problem-solving device to protect society, see Norman R. Ball "Professional Self-Regulation: Striking A Bargain With Society," *Engineering Dimensions* 13, no. 3 (May–June 1992): 36–38.
7. "Policy Statement" as given in Canadian Engineering Accreditation Board, Annual Report 1991 (Ottawa: CEAB, 1992), 13–14.
8. Diane Francis, The Insiders. "OSC Needs Power To Punish Pros," *Financial Post*, 30 November 1990, 3.
9. Not all engineering schools offer the same areas of specialization. For example, not all offer engineering physics, only the University of Waterloo offers Systems Design Engineering as a wholly separate department and specialization. Some of the traditional areas are undergoing significant change as at the University of Windsor where a Chemical Engineering degree is no longer offered and was replaced by Civil and Environmental Engineering combined as a unit. In addition, there are various options that may be taken as part of a conventional four-year degree. There are also special longer programmes such as the new five-year Engineering and Society degree offered by McMaster University. Admission is also far from uniform. In many universities admission is to a common first year of engineering with choice of engineering department or specialization made after passing first year. In at least one school, one may pass first year but not be eligible to enter a second-year engineering programme. At the University of Waterloo there is neither a common first-year curriculum nor common admission standard or cut-off point. Students are admitted to a particular department, each with its own cut-off point. At Waterloo a student might apply for one department and be told she or he will not be admitted to it but will be admitted to a different one with a lower cut-off point. The cut-off point varies from year to year with fluctuations in demand and grades of the applicants.
10. The combination of a static resource base and increasing engineering emphasis on technology and society courses could mean that the desirable faculty and discipline mix will be less pronounced despite efforts to maintain that desirable feature. It is curious that many courses labelled interdisciplinary are taught to monodisciplinary audiences.
11. John English, "The Tradition Of Public History In Canada," *Public Historian* 5, no. 1 (Winter 1983): 26–59.