

MONITORING WELL-BEING OF CIVIL ENGINEERING PROFESSION

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ABSTRACT: Deficiencies in seven key professional aspects are identified as being potentially responsible for the frequently reported decline in the well-being of the civil engineering profession. These deficiencies are: (1) Public profile; (2) quality of entering class; (3) quality of graduating class; (4) supply/demand of good engineers; (5) professional fees; (6) professional income; and (7) innovation and R&D. These deficiencies are demonstrated to be closely intertwined, and a professional well-being chart modeling this closed-loop interrelationship is proposed. Using this chart, a method is proposed to periodically monitor the well-being of the civil engineering profession, as well as the evolution of this well-being. Quantitative performance indices are formulated to achieve this objective. It is contended that the proposed monitoring activities are crucial to identify where corrective policies must concentrate if they are to enhance the well-being of the profession. It is also anticipated that strategies to reach that enhancement and a proposed comprehensive action plan for immediate implementation can be formulated thereafter.

INTRODUCTION

In the writer's view, civil engineering undeniably remains one of the most challenging and rewarding professional careers. Yet, along with many of his colleagues, the writer has come to realize that this perception is definitely not shared by all practicing civil engineers, and may be somewhat idealistic. With an increasing frequency, articles deploring a decline in the quality of working conditions in civil engineering are published in the professional literature. Whether written by senior engineers having witnessed this erosion, or by already disabused recent graduates reporting on current conditions, this trend is disturbing. Although most liberal professions periodically indulge in self-criticism with positive consequences, the recent concerns expressed regarding the current state of the civil engineering profession appear to be more alarming than constructive, especially if the observed trends are extrapolated into the future.

Although these critical articles and commentaries address many apparently unrelated aspects of civil engineering, a closer scrutiny reveals that many of these problems are actually closely intertwined. This paper proposes a model of the interrelationship between the key professional aspects identified as responsible for the reported decline. The writer also proposes a method to periodically monitor the well-being of the profession as well as the evolution of this well-being. Without proclaiming it to be an absolute solution to the problem at hand, the model presented should serve as a useful tool in future debates on these issues. It is contended that the proposed monitoring activities are crucial to identify where corrective policies must concentrate if they are to enhance the well-being of the profession. It is also anticipated that strategies to reach that enhancement and a proposed

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comprehensive action plan for immediate implementation can be formulated thereafter.

The following comments are meant to be generally applicable to the broad field of civil engineering. However, because the writer's background is in structural engineering, examples and illustrations of the concepts will be given in relation to that field.

LIST OF CONCERNS

Essentially, the recurring criticisms and concerns regarding the state of the profession can be grouped into seven distinct categories, which are reviewed in the following sections. This list purposely concentrates on the negative aspects reported by the profession at large, and may be perceived, without proper perspectives as an overly pessimistic view of the situation. However, for the sake of conciseness, it must be assumed that the reader is well aware of the numerous positive aspects of the profession, which are not the subject of the current paper.

As transpires in the following sections, the presentation of the concerns is structured to emphasize the close linkage between each problem category; this presentation also serves to support the proposed model of this inter-relationship introduced in a later section.

Low Public Profile

Civil engineering is an almost anonymous liberal profession, a profession with free-thinkers, open-mindedness and capable of criticism and self-regulation. To be frank, it has an image problem. Most citizens have only a remote idea of what a civil engineer does, unless they happen to be one or to work with one. In fact, many first-year civil engineering students are similarly unaware of the demands of their chosen career. A career suffering from a low public profile is in a very difficult situation to control its well-being.

A defeatist view upholds that the law and medical professions enjoy a level of fame and glamour artificially inflated by Hollywood, and thus benefit from free prime-time publicity simply on the account of being more "soaps-worthy" professions in close contact with life, death, crime, and drama. Engineers, when mentioned at all in such productions, are portrayed as unethical, nonidealistic, and/or instrumental to unscrupulous and greedy developers. Although this makes for an interesting excuse for holding a defeatist view, embracing it is tantamount to abdicating responsibility for the profession's image. The image of the civil engineering is in such disarray that in a not untypical case a secretary having worked one year in an office staffed with a large number of Ph.D.s and P.Eng.s was unable to explain the meaning of these initials. The defeatist view also fails to explain why most people have a clearer idea of what architects, computer programmers, certified accountants, or even actuaries do than engineers.

Public recognition and appreciation appears to stem from a number of issues, namely exposure to the profession's achievements, perceived benefits from the everyday accomplishments of the profession, responsiveness to the profession's public-relation efforts, and perception of the financial well-being of the profession's members. In the culture of North America, the importance of this last item should not be underestimated; no parents in their right mind would discourage their children from seeking a secure and well-paid profession. And by the same token, nothing can be more damaging

to the public profile of a profession than poorly paid or unemployed graduates.

Losing the Best Students to Other Professions

A consequence of the aforementioned factors, and directly or indirectly responding to peer, parent, or societal pressure; the absence of role models to emulate in civil engineering; and expectations of larger financial gains, many students with outstanding grades lean first toward one of the aforementioned more prestigious careers, particularly if substantial future earnings rank high on their priority list. Fortunately, many still choose civil engineering, and do so for the right reasons, for example to quench a personal desire to learn how to design and build buildings.

Oddly enough, most engineering undergraduate students have only a very fuzzy idea of the annual income of an engineer. Obviously, it may not be in the interest of the profession to voluntarily disclose this information to high school students. Because most students do not perceive engineers to be cheap labor, the assumption goes that money will not likely be an issue following graduation.

The first hint undergraduate students get that the working conditions awaiting them following graduation may not meet their expectations is often recorded in the course of their first engineering summer jobs. Working under the direction of senior engineers, and eager to learn the ropes, the student often learns with disbelief that a great number of construction workers (crane operators, site superintendents, welders, etc.) earn more than engineers. Facing the harsh reality that some of their old classmates who flunked high-school can be earning more than an engineer, the need to learn differential equations takes a new perspective. Fortunately, few students elect to join the Teamsters and quit school, although some of the best students are known to have enrolled in medicine shortly after graduation. With few exceptions, most students overcome their initial naiveté and rationalize that the rewards of a fun and challenging career are incentive enough to compensate for the injustice in relative income levels.

Unless they become unduly exposed to disabused and/or incompetent engineers, most students will graduate with a certain pride and a refreshing enthusiasm. This is not to say that all graduates will have an outstanding academic record.

“Ordinary” Students in Graduating Class

It has been said by some structural engineers that in practice a “grade” of 95% is not good enough: the design in each project must get a grade of 100%. Failure is the potential consequence of an error in design. Yet, the typical passing grade in North American universities is 60%. Students argue that, in light of the constraining aspects of exams, particularly the pressure, time restrictions, and “tricky” (according to the students) nature of some questions, a 60% passing grade does not accurately reflect their knowledge of the subject matter but rather their performance in a ranking exercise. This statement is obviously debatable. To allege that pressure, time restrictions, and difficult questions do not exist outside of the academic environment is ludicrous; however, once in practice, evenings, weekends, and nights can be intensively employed to improve on weaknesses identified during working hours.

This writer contends that passing a course with slightly over the 60% passing grade is no proof of an understanding of the subject matter. If

anything, it is convenient in allowing students to demonstrate a basic knowledge of the subject. For a mandatory course outside of the primary field of interest of a student, this weak performance may be sufficient and acceptable. However, one would expect each student to develop a taste for a particular aspect of civil engineering and demonstrate a more comprehensive knowledge in that subdiscipline, expressed by better grades. The writer has rarely seen students fail a course for which they are truly motivated.

Unfortunately, North American civil engineering programs are not currently structured to ensure that graduating students excel in at least one subdiscipline. In fact, it is conceivable—and often the case—that a student collects, after one or more attempts, the bare minimum passing mark in nearly all courses and graduates with a poor academic record. The existence of such students in all universities is a frequent cause of sour complaints throughout the academic community.

Shortage/Oversupply of Engineers

Despite all of the talk with regard to the potential future shortage of engineers, the current reality is much different: engineering is a very competitive environment. There is a large number of graduates competing for a limited job market. At all times, but particularly during recessions, many graduates fail to find employment in their field of interest. In good economic times, most universities brag that all their graduates have found a job, but the reality is that these are not necessarily permanent jobs. Most engineering firms hire on a trial basis, usually for a period equal to the maximum permissible time allowed by provincial or state laws up to which an employee can be fired without any compensation.

This practice allows the firm to internally assess the overall qualities of the candidate, including his technical abilities, while getting inexpensive labor. If the candidate is brilliant, his first months or years translate into a real benefit for the firm. Alternatively an atrocious employee is fired at the earliest moment to minimize losses, if any. The fate of these less-fortunate graduates, whose career is early set on the downward-path, remains uncertain. Thus full employment of a graduating class is an imperfect indicator of its long-term career success.

If there is a current shortage to be reported, it is not one of graduates, but rather one of good engineers. The much publicized future shortage could be very much the same.

Cutthroat Professional Fees

Once a good graduate has secured a job and become a professional engineer, he then finds himself in the ferociously competitive arena of low-price professional services. Unlike many other professions in which services are provided at a uniform cost throughout an industry (dentistry, for example), the engineering profession has been suckered into a price war.

Although most people would regard suspiciously a lawyer offering his services at 50% less than the competition, and not even consider visiting a dentist renowned more for his bargain-basement prices than for the quality of his work, buyers of engineering services seem satisfied that less is best. However deplorable, such an attitude can be understood coming from entrepreneurs who will not own the final engineered product for longer than the time of a sale; that public agencies adopt the same attitude toward projects that they will own, maintain, and repair forever is illogical.

Client education is lacking on two fronts. First, on the pricing of a product.

Most people are implicitly aware that there is a true cost for every basic product of a satisfactory quality. Around this true cost, there are alternatives of inferior price and quality, and upper-scale items that seem artificially high priced. The writer once read a sign in a shoe store that said, "If one can make shoes \$1.00 cheaper by reducing their quality by \$1.00, sure enough there will be fools to buy them." The writer confesses to having bought incredibly low-priced shoes that were found to have a useful life of approximately three months. However, the lesson has since been learned; he subsequently not only identified the quality/cost ratio appropriate to his needs, but in the process established brand-name preferences, and formulated clear expectations of costs and useful life. Unfortunately, most engineers have repeatedly witnessed instances in which public agencies have elected to hire small, inexpensive firms with limited resources on the basis that their proposals were a few dollars cheaper, only to be completely dissatisfied with the final product and to become entangled in time-consuming dead-end arguments and/or litigations. This nonsense seems destined to repeat itself endlessly, unless a radically new approach is taken regarding this least-cost philosophy.

The low-cost approach to engineering services is contrary to common sense. By definition, engineering is the search for economical solutions. All engineers know that the more time (i.e., more budget) they have to devote to a problem, the more likely they are to devise a higher-quality product, and a more economical one. A saving on engineering fees is a rather short-sighted approach, which can result in a higher cost for the final product or its construction.

This cheap-engineering philosophy is of serious, long-term, detrimental consequence to the profession itself. As so rightly stated by the Commissioner Inquiry of the in-service partial collapse of the Station Square structure that occurred in British Columbia, Canada, April 23, 1988 [Closkey 1988]

Owners and their representatives are increasingly calling for tenders from architects and engineers . . . In the past, fees for these services normally were based on a fraction of the value of the project, but with tendering, relatively intense competition has driven fee levels down, and this has raised questions about the quality of professional services in this environment. . . . Bidding for the provision of those services may result in the provision of those services at a lower rate, in the provision of fewer services at the same rate, or in some combination of the two. . . . The association [of professional engineers] maintains a "schedule of recommended fees" for members who practice as consultants. Compliance with this schedule is voluntary only and the association does not attempt to discipline members who deviate from it, out of concern for the "price fixing" provisions of the federal Competition Act.

Clearly, as engineering fees cannot be enforced in times and regions where recessionary pressures are acute, the competition for work becomes fierce, and fees may bear no relation to those necessary for the normal performance of engineering services, not to mention profit. It is noteworthy that, in the Station Square case, structural engineering services were provided for 0.31% of the cost of the building that collapsed, or for approximately half the cost of the building permit. One of the recommendations of the Inquiry Com-

missioner to the Lieutenant-Governor-in-Council was that the Engineers Act be amended to permit an enforceable schedule of minimum engineering fees.

According to the perfect-market economic theory, the profit on any product must become null with time (Lipsey et al. 1982), and engineers have little to gain by trying to shoehorn their professional responsibilities into an ever-decreasing fee. At best, not-so-good engineers can thrive by providing mediocre services at a low cost, again to the detriment of the good engineering. Even under these conditions, any professional is bound to question the value of his work in an environment in which price is the ultimate gauge of his performance.

Fortunately, many firms have been successful in marketing one or more of their specific strengths in an effort to counteract low-cost pressures. Many strategies on how to achieve this result are available in the published literature (Gerwick 1983). And, thankfully, some public agencies have devised alternative ranking systems whose emphasis is not all cost oriented, although much remains to be done to enhance the methodology followed by these systems.

Years of pressures to keep engineering costs down has exacted a toll on the profession, largely in terms of self-imposed wage restraints on engineer employees. In some regions where the economy has been depressed for years, this self-punishment now verges on being worthy of ridicule.

Low Salary Pressures and Lack of Job Security

External pressuring toward the lowest possible professional fees directly impacts the internal structure of an engineering firm, as briefly introduced in the previous section. Although overall salaries remain fair relative to other professions, there is no compelling reason to believe that engineers would not accept working for less money. Based on taxation statistics from Revenue Canada, the total income of engineers and architects (combined average) doubled between 1968-88, thanks largely to inflation, while the

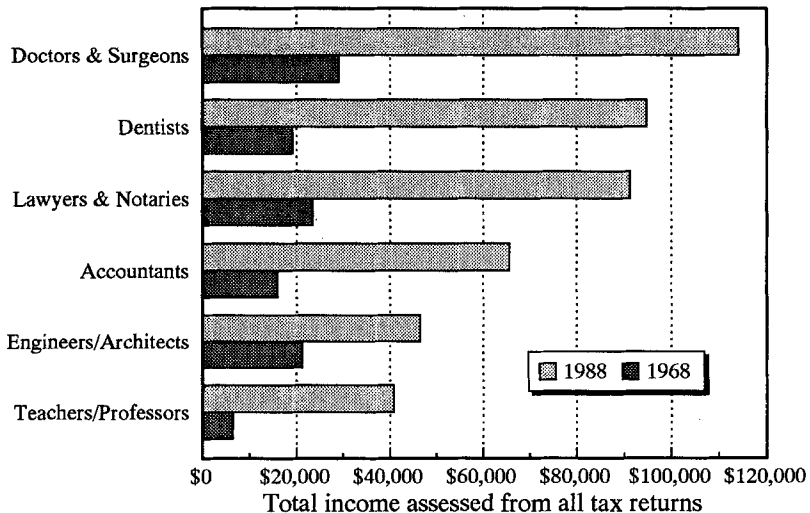


FIG. 1. Variation of Income of Self-Employed Professionals from 1968 to 1988

income of most other professions has increased fourfold or more, revealing a net and serious relative loss for engineers [Fig. 1 (Association of Professional Engineers of Ontario, personal communication, 1991)]. Although the results for civil engineers alone were not available to the writer, it usually comes as quite a surprise to younger engineers to learn that their peers once earned nearly as much as lawyers, and definitely more than dentists and accountants. Civil engineers now trail far behind all of these groups and are about to be passed by grade-school teachers (thanks to strong Canadian teachers' unions). A similar trend has developed in the United States, as reported in a study comparing the starting salaries of civil engineers with those of other professions (Alexander 1991).

Everybody knows that a university degree nowadays bears little relationship to future income. However, engineers have traditionally believed that salary and level of responsibility are closely interrelated. Although this responsibility/income symbiosis may prove to be true within the profession, compared to other professions (computer scientists, grade-school teachers, etc.), engineers are undeniably the underpaid member of society.

To make matters worse, civil engineers enjoy comparatively far less job security and employment benefits than are found in most other professions. In extreme cases, some are still employed on a project-per-project basis, and released in between. Most other professions subjected to repeated fluctuations in work load usually compensate for those downtimes by building up wealth in the uptimes, but engineers are usually denied this opportunity, for obvious reasons.

Increasingly, younger engineers have had difficulty rationalizing that their working conditions barely exceed those of municipal policemen or grade-school teachers. Whether to make the reality more palatable, or whether they truly believe it, these engineers all subscribe to the classic one-liner "I'm not in it for the money." For reasons previously stated, this is the perfect attitude to ensure a further decline in salaries. It perpetuates an attitude of low self-worth and of powerlessness. Do engineers feel that their title is unprestigious and easily acquired, and their profession undeserving and one without accomplishments?

In the meantime, the perception is that financial success lies in the hands of the partners who participate in the profit sharing and managerial aspects of the firms. All employed engineers aspire to be rewarded by such status. There is nothing wrong with this position, although it can lead to the potential offspring of new firms set up by past members of a larger firm, which will then compete directly for the same customer base, further increasing the aforementioned low-fee pressures. An across-the-board improvement in working conditions would probably not curtail this largely ambition-driven phenomenon. However, the point is that engineers at all levels of responsibility would obviously benefit from any improvement.

In brief, so many complaints have been voiced regarding salary issues that the writer now wonders how to qualify his reply to high-school students visiting his university for the annual open house, at which they inevitably inquire about this matter.

Noninnovative Practice/Low-Tech Profile

As a consequence of the time and budget pressures on most projects, engineers will resist departing from traditional and proven techniques. Although trade magazines are full of descriptions of projects in which inno-

vative technology was employed, many engineers still somehow claim that the field is outrageously conservative and remains low-tech.

The writer is biased against these claims in light of his research-oriented professional activities, but the message from a number of designers appears to be that their right to engineer has been replaced by a duty to produce. Thus, opportunities for professional development and innovation are beyond the reach of these engineers. Consequently, this unduly delays the adoption of more rational methods of analysis and design, and can extend the life of obsolete and conceptually deficient approaches (unless changes can yield overwhelming savings in engineering time). By analogy, if dentists acted as engineers, they would be promoting the pulling-out of teeth as opposed to the performance of root-canal treatments. To their credit, in spite of the nearly 10-fold cost differential, dentists have no qualms about promoting the higher-technology solution.

Still, given the nature of engineering and its wealth of opportunities, it is difficult to understand how a designer can chain himself to an unsatisfactory, nonfulfilling job. Worse, one may seriously question the current well-being of the profession at large after seeing many practicing engineers openly and routinely comment that they are encouraging their children not to become engineers. Needless to say, these comments do no good to the public profile of the profession.

MODELING THE INTERRELATION OF CONCERNS—THE PROFESSIONAL WELL-BEING CHART

Many of the commonly expressed concerns on the state of the profession (as grouped in the aforementioned categories) are interrelated and linked, as schematically summarized in Fig. 2. It is the writer's contention that all of these negative aspects influence the public perception and can progressively contribute to a further decline of the well-being of the profession.

However, the static representation of Fig. 2 is of no assistance in mea-

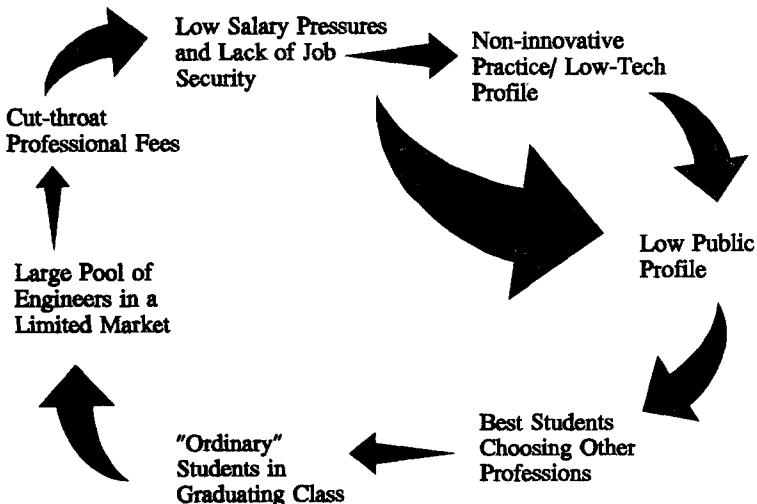


FIG. 2. Interrelationship between Key Professional Aspects of Civil Engineering

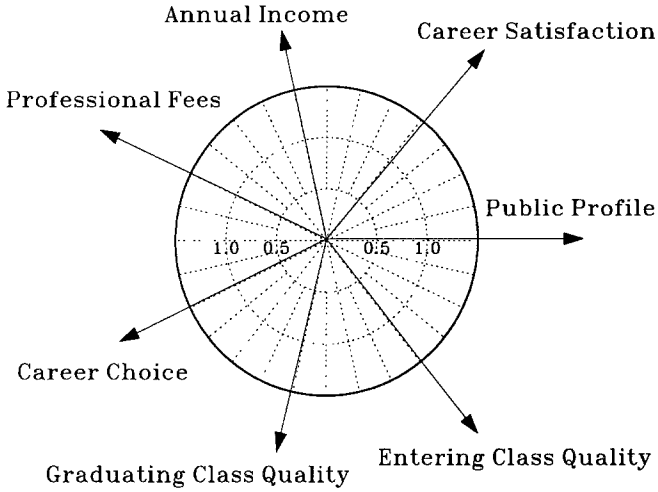


FIG. 3. Professional Well-Being Chart

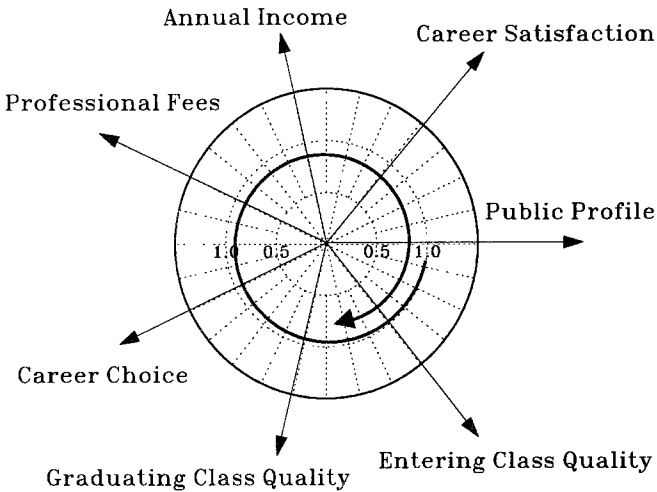


FIG. 4. Spline-Curve of Data Collected Sequentially—Theoretical Example

asuring improvements or deterioration of this well-being. A better representation of this interrelationship is proposed in Fig. 3. The professional well-being chart of Fig. 3 is a concentric polar plot with multiple axes. Each axis is descriptive of one of the categories listed in Fig. 2 and described in the previous section. By periodically measuring the state of well-being in each category (i.e., along each axis), a dynamic recording of the profession's overall well-being and its evolution is possible. The monitoring of this progress can then be instrumental in formulating corrective policies, if judged necessary.

Normalized performance indices, with values set equal to 1.0 along each

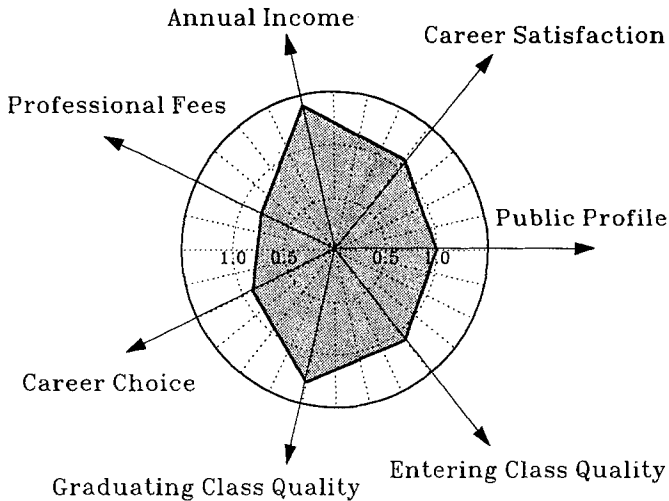


FIG. 5. Surface Area of Data Collected Simultaneously—Theoretical Example

axis at the start of the monitoring period, are one possible way to measure this state of well-being in each category, but alternative methods could be devised. If data are periodically gathered in the sequence corresponding to Fig. 3, a spline-curve of the results can eloquently illustrate the evolution of the well-being of the profession. For example, a profession becoming progressively less attractive every year would find itself on a collapsing spiral path, as shown in Fig. 4. An expanding spiral path would correspond to the opposite scenario.

Alternatively, if all of the data are gathered simultaneously, connecting the various indices by a curve may erroneously suggest a time dependency unrelated to the data collection method. In this particular case, a global measure of the enclosed surface could provide an annual global index, against which progress could be gauged, as shown in Fig. 5.

MONITORING THE WELL-BEING OF THE PROFESSION

For the aforementioned model to be effective, a formal method of monitoring each of the seven indices must be devised. Data must be gathered, then analyzed by one of the many existing methods. The writer suggests in the following section one possible way that this can be achieved, mainly to demonstrate that it can realistically be done. Undoubtedly, superior methods can be formulated by professional associations wishing to conduct such monitoring operations. Independent monitoring should be conducted in each province or state. The results for California bear no direct significance to the well-being of engineers in Ontario, because the civil engineering works in these dissimilar areas can have significantly diverse implications, on both the public perception and on working conditions.

The public profile of the engineering profession can easily be gauged by contracting a survey agency to ask a few yes/no questions to the general public. These questions could be “Do you see civil engineers as having a positive impact on society?” “Do you know what a civil engineer does?” and “Would you encourage your children to become civil engineers?” This

simple set of yes/no answers would allow civil engineers to assess whether or not the general public values, understands, and respects the profession. The writer contends that these three aspects are closely interrelated, and that giving equal weight to each of the questions would be proper. A composite public profile index (PPI) could be constructed from this information, using an equation such as

$$PPI = \frac{(\% \text{ of yes})^{\text{given year}}}{(\% \text{ of yes})^{\text{reference year}}} \dots\dots\dots (1)$$

Because the results for the reference year are currently unknown, the sensitivity of this index is unknown and adjustments to the way this PPI is calculated are possible over the long run.

The quality of the entering classes in civil engineering can easily be assessed from statistics published in many provinces and states. In Ontario, the average grade of high-school students entering civil engineering usually hovers at around 80%. The quality of the graduating classes in civil engineering may be more difficult to assess. This average is not necessarily readily available; it can easily be compiled and provided to the professional associations, with or without confidentiality agreements, as seen fit. However, this last measurement could not be indirectly inferred from the passing grade on professional civil engineering exams in states where these are given, because these exams exclude many graduates who elect not to take these exams, and the average grade on these professional exams is not proven to be correlated to that of the graduating class.

Thus, the quality of the entering and graduating class indices (QECI and QGCI respectively) could be monitored by

$$QECI \text{ or } QGCI = \frac{(\text{grade average of group})^{\text{given year}}}{(\text{grade average of group})^{\text{reference year}}} \dots\dots\dots (2)$$

Ideally, a career choice index would aim at monitoring the success or desire of graduates in actively practicing civil engineering following graduation. A close monitoring of each graduate and his or her long-term career path is obviously unrealistic. However, a short-term monitoring is possible by comparing the yearly number of newly registered civil engineers (NNRCE) with the number of civil engineering graduates (NCEG) a few years earlier. This lag time is a function of the average time between graduation and registration according to each province or state. Therefore, the career choice index (CCI) becomes

$$CCI = \frac{\left(\frac{NNRCE}{NCEG}\right)^{\text{given year}}}{\left(\frac{NNRCE}{NCEG}\right)^{\text{reference year}}} \dots\dots\dots (3)$$

The adequacy of professional fees is the most difficult performance index to measure. In a good marketing fashion, engineering services are billed in a number of varying ways (fixed fees, cost-plus, etc.) as seen fit for each project. In addition, even if a prorated hourly rate calculation was possible for comparison with the recommended rates of the professional associations, it is unlikely that private companies would divulge such strategic financial information. At best, the voluntary participation of public agencies (or,

indirectly, their engineers) could be enlisted to provide the average cost of civil engineering fees as a percentage of the total project cost. Although the shortcomings of such a comparison are obvious, it could be a sufficient indicator while awaiting more accurate information. Tentatively, the professional engineering fees index (PEFI) could be

$$\text{PEFI} = \frac{(\text{fees as \% of total cost})^{\text{given year}}}{(\text{fees as \% of total cost})^{\text{reference year}}} \dots\dots\dots (4)$$

Evolution in annual income is undoubtedly the easiest index to measure, given the existing salary surveys conducted by the various professional associations across North America. The exercise should not only compare average income in inflation-corrected dollars, but, more importantly, compare the income of civil engineers (ICE) to that of a selected sample of other nonengineering professions (INEP). A mutually beneficial exchange of the necessary information could be arranged between the various concerned professional associations. The comparative annual income index (CAII) could then be

$$\text{CAII} = \frac{\left(\frac{\text{ICE}}{\text{INEP}}\right)^{\text{given year}}}{\left(\frac{\text{ICE}}{\text{INEP}}\right)^{\text{reference year}}} \dots\dots\dots (5)$$

Finally, the career satisfaction index is easy to obtain. Given that most professional associations already perform salary surveys by forwarding questionnaires to registered civil engineers, the addition of one simple question to the form would provide all of the necessary information. This question could be: "How much satisfaction do you get from practicing your profession, on a scale from 1 (least satisfaction) to 100 (most satisfaction)?" It could also be interesting to repeat the question: "Would you encourage your children to become civil engineers?," as an additional measure of self-esteem within the profession. Either way, the career satisfaction index (CSI) could be measured by

$$\text{CSI} = \frac{(\text{satisfaction \% grade})^{\text{given year}}}{(\text{satisfaction \% grade})^{\text{reference year}}} \dots\dots\dots (6)$$

In all cases, the anticipated annual variations of these factors would be small and would likely not lead to dramatic adjustments within the profession. However, over a period of five to 10 years, definite trends on the well-being of the profession would be revealed. These results, hopefully, would be substantiative enough to either confirm or repudiate the aforementioned pessimistic views on the state of the profession. Following a close review and interpretation of the data, effective corrective measures could be taken if needed.

CONCLUSIONS

Often-heard complaints about the civil engineering profession have been compiled under broad categories. It is proposed that a straightforward closed-loop relationship exists between these categories; consequently, the evolution or decline of the well-being of the profession can be plotted on a

multiaxial polar plot. A procedure to collect and analyze the data for this plot is suggested to periodically monitor the state of the profession, and reveal clear trends over a number of years for which well-targeted, concerted corrective measures can be taken if necessary.

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