PROTECTING THE PUBLIC AND THE ENVIRONMENT

– A Responsibility of Canadian Professional Engineers –

A Report of the

Canadian Academy of Engineering

Prepared by a Task Group chaired by
Dr. Gordon Slemon, FCAE
February 2002

ISBN: 0-9682770-7-1

Canadian Academy of Engineering
180 Elgin Street, Suite 1100
Ottawa ON K2P 2K3

Tel: (613) 235-9056 Fax: (613) 235-6861
acadeng@ccpe.ca
www.acad-eng-gen.ca

PROTECTING THE PUBLIC AND THE ENVIRONMENT

- A Responsibility of Canadian Professional Engineers -

EXECUTIVE SUMMARY

The profession of engineering in Canada faces a number of issues: an increased public concern for health, safety and the environment, the expanding roles filled by engineers coupled with increased interaction with other professions and occupations, a decrease in professional engineering licensing (particularly in the rapidly-expanding computer and biology related disciplines) and questions from employee engineers regarding the value of professional registration.

In view of these concerns, the Canadian Academy of Engineering undertook a study of areas where the engineering profession could evolve to enhance its stature and its service to the public. Accepting without elaboration the many positive contributions and accomplishments of engineering, the study report focuses on the profession itself. It concludes that most of these concerns can best be addressed by enhancing the basic reason for existence of a licensed profession of engineering, that of ensuring that the benefits of engineering activity are provided with adequate measures for protecting the health, safety and well-being of the public and the safeguarding of the environment.

This report has been produced primarily to stimulate discussion and action by engineers in Canada and, particularly, by the responsible councils and committees of their provincial and territorial Associations of Professional Engineers/Ordre des ingénieurs du Québec and their coordinating body, the Canadian Council of Professional Engineers.

The report recommends that a clause on acceptance of responsibility be included in the legal definition of the practice of engineering and that employers assign responsibility to an echelon of qualified professional engineers on any engineering-related project which involves potential risk to health, safety or the environment, whether the products or services are provided directly to the public or through the marketplace. Such assignment should be required for companies providing services where failure can have a major impact on life and property. Other companies with potential for adverse impact should be encouraged to adopt a voluntary approach to assignment of responsibility.

Individual employee engineers are encouraged to exercise voluntarily their duty to the public by anticipating the impact of their work and alerting their employers to the potential for adverse impact. In case this leads to an unresolved conflict between the employee and the employer, it is recommended that the responsibility for resolution be transferred to the Association, thus obviating any occasion for individual “whistle blowing”.

To accommodate the increased interaction of professional engineers with team members from other professions and disciplines, it is recommended that cooperation agreements be negotiated with the appropriate bodies, making adequate provision for engineers to carry out their special responsibility in the protection of the public.

Engineering as a profession in Canada is a world leader in its regulation, its self governance and the competence of its members. The proposals and recommendations of this report are directed at enhancing still further the stature, relevance, public service and perception of the profession, an enhancement that can be best achieved by accepting more fully the special responsibility of engineers to the public in matters of safety, health and environment.

In making these recommendations the Canadian Academy of Engineering recognizes that many of these issues have been under discussion in the Associations and in the Canadian Council of Professional Engineers. It is hoped that these views of an external and independent body will serve to promote discussion and facilitate action. The Academy is willing to assist in any way that is considered appropriate.

The full report can be downloaded from the Academy's web site: *www.acad-eng-gen.ca.*

RECOMMENDATIONS

A To clarify the guardian role of the profession of engineering for the public and for engineers, the Academy recommends :

That the role of professional engineers as protectors of the health and safety of the public and as guardians of the environment be given paramount attention in the evolution of the engineering profession in Canada. [1]

That the Canadian Council of Professional Engineers (CCPE) and the provincial/territorial Associations give wide publicity to the commitment made by their professional engineering members in their Code of Ethics to the welfare of the public. [2]

B To establish uniform legislation of the engineering profession adequate for the protection of the public, the Academy recommends:

That the Associations in cooperation through CCPE take action to establish a standard legal definition of the practice of engineering, that this definition include the safeguarded areas of the CCPE definition and that it incorporate a specific statement on the acceptance of responsibility. [3]

That legislation be clarified, where necessary, to ensure that responsibility for engineering work deemed to be important to the health and safety of the public is reserved for professional engineers whether or not the work is carried out directly for a public client. [4]

C To implement the extended public protection role of professional engineers employed in industry, the Academy recommends:

That the Associations encourage corporations operating under a certificate or permit to practice, to assign responsibility for engineering-related work to an echelon of professional engineers having an appropriate range of competence. [5]

That the Associations take action to ensure that assignment of specific responsibility for engineering work to an echelon of professional engineers having appropriate competence is a requirement for those corporations providing engineering related products and services which are judged to be critical to the health and safety of the public and to the control of environmental impact. [6]

That the Associations, coordinated through CCPE, launch a campaign to demonstrate to engineering-related companies the advantages of voluntary compliance with legislation related to the protection of the public, through assignment of responsibility to professional engineers. [7]

That the Associations encourage professional engineers employed in industry to accept voluntarily personal responsibility to the public for predicting the impact of their engineering activities and informing their employers of potential risks. [8]

That the Associations encourage professional engineers individually or collectively to negotiate employment agreements or contracts with their employers, which make adequate provision for their responsibility to the public. [9]

That the Associations establish workable processes of mediation and intervention, to support professional engineers who are in dispute with their employers on matters relating to responsibility for public welfare, and that the Associations assume ultimate responsibility for public protection as necessary. [10]

D To ensure and enhance the protection of the public in shared areas the Academy recommends:

That the Associations, coordinated through CCPE, negotiate appropriate cooperative arrangements for shared jurisdiction in areas of the public interest, which are common to two or more licensed professions. [11]

That, in the public interest, the Associations take action to ensure that professional engineers take a leading position in areas of engineering-related work, which has health, safety or environmental impact, and which is shared with members of non-regulated or non-licensed bodies. [12]

PROTECTING THE PUBLIC AND THE ENVIRONMENT

– A Responsibility of Canadian Professional Engineers –

INTRODUCTION

The impact of engineering on society is all pervading and continues to increase. Unquestionably, engineering plays a major role in providing society with useful products, infrastructure and services and in the creation of new wealth. It is for this role that the engineering profession is best known.

Arising from their specialized knowledge and skill, engineers have a special responsibility in ensuring that the benefits of engineering activity are provided to society, along with adequate measures for protecting the health, safety and well being of the public, and for preserving the environment.

This report, developed by the Canadian Academy of Engineering (CAE), explores the question:

> "*Is the legislation and practice of professional engineering in Canada adequate to provide the public with the protection that it needs and deserves?*"

Canadian engineers are widely regarded as being among the best in the world. Canada's approach to the organization and administration of the profession of engineering has been admirable. It is a world leader in its breadth of coverage and in the equity, rigour and effectiveness of its self governance. However, the scope of engineering is rapidly expanding and the potential for impact on safety, health and the environment is growing. The Canadian Academy of Engineering considers that a review of the professional role of engineers is desirable at this time, and that the credibility of its conclusions may be enhanced by being undertaken by a independent unbiased body of senior professional engineers.

This report has been produced to stimulate discussion and action by engineers in Canada, and particularly by the councils and committees of their provincial and territorial Associations of Professional Engineers/Ordre des ingénieurs du Québec (Associations) and their coordinating agency, the Canadian Council of Professional Engineers (CCPE).

A LEGALLY-RECOGNIZED PROFESSION OF ENGINEERING

The central role of engineering is to design and innovate the products, processes, infrastructure and systems that serve society and create wealth. In carrying out this role, the engineering profession is effectively supported by an array of educational establishments, technical societies and trade organizations. This report is focussed particularly on the special professional status and responsibility of engineers, which arises out of the impact that these engineering activities

can have on the health, safety and well being of the public, on the health of the environment and on long-term sustainability. In each of the provinces and territories in Canada there is legislation which, in the public interest, assigns certain areas of work exclusively to licensed professional engineers. In this section we examine the need, the principles and adequacy of such legislation. Without the recognition of this special responsibility to public welfare, there would be no need for a legally-recognized and regulated profession of engineering.

The term "profession" is used by many in our society including professional athletes and musicians. For the purposes of this report, this term will be restricted to describe those who qualify, in the public interest, to be legally granted an exclusive area of activity and right to practice.

There are three essential attributes of members of a legally-recognized profession. The professional must be competent, must act ethically and must accept responsibility. These are the attributes that provide assurance to the public that its crucial interests are being protected in areas where the public cannot be expected to have the necessary competence and judgment.

Traditionally, the major areas of engineering activity that have been so covered relate to construction, consulting and some areas of operation. There are however activities in essentially all disciplines of engineering for which the public needs protection. Newer disciplines – such as software engineering, information engineering and bio-engineering – introduce new and real concerns for the protection and welfare of the public. Issues of environmental control and sustainability are also of major and increasing public concern.

We recommend: That the role of professional engineers as protectors of the health and safety of the public and as guardians of the environment be given paramount attention in the evolution of the engineering profession in Canada. [1]

Publicity on Ethics: The public is not generally aware of the commitment that is made by Canadian professional engineers in their Code of Ethics to public welfare. The Associations could do much to enhance the reputation of the profession for responsibility and public service by publicizing this commitment and the expectations that the public should have of members of the profession. The public image of professional engineering could be clarified and promoted by publicity focussed on the paramount duty of professional engineers to public welfare, coupled with a statement of how engineering design and planning predetermines much of the eventual impact on safety, health and the environment.

Some engineers may see such publicity as an invitation to become the central target of certain pressure groups. They may prefer to keep a low profile and allow the main attention to be directed toward politicians, scientists and business leaders. However this "quiet, unknown" position, all-too-frequently adopted in the past by engineers, is not compatible with the desired image of a proactive profession with a special responsibility for the protection of public welfare.

We recommend: That the Canadian Council of Professional Engineers (CCPE) and the provincial/territorial Associations give wide publicity to the commitment made by their professional engineering members in their Code of Ethics to the welfare of the public. [2]

DEFINITION OF ENGINEERING

To establish a clear understanding of the scope and bounds of the engineering profession, an effective definition of engineering is required. The Academy has attempted to capture the essence of engineering as follows:

> *Engineering is a profession concerned with the creation of new and improved systems, processes and products to serve human needs. The central focus of engineering is design, an art entailing the exercise of ingenuity, imagination, knowledge, skill, discipline and judgment based on experience. The practice of professional engineering requires a mastery of engineering methodology together with a sensitivity to the physical potential of materials, to the logic of mathematics, to the constraints of human resources, physical resources and economics, to the minimization of risk, to the protection of the public and the environment.*

This definition may be useful in describing desired attributes of an engineer. However, it is not a legally-useful definition which can clearly distinguish boundaries between professional engineers and others or distinguish functions which must be reserved for licenced professionals.

The CCPE Guidelines include the following definition:

> *The "practice of professional engineering" means any act of planning, designing, composing, evaluating, advising, reporting, directing or supervising, or managing any of the foregoing, that requires the application of engineering principles, and that concerns the safeguarding of life, health, property, economic interests, the public welfare or the environment.*

The list of functions in this definition is appropriate for engineering but some detailed modification may be deemed necessary to arrive at acceptable relations with related professions and disciplines. For example, the definition adopted in Ontario is similar to that in the CCPE guidelines but the functions of planning and managing are not included although these are important engineering functions. Also in Ontario, the phrase "*but does not include practising as a natural scientist*" has been added. but without defining the practice of natural science.

The phrase "*requires the application of engineering principles*" may be appealing to engineers but does little to define the boundaries of the profession or to inform the public. Any argument

for its use is inherently circular, ie. "*engineering is what engineers do*". The Alberta definition uses the phrase, "*principles of mathematics, chemistry, physics or any related applied subject*". Some may question whether such a phrase covers adequately the important non-physical engineering principles such as occur in software, control and optimization. Detailed definition of the wide variety of principles applicable to the many branches of engineering has been attempted but has not been found to be practical. A preferable approach is to retain the CCPE wording and qualify it for any specific justifiable instance of conflict.

Arguments of varying weight may be made regarding the list of areas to be safeguarded. For example, the Ontario definition does not include economic interests or the environment. The Alberta definition does not contain any safeguarding clause. Breadth in this list of safeguarded areas is important in the public interest. As a minimum, the areas of life, health and the environment should be included. Also, retention of a general phrase such as "public welfare" provides a flexibility to respond to a range of risks to society as they are encountered.

The CCPE definition is sufficiently broad to apply to the activities of most of those who have graduated with a baccalaureate in engineering. Essentially all will carry out one or more of the broad range of functions listed, and will make some use of engineering principles, even if working in such areas as management, financial services and entertainment. Also, it would be difficult to envision areas of their activity that would not impinge in some way on one or more of life, health, property, economic interests, the public welfare or the environment.

The CCPE definition of engineering has the advantage that it includes all those who consider themselves engineers. However, when used in legislation, the definition might be interpreted to mean that all work within the definition should be reserved specifically for licensed professional engineers. Such an interpretation is much more far-reaching than is reflected in most current practice, and is deemed to be impractical and unnecessary.

The CCPE definition does not define with precision what distinguishes professional engineers from others. For example, a technologist or technician may, using engineering principles, design a product which is intended to safeguard certain property or economic interests of a client. This would appear to qualify under this definition. What is desired for legal purposes is a definition that is focussed specifically on the need to provide adequate protection of the public.

Earlier it was noted that a professional must be competent, must act ethically and must accept responsibility. There are many who would argue that they possess the needed competence to carry out engineering work. They may well be part of the team which is carrying out functions listed in the CCPE definition. Some may be licensed as technologists or technicians. Thus, while competence is essential, it alone does not define the profession.

Professional engineers adhere to a **Code of Ethics** that guides them in their relationships to society and to other professionals, and also limits their practice to their specific areas of competence. However, adherence to a Code of Ethics is not in itself enough to define the licensed profession. Many others may be willing to adopt such a code, possibly through their

membership in an appropriate technical society. While this may contribute somewhat to public confidence, it lacks an adequate and credible system of public accountability, discipline and enforcement.

The acceptance of responsibility appears to be the major feature that distinguishes a legally regulated professional from those in other occupations. It is through this assumption of responsibility that the professional gives assurance and security to the client in an area where the client must rely on the advice and judgment of the professional rather than solely his/her own judgment. A continual awareness of this responsibility and its implications leads the professional to achieve and retain a necessary level of competence and to act ethically.

The CCPE definition of professional engineering can be made specific in the area of responsibility by amending it to read:

> *The "practice of professional engineering" means providing and accepting responsibility for any act of planning. designing, composing, evaluating , advising, reporting, directing or supervising, or managing any of the foregoing that requires the application of engineering principles, and that concerns the safeguarding of life, health, property, economic interests, the public welfare or the environment.*

If so amended, the definition would draw a distinction between those who accept responsibility and can be held accountable, and those whose contribution is primarily their expertise.

We recommend: That the Associations in cooperation through CCPE take action to establish a standard legal definition of the practice of engineering, that this definition include the safeguarded areas of the CCPE definition, and that it incorporate a specific statement on the acceptance of responsibility. [3]

ACTIVITIES REQUIRING A LICENSE TO PRACTICE

The objective of legislation relating to the practice of professional engineering is the delegation of responsibility and accountability for protecting the public. Many societies, through their governments, have enacted legislation which requires that a licensed professional engineer take responsibility for certain classes of work having significant safety or health implications when carried out directly for public bodies or individuals. Such legislation has direct application to only a small minority of engineers. It is worth examining whether this restricted range of application provides adequate public protection.

Products and Services: If engineering work is deemed to be important to the health and safety of the public or to the preservation and sustainability of the environment, it is immaterial whether it is carried out directly for a public client or whether it is provided through the public marketplace by a company or agency. The public can certainly be placed at risk because of

failures in manufactured products. The public welfare can be seriously disrupted and damaged by failures in major engineered systems such as electricity generation and distribution, communications networks, transportation systems, manufacturing facilities, fuel supply systems and financial systems. In the extreme, such failures in systems or products can be catastrophic, can lead to loss of life and can result in significant economic harm to the nation.

Governments require compelling evidence of significant public risk to impose restrictions on freedom of employment. In the case of professional engineering, the strongest evidence for new restrictions comes from incidents, failures and accidents that have placed the public in danger. A typical response following such an occurrence is specific amendment of regulations expanding the domain for which a professional engineer must take responsibility. A recent case related to a requirement that professional engineers oversee community water supply installations in Ontario.

This reactive approach is deemed to be inadequate, particularly in an era when there is rapid or revolutionary development and technological innovation. The central role of engineers is the design of products, systems and processes, and the specification of procedures for operation, inspection and maintenance. It is at this design stage that most of the potential for success and failure is built in. A much more effective protection of the public can be achieved by requiring design leaders to foresee the implications of their designs and take a measure of responsibility for eventual outcomes.

We recommend: That legislation be clarified, if necessary, to ensure that responsibility for engineering work deemed to be important to public health, safety and sustainability of the environment is reserved for professional engineers, whether or not the work is carried out directly for a public client. [4]

LICENSING AND THE EMPLOYEE ENGINEER

The typical Code of Ethics to which professional engineers subscribe calls on them to regard their duty to public welfare as paramount. Engineers are aware that the operations, products and services provided to the public by their employing companies can impinge, directly or indirectly, on health, safety, property and the environment. What should then be their position as employee engineers?

The range of the practice of engineering under the current CCPE definition appears to be very broad. However, the number of engineers who are required to be licensed is limited in most provinces/territories by a provision that excludes those who are practising engineering where a professional engineer assumes responsibility. This exclusion allows some unlicensed individuals to do engineering work and allows engineers in training to gain necessary experience.

The responsibility clause proposed in the engineering definition of recommendation [3] narrows the definition of the practice of engineering as compared with the CCPE definition. However,

with this typical exclusion clause in present legislation, the requirement for licensing is actually limited to those who have been assigned responsibility.

Echelon of Responsibility: Professional engineering legislation normally requires that companies doing engineering work which impinges on health, safety and the environment obtain a permit or certificate to practice. A normal requirement of this permit is that the company employ a professional engineer to take responsibility for the work. In companies which have a well-defined, single-disciplinary area of activity, delegation of responsibility to a single professional engineer may occasionally be considered adequate. However today, much engineering work is done with teams including senior and junior engineers of several disciplines as well as technologists, other professionals and scientists. In these circumstances, it becomes evident that it is inadequate to assign responsibility to a single chief engineer. It is unreasonable to expect that one person can have all the knowledge and skills needed for the design of most engineering projects. As an example, many engineered products and systems will contain software components. Unless the chief engineer is expert in the software area, she/he cannot reasonably take full responsibility for this aspect. The responsibility of the chief engineer in this instance should be to ensure that this area of work is assigned to someone in the team who is in a position to accept such professional responsibility. Depending on the nature, scope and complexity of the work, a tree of clearly assigned responsibilities would need to be established.

We recommend: That the Associations encourage corporations operating under a certificate or permit to practice, to assign responsibility for engineering-related work to an echelon of professional engineers having an appropriate range of competence. [5]

Government employees: Engineering legislation often provides exemptions from required licensing for the engineering-related work of employees of governments and their agencies. It can be argued that this work has significant public impact, that there is a need for assurance of professional competence and accountability, and that the removal of this exemption would be in the public interest.

In-house engineering: Some engineering legislation provides exemption from required licensing of employees for the engineering of facilities for use in production by an employer. These facilities can impact on the health, safety and the environment of the company's employees, and should logically be subject to the same provisions as apply to the external public.

Industrial exemption: In practice, the range of activities that is actually reserved for professional engineers has been even further limited by a perception or interpretation of the applicability of the legislation to that majority of engineers who are employed in industry**.** Many engineers and their employers are under the impression that they are covered by an industrial exemption clause under which is assumed that it is the employing company that takes responsibility. Relying on this assumption, many industrial companies place very little value on whether any of their engineers are licensed.

Such a blanket exemption for industry does apply in most states of the United States and no requirements for employment in industry of licensed professional engineers exist in many other countries. With the proliferation of multinational companies and international trade, it is not surprising that many Canadian companies and their engineers incorrectly assume that a blanket exemption applies here, or that their activities do not fall under the terms of the legislation.

Opposition: Strong opposition from industry can be expected in any attempt to place constraints on their freedom of choice in employment. Industrial employers will be particularly opposed to a general requirement that all their employees who practice engineering according to the present definition be professionally registered. They will contend that such a restriction is not justified or necessary in the public interest. They will contend that they assure themselves that the people to whom they assign responsibility are competent. They will hold that it is the company that takes overall responsibility for its products and services. They will contend that such a requirement would place them at a serious competitive disadvantage in the world marketplace, since other countries do not have such a requirement. In particular, they note that in the United States, our major trading partner, the engineering profession is considerably less regulated than in Canada.

Opposition may also be expected from some groups of employees who will contend that their freedom to work in areas where they deem themselves to be competent is being unreasonably restricted. They may contend that professional engineers are really attempting to protect their turf without adequate justification.

Counterarguments: In view of its special role in the protection of public welfare, the engineering profession in Canada has a responsibility to put forward valid and effective counterarguments. It is unquestionable that the products and services of many companies can have a significant impact on the health, safety or property of the public and on the environment. Also the design of these products and services usually does involve the practice of engineering.

Employers may contend that they operate within a set of accepted codes, standards and regulations that are designed to protect and serve the public. In a very stable industry it may be argued that the public can be adequately protected by having the company adhere to these accepted standards and regulations. But, with today's rapidly changing technology and with rapidly evolving safety and environmental concerns, standards and codes may be far too slow in development and adoption to provide adequate protection for the public.

Employers may contend that it is the company that takes responsibility. Under this company-based approach, employee engineers may assume that they are absolved of direct responsibility. In response, it can be argued that the safeguarding of the public cannot adequately be provided solely by an impersonal corporate entity. It must involve the direct responsibility of individuals. Unless responsibility and accountability are specifically assigned to competent individuals, they may well be ignored.

The company normally carries appropriate liability insurance to cover damage settlements following a failure. It is questionable whether the public is adequately protected under such a reactive insurance-based approach. The public is concerned that failures and damages be prevented rather than just compensated after the fact. It is therefore essential that persons who are knowledgeable and accountable take responsibility for each critical function, process or system that can place public welfare at risk.

Given the current situation and attitudes in industry, any sweeping extension of professional engineering legislation or its enforcement in Canadian jurisdictions would not appear to be acceptable, feasible or advisable. However, consideration should be given to aggressive but reasonable incremental measures that would progressively enhance both public safety and public welfare.

Mandatory Compliance: In the public interest, consideration should be given to a review of areas justifying mandatory compliance. A mandatory requirement that certain responsibilities in corporations be assigned to an echelon of professional engineers should be enforced for certain classes of corporations which provide general public services such as communications, electricity, fuel, transportation, banking and credit and also to corporations for which pollution control is of special importance to society. Failure of some of these services can have catastrophic effects. Competent engineering design and control is needed to minimize the likelihood of failures and to mitigate their damaging effects.

We recommend: That the Associations take action to ensure that assignment of specific responsibility for engineering work to an echelon of professional engineers having appropriate competence is a requirement for those corporations providing engineering related products and services which are judged to be critical to the health and safety of the public and to the control of environmental impact. [6]

Voluntary Compliance: The products and services provided by many companies to the general public through the marketplace may have a significant impact on public health, on safety, on property and on the environment, but this impact may not be considered to be sufficient to justify mandatory compliance at this time. It seems reasonable that these companies be identified and encouraged to assign responsibility to one or more professional engineers. A number of companies supplying the marketplace have voluntarily adopted this practice. Such a positive response from a number of leading corporations establishes a good precedent for others.

We recommend: That the Associations, coordinated through CCPE, launch a campaign to demonstrate to engineering-related companies the advantages of voluntary compliance with legislation related to the protection of the public, through assignment of responsibility to professional engineers. [7]

Advantages of Voluntary Compliance: Recognizing that imposition of mandatory compliance with professional engineering legislation will encounter substantial resistance from some sectors

of industry, the profession should develop and present cogent arguments that would encourage these industrial sectors to comply voluntarily, even in areas where the interpretation of significant public impact may be hazy.

Product Regulation: Early action by companies or groups of related companies to assign the suggested responsibilities to professional engineers could avoid the imposition of some forms of product regulation which the companies would find to be restrictive.

Legal Defence: It is a fact that our society has become increasingly litigious. Individual and class actions for damages arise following many engineering-related accidents and failures. The size of the resulting judgments is rapidly escalating. Also, more companies are becoming sensitized to their legal exposure on environmental issues. It can be pointed out to company management that, if legal action is taken against the company on a health, safety or environmental issue, it will be necessary in mounting a credible defence that the company be able to show that appropriate procedures for assuring both competence and responsibility were in place. Clear documentation of the procedures and the responsibility assignments within the company would be needed.

By way of example, in a legal action claiming a design defect, it would be normal that the plaintiff would identify and call the individuals designated as responsible for various aspects of the design. Lack of an echelon of clearly assigned responsible persons could be argued as evidence of negligence. Lack of a requirement for professional registration of those responsible could be argued as evidence of a lack of independently-assured competence. If industrial employers can be convinced that legal precedent will soon establish such an interpretation of company and individual responsibilities, it would be to their advantage to be proactive in taking action to limit their exposure.

In eliciting support for voluntary compliance, arguments showing distinct advantage for individual engineers in the company need to be formulated. An engineering employee is normally protected by the employer from financial liability arising out of a legal action against the company. However, the engineer cannot be protected from being called as a party to the action. The engineer may be required to answer as to the actions taken to protect the public within his/her area of activity. The competence and performance of the engineer may well be challenged as well as failure to adhere to the Code of Ethics. Assignment of responsibility by the company and its acceptance by the employed professional engineers may become crucial to an acceptable individual defence.

Image and Public Relations: The free-market concept of *caveat emptor* (let the buyer beware) is encountering increased public hostility. Corporations are experiencing more public distrust and more frequent litigation. To counter this trend, a company could focus its public relations efforts on measures that it takes to assure reliability and safety through sharing its responsibilities with its professional engineers. The existence and publication of the company's dependence on an echelon of licensed professionals would add to customer confidence.

Companies can retain the freedom to offer employment to engineers that are not licensed. However, the future service which these engineers can provide may be considerably enhanced by their applying for registration, and being available for assignment of responsibility.

Corporations may find that an approach that places emphasis on professional responsibility provides them with a distinct advantage in national and international competition for certain contracts. The most valuable intangible assets of a company are the capabilities, knowledge, experience and dedication of its employees. The requirement and commitment of professional engineers to maintain a high level of competence is a distinct asset to their employers in maintaining a strong and flexible work force.

Associations of industrial companies in specific sectors may be encouraged to emphasize the public responsibilities of their professional engineers in their statements of public policy and their codes of ethics, thus enhancing their group status and image. Adoption of a policy of employing professional engineers in areas of sensitivity to public welfare could be a major factor in assuring company shareholders that their investment was not at undue risk, particularly from foreseeable incidents affecting public health and safety.

The assurance of professional responsibility in design and production is a distinct advantage when products are submitted for standards and underwriters approval. The existence of an echelon of professional engineers with assigned responsibility, the increased value of such persons to the corporation, and their improved level of personal compensation can be a strong encouragement for other engineering graduates within the organization to qualify as professionals in anticipation of later advancement.

A successful campaign promoting voluntary compliance, coupled with a firm requirement for compliance in a range of specific corporations providing critical services and products, should lead to a progressive and general acceptance of the principle of reliance on professional responsibility in engineering-related matters.

RESPONSIBILITIES OF THE INDIVIDUAL ENGINEER

By the nature of their work, engineers have a special responsibility to the public welfare whether acting within regulations or voluntarily. Most if not all should demonstrate their acceptance of this responsibility through qualifying for registration in their profession. It is important that we articulate to the public and to the policy makers in government that we are a key profession, and that the public should expect us to be guardians of their interests in matters of safety, health and environment.

In fulfilling the requirement of duty to public welfare professional engineers have an individual responsibility to predict the impact and limitations of their work, to document potential adverse

outcomes and, where appropriate, to bringing this information to the attention of their team and those in overall responsibility. This individual responsibility applies even if not assigned by the employer.

We recommend: That the Associations encourage professional engineers employed in industry to accept voluntarily personal responsibility to the public for predicting the impact of their engineering activities and informing their employers of potential risks. [8]

Conflict of Responsibilities: Any move toward enhanced responsibility of professional engineers in industry should be accompanied by a clarification of the responsibilities of individual employee engineers. It is accepted that an employee engineer has a responsibility to her/his employer as a faithful agent or trustee with proper regard for confidential information. However, there is a further professional responsibility to the welfare and protection of the public. This dual responsibility is a significant feature of the engineering profession and is in marked contrast to the professions of law and medicine, where the responsibility of the professional is almost exclusively to the client.

Employment Agreements: To resolve this apparent conflict of responsibilities, professional engineers need a clear and workable agreement with their employers. Engineers in a company might take group action to establish such an agreement. Alternatively, each engineer should give consideration to incorporating such an agreement into an employment contract. Action on this issue is particularly important for those in the echelon of assigned responsibility.

We recommend: That the Associations encourage professional engineers individually or collectively to negotiate employment agreements or contracts with their employers, which make adequate provision for their responsibility to the public. [9]

Protection of Employee Engineers: Provincial/territorial Professional Engineering Associations should provide guidelines for their members on appropriate provisions in such agreements or contracts and on how to address issues which may arise from a conflict of responsibilities. They should also provide adequate support and protection for their members in instances where undue pressure may be applied by the employer in a matter of public protection. For conflicts that are not satisfactorily resolved between the engineer and the employer, the matter should be referred by the member to the Association. If the Association considers that a substantial risk to public welfare has been reported, it should enter into negotiations with the employer and should assume responsibility for protecting the interests of both the public and the engineer involved. Ultimately, responsibility for protecting the public interest should reside with the collectivity of the Association rather than with the individual engineer**.** Through this approach, individual public “whistle blowing” should be effectively avoided.

We recommend: That the Associations establish workable processes of mediation and intervention, to support professional engineers who are in dispute with their employers on matters relating to responsibility for public welfare, and that the Associations assume ultimate responsibility for public protection as necessary. [10]

The actions of the Associations in this area should be motivated solely by the special responsibility of the profession for protection of the public. It is this responsibility which is the *raison d'être* of these organizations. Actions in support of this responsibility are not only justified but should be considered as a duty.

RELATIONS WITH OTHER PROFESSIONS AND OCCUPATIONS

During the early history of engineering in Canada, civil engineering carried out for public clients was a dominant component of engineering practice. Systems of professional registration were introduced to protect the public and were readily accepted. Gradually there was growth in other engineering disciplines, many of whose members were employees of industrial companies. Such was the well established image of the profession that a dominant majority of engineering graduates in all disciplines chose to qualify for professional licensing. In this respect, until recently, Canada has been markedly different from most other countries.

The historic pattern of near-universal licensing has changed markedly over recent decades. Many of those graduating in such high demand disciplines such as computer engineering, electrical engineering and software engineering fail to see advantage in licensing. This attitude is compounded by the fact that many of their professors are not licensed professional engineers. The computer-oriented disciplines are closely linked to computer science and mathematics, where there is no tradition of professional licensing. Most employers draw little distinction between computer scientists and computer/software engineers. Some of these graduates see more significance in the qualification certification programs of certain multinational employers.

There are significant aspects of the work of these information-related disciplines which justify a requirement of professional licensing for protection of the public. There have been many instances where software deficiencies have led to public harm. Some have led to major failures of basic supply systems – energy, communications, transport – causing disruption, economic loss and danger to health and safety. A few failures have led to deaths. Accordingly, certain sectors of this industry should be required to demonstrate their commitment to public welfare by employing professional engineers whose competence and responsibility are ensured by their license.

Finance, management and banking have become major employers of engineering graduates. Application areas such as banking, stock exchanges, credit card systems, management systems

and personnel information systems are examples of areas in which inadequacies in system design can lead to public disruption, loss of property or even human life. The engineering profession should accept this expanded responsibility, and take a lead in developing cooperative working arrangements with other occupations as required in the public interest.

The scope of engineering is continually broadening and the interaction with other professions and disciplines is increasing. A general principle to be established is that, where it can be shown that there is significant potential for impact on public health and safety, there should be regulation and assigned individual responsibility. Where appropriate, mechanisms and arrangements with related bodies must be established.

Engineering disciplines under the general classification of bio-engineering have existed for many years and are expected to expand rapidly in the future. Some of these involve close links with the medical profession in areas such as aids to the handicapped, instrumentation, prostheses, imaging and organ regeneration. In the medical profession, the requirement for professional licensing and acceptance of responsibility is unquestioned. The same requirement should apply for engineering involvement in this area. This calls for the development of fair, cooperative, balanced working arrangements between the medical and engineering professions.

The important and expanding sector of bio-engineering involves a major linkage of engineering with biology in such areas as agricultural and food engineering. Biology is a science discipline with no history of professional licensing. In sectors such as this, it is important that the scientific role of producing reliable useful information be distinguished from the engineering role of designing a safe reliable product and delivery system. In such work areas it seems appropriate and necessary that the engineering profession take a lead role in protection of the public.

We recommend: That the Associations, coordinated through CCPE, negotiate appropriate cooperative arrangements for shared jurisdiction in areas of the public interest, which are common to two or more licensed professions. [11]

We recommend: That, in the public interest, the Associations take action to ensure that professional engineers take a leading position in areas of engineering-related work, which has health, safety or environmental impact, and which is shared with members of non-regulated or non-licensed bodies. [12]

Failure to address these increasingly important relationships with other professions and disciplines can lead, at the least to confusion over responsibility, and at the extreme to a danger to public welfare. It can also cause the image of engineering to becoming increasingly blurred in the view of the public and of engineers themselves.

CONCLUSION

The engineering profession in Canada is a world leader in its regulation, its self governance and the competence of its members. The proposals and recommendations set forth in this report are directed at enhancing still further the stature, relevance, public service and perception of the profession to meet current challenges. A central proposition of the report is that this enhancement can be best achieved by accepting more fully the special responsibility of engineers to the public in matters of safety, health, and environment.

In making these recommendations the Canadian Academy of Engineering recognizes that many of these issues have been under discussion in the Associations and in CCPE. It is hoped that these views of an external and independent body will serve to promote discussion and facilitate action. The Academy is willing to assist in any way that is considered appropriate.