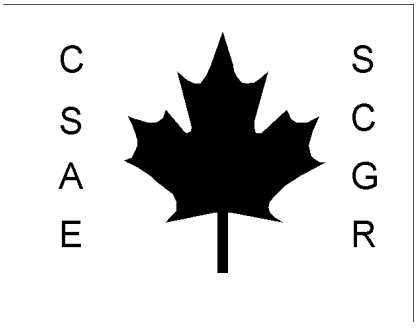
Engineering in Agriculture, Food Production, and Bio-Resource Systems

A

Vision

for the

21st Century



ENGINEERING IN AGRICULTURE, FOOD PRODUCTION AND BIO-RESOURCE SYSTEMS

A Vision for the 21st Century

May 1995

A Document Prepared for
The Canadian Society of Agricultural Engineering by:

Hugh Fraser
John Higgins
Don MacAulay
Eric Norris
Ralph Winfield
Martin Wrubleski

TABLE OF CONTENTS

1 Introduction

Many events during the past number of years have had a direct and profound impact on the profession of Agricultural Engineering.

Events such as the downsizing of Extension Engineering groups in Provincial Departments of Agriculture, closing of Agricultural Engineering Departments in several Canadian universities and the integration of the Engineering Research Centre into other Research Centres within Agriculture Canada have all had a very significant impact on the profession.

Technologies are changing at an accelerating rate and the traditional client base served by our profession is changing. We are also concerned about the nature of training, which should be provided for Agricultural Engineering students and the body of knowledge, which the new Engineer should possess.

It is also evident that members of the profession are facing somewhat of an identity crisis. For example, there is some disagreement on the appropriateness of our name. For this document, Agricultural Engineering means engineering in agriculture, food production and bio-resource systems.

More generally, the employment picture for all of today's professional engineers is clouded with uncertainty. Many have lost jobs and others have gone through major changes in their employment situation due to global restructuring and technological change.

Agricultural Engineering is not alone in facing these and other uncertainties. The statement that we are all faced with great opportunities brilliantly disguised as impossible or difficult situations is true of our profession today.

The future of the profession of Agricultural Engineering will not be assured by simply following the "correct" approach and being correctly positioned in the technical field in which it serves. The future success of the profession will also depend on the practical reality of having a critical mass of people in the field to sustain and build the technical base.

As well, a successful professional entity must have enough people to do the unspeakable work of showing our flag and defending our profession at the policy decision level of leadership in both our industry and our country. To be a whole profession, we must operate in all of these areas.

Our profession must ask such questions as; Who are we? Where do we want to go? What do we want to look like? What contribution can we, and do we want to make to industry and to society?

The purpose of this paper is to encourage the profession to pause, reflect, and try to capture a vision of its future.

To that end, the Council of the Canadian Society of Agricultural Engineering commissioned a strategy planning exercise at its summer meeting in 1992. This document is a result of the planning exercise commissioned by CSAE. The document **is not** a strategic plan for the Society, but rather a look at future directions for the profession of Agricultural Engineering.

It is not intended that this document be adopted as a strategy by any local jurisdiction or engineering group or body, but rather that it serve as a road map for the future of various segments of the profession. The intent is to provoke thought and provide a stimulus to develop a vision and a focus for leading our profession into the twenty-first century.

2 Reflections-Where We Have Come From

Agricultural Engineering could be termed a relatively young profession in Canada. While the profession does not have a long history, it has a proud heritage.

No attempt will be made in this document to give a further definition of the term Agricultural Engineering. It has been described in a strategy document prepared for the Canadian Agricultural Research Council (CARC) in 1988 by the Canada Committee on Engineering Services. References to history and achievements do, however, in some cases include Food Engineering and Bio-Resource Engineering.

Only brief highlights of various segments of the profession are presented in this document, and thus, the term "reflections".

2.1 University Education

Accredited programs in Agricultural Engineering have been offered at eight universities, at different times, and with various names. There are currently seven universities offering accredited programs, with one phasing out of the program in 1995.

The University of Saskatchewan granted the first degrees in Agricultural Engineering in 1925. This represents the formal beginnings of the profession in Canada. It is worth noting, however, that various forms of training and non-degree programs were offered several years prior to 1925 in several universities.

Appendix 1 shows the Canadian Universities, which have offered or continue to offer accredited Agricultural Engineering programs leading to a Bachelor of Science Degree. The table also shows the beginning of non-accredited programs where such programs were offered.

2.2 Research

Much of the research work in the field of Agricultural Engineering has been done through the University system in Canada, and through the Research Branch of Agriculture & Agri-Food Canada. The private sector of the agri-food industry has also made significant contributions to research.

The Federal Government has Agricultural Engineers on staff at one third of the research stations across the country. There also was an Engineering and Statistical Research Centre in Ottawa with a staff dedicated to engineering research. This centre was down sized and integrated into other Research Centres in 1991.

Agriculture and Agri-Food Canada was also involved in engineering research through a contracting-out program.

The 1988 strategy report of the Canada Committee on Agricultural Engineering Services provides an excellent compilation of the breadth and scope of research undertaken by Agricultural Engineers and the impact this has had on the industry.

2.3 Engineering Services

2.3.1 Public Sector

Most Provincial Departments or Ministries of Agriculture in Canada have provided and continue to provide Agricultural Engineering services. These services are provided in various forms through a variety of administrative frameworks. Many of these services were established in the 1940's and 1950's and are still in place.

Currently there are 114 Extension and Regional Engineers in Canada (1994). This does not include supervisors and engineers in government agencies. This represents a decline of 10% in recent years.

Engineering services have assisted producers and industry through the introduction, development and adoption of technology. This technology transfer process has been in all traditional areas of engineering such as farm structures, soil and water, power and machinery, electric power and processing, energy and emerging technologies. Public sector engineering has had a very significant impact on the development of the agri-food industry.

2.3.2 Private Sector

Establishing the beginnings of Agricultural Engineering in the private sector of the agri-food industry is difficult. This does not minimize its importance. Indeed, formally trained engineers have been involved in the industry since the 1920's and have made very significant contributions since that time.

This private sector engineering is provided through avenues such as consultants, manufacturers of equipment, agri business, and regional organizations.

The agri-food sector with its allied services is a multi-billion dollar business. Engineering contributions comprise 25% to 30% of the activity, and engineers make up 5% to 10% of the resources in many areas of the system.

2.4 Canadian Society of Agricultural Engineering

The Canadian Society of Agricultural Engineering was formed in 1958 at a meeting in Wolfville, Nova Scotia. CSAE was formed to advance the application of engineering principles and practices for the betterment of agriculture and allied sciences.

The Society functioned as an affiliated society of the Agricultural Institute of Canada (AIC) from its humble beginnings in 1958 unti11987. In 1987, the Society decided to sever its formal ties as an

affiliated society of AIC and to establish a formal partnership with the American Society of Agricultural Engineers (ASAE).

The Society has grown from 63 charter members to over 700 members in 1994.

2.5 Summary

The profession has a proud heritage in Canada. It has been vitally involved in the development of the agri-food industry through the eras of settlement, expansion, and industrial mass production using mechanization and related technologies.

Our history could be tied to several eras as follows: 1925- 1949 represents the formative years; 1950- 65 was the birth of the modem era; 1966- 1980 was the rapid growth period during which Canadian agriculture and Agricultural Engineering expanded rapidly; and 1981 to the present time represents a period of re-adjustment and change.

Agricultural Engineering has made very significant contributions to many important developments in agriculture. Some of the highlights include livestock housing systems, crop storage facilities, horticultural crop equipment, conservation tillage equipment, remote guidance systems, remote sensors and robotics. All of these contributions have had a profound effect on the viability and efficiency of the agri-food industry in Canada.

This section has only given a brief overview of the history of some segments of the profession and has not attempted to develop cause and effect relationships of the profession with the industries it serves. The significance and impact of engineering in the system has been well documented in the 1988 CCAES Strategy report to CARC.

3 Current and Emerging Trends - The Influencing Forces

3.1 Agricultural

It is important when considering the profession of Agricultural Engineering to view it in the context of the agri-food industry. Where much of our history has been intertwined with the development and evolution of the agri-food industry through the industrial era, so will our future be intertwined with the industry as it evolves through the next era.

The agri-food industry in Canada is a multi-billion dollar industry. Primary agricultural output made up 21% of Canada's gross domestic product or total output of goods and services in 1992. Food processing accounted for another 18%. There are other agricultural related sectors such as the fertilizer industry, the farm machinery industry, the grain transportation system and many other farm supply businesses, which account for a further 4-5% of GDP.

The major commodity sectors of production agriculture are grains and oilseeds, dairy, livestock, poultry and eggs, and horticulture.

Labour productivity in agriculture has been advancing steadily but industry growth has sustained

employment. Advances in mechanization and other technologies have allowed for these advances in productivity. Agricultural Engineering has certainly been on the leading edge of mechanization advances.

The average size of farms has been increasing for 50 years and this trend is continuing. The total land area of farms has remained close to 68 million hectares for the past twenty years while crop land has increased slightly over the past decade.

Canada is a major agricultural exporting nation Asia is Canada's largest market for grains, the United States for livestock, with international meat sales to the U.S and Japan. Japan is also the chief market for oilseeds and canola. In recent years, higher value products and value added products have been the fastest growing components of the industry's export sales.

Agriculture has been a significant component of the recently concluded Uruguay Round of the multilateral trade negotiations. In the past, agricultural issues were too difficult and the sector was left out of the final agreements. This led to unclear rules and an increasing number of trade disputes within agriculture. The new GATT will provide more effective trading rules for agricultural products. It also will limit the use of export and domestic subsidies. Public support for direct subsidies will also wane. Canada's supply management programs for dairy, poultry, and eggs will apparently not be significantly altered by the agreement. One result of the agreement is that agricultural programs will likely evolve in a less trade distortive direction. One element of this in Canada is widespread interest in "whole farm stabilization". It is expected that farm safety net measures in the future will be less commodity specific and more focused on the overall situation of individual farms.

The trend towards larger farms will continue. These commercial farms will be in business to maximize profits using modern technologies, the latest marketing information and up-to-date skills. It is evident though, that North America's long-standing low-cost food policy for consumers will remain in effect. This policy along with increasing pressure from falling trade barriers will mean that only efficient producers will remain viable.

The larger farms will develop through mergers of many of today's production units. These new super farms will be more specialized, assume a corporate structure and be involved in direct marketing of their products. At the opposite end of the spectrum will be "lifestyle" farms whose major objective will be to maximize a rural lifestyle in a pastoral environment. Between these two extremes will be the majority of agricultural production capacity, which is made up of traditional family farm units, albeit larger units than they have been in the past. All of these types of farms can and will make a positive contribution to the agri-food industry and to the general economy.

This leads to a diverse clientele with which professionals serving the industry must work.

3.2 Societal/Industrial

The agri-food industry has had to adapt to tremendous change in the past and this process is continuing. The pace of change confronting the industry may even be accelerating. Much of this change will be brought to bear by societal pressures and influences from other industries.

Society concerns have shifted in recent years, and today's concerns are much more in support of

environmental protection and stewardship as well as natural resource management. There is not much support from the uninformed public for pure technological advance, and very little support for production agriculture using a technological and chemical approach.

Shifts in consumer demand or consumption trends are also a source of change. For example, the rapid decline in butterfat consumption has required major adjustments in the dairy marketing system and at the farm level In future, health and product nutrition are going to play an even greater role. Timeliness and convenience of food preparation and marketing to the urban consumer will steer the industry. Exotic foods may become more in vogue. Consumers will be further removed from and hence less informed of the agri-food industry and the food chain.

Economic, social and cultural development throughout the world is increasingly influenced by technology. The scope of information and required management skills will expand rapidly. Information is presently doubling in volume every 18 months. Technologies will become more and more sophisticated. The most revolutionary changes are expected to take place in the area of biotechnology and the non-food and fibre uses of agricultural crops.

The industry will come under increased public scrutiny. Every effort will need to be made to sustain productive natural resources. Many current practices may need to be modified to meet new and more stringent environmental regulations.

The larger issue will be keeping the general public informed of the industry's contribution to environmental responsibility and sustainability and to counter misinformation that gets into the hands of an uninformed and unsympathetic public.

It is evident that engineering will continue to be a vital ingredient in the future of the agri-food industry. Engineering is needed to assist in providing the stewardship of the natural resources managed by the industry and to develop future technologies to advance the industry in concert with societal expectations.

4 Agricultural & Bio-Resources Engineering for Tomorrow - Continuing the Evolution

4.1 Introduction

The book of Proverbs states "where there is no vision, the people perish". The truth of that proverb still holds true today. If there is no vision, the profession could perish.

Agricultural Engineering in Canada and, indeed, the western world is at a crossroads. On one hand, some would wish to consolidate and defend the profession in the traditional areas that have stood well for many years. These are the familiar groupings of structures, machinery, soil and water, and electric power and processing. On the other hand, there is growing interest in expanding the horizons of Agricultural Engineering to also respond to the broader needs for biological production and processing systems ranging from silviculture and aquaculture to bio-reactor systems.

As the agri-food industry evolves through the next era, whether we call it the technology age, or the information age or some other appropriate name, it is evident that engineering has a major role to play in

the industry.

Engineers are really at the center of the current technological revolution since they are one of the primary creators and purveyors of technology. Engineers, working effectively with other scientists, economists, administrators, technologists, and others have a very vital role to play in the development of the agri-food industry through the development and application of appropriate technology.

On a broader note, the general message seems to be that all engineers the world over must become more highly educated, and gain broader ranges of experience than ever before. Engineers must also be prepared to work with a wide variety of team players, both nationally and internationally.

A recent Canadian Council of Professional Engineers report states that engineering enrollments and employment opportunities have traditionally reflected the business cycle. There is the belief that engineering knowledge and creativity must be a major component in an economic recovery based on innovation, creativity, productivity and quality.

This should ensure a future not only for engineering in general but also for the profession of Agricultural Engineering as a particular discipline of engineering.

To position itself as a viable entity in the future and to best serve the industries and segments of society where its skills are appropriate, the Agricultural Engineering profession must develop an up-to-date vision. The profession must look at its traditional and potential strengths, its real and perceived weaknesses, the threats that it faces, and the opportunities that are available to it. Having done this self-analysis, the profession must then take appropriate actions.

Following are some of the key areas where the profession must be prepared to make adjustments to prepare for the future.

4.2 Education

The Oriental curse "May you live in interesting times" is an apt description of the situation in which the Agricultural Engineering Education system finds itself in the 1990's. The education system in Agricultural Engineering in Canada has been struggling to survive during the past decade. In some cases, that struggle has been lost. In other cases, small steps toward a stronger, more vibrant and relevant program have been taken. In all cases, the struggle has been waged by professionals who are motivated, not by self-interest, but by a deeply held conviction that their discipline has the potential to be a potent force for improvement in the human condition. That is, if some form of Agricultural Engineering did not exist, it would, of necessity emerge by some means or other to fill an innate need of the food system. It is the thesis of this section of the report that the bio-agro-environmental system is best served by an evolution of the Agricultural Engineering education system presently in place, rather than by a complete "re-invention or re-creation".

In a survey of the profession leading up to the preparation of this report, practising CSAE member Agricultural Engineers were asked to consider the possibility of two educational institutions (one French, one English) to serve the needs of the entire country. A minority of respondents favoured that idea with certain qualifications. A majority of respondents felt that one French, and at least three, possibly four, English institutions were required to meet the needs of our diverse climate, agricultural systems, and

far-flung geography. One interesting suggestion was that of one French institution in Quebec and one English institution made up of several electronically-linked campuses across the country.

Members of the profession conceded that certain aspects of present Agricultural Engineering practice could be handled by professionals educated in related disciplines; mechanical and civil engineers might serve the food system adequately in some traditional areas such as power and machinery and agricultural structures. However, the overwhelming opinion was that in developing areas of the profession, i.e. environmental engineering, biological engineering, food engineering, there will be an increased need for the unique background of the bio-agro-environmental engineer.

With these introductory comments in mind, what will the education system for our profession look like in ten years when it has survived and thrived? There will be a new and greater emphasis on biological engineering. Simply changing the name of a department or changing the name of a curriculum will not suffice. The educational "interface" with production agriculture cannot be at the introductory production course level. Bio-agro-engineers need to know much more genetic manipulation, recombinant DNA and bio-technology if they are to serve the changing agricultural system well. They will be required to take leadership roles in the development of engineering systems utilizing these new technologies; to meet this challenge they will need to interact effectively with the biological scientists working in these areas.

The "information super highway" will be part of the educational experience as well as the professional life experience. The concept of individual campuses electronically linked in such a way that students can participate in a course being given on a campus 3000 kilometres distant must be given serious consideration. This is one possible way in which the valuable time of university professors might be used more efficiently.

A greater emphasis on the awareness of ethical issues will become important. Agricultural Engineering graduates will face increasingly complex agricultural technology emanating from the uncharted waters of biotechnology as well as an employment market, which will become increasingly "global" in nature. A broader training in humanities and social sciences will be necessary to make reasoned judgments in the brave new world.

Education in Agricultural Engineering will have a more "international" flavour. The increasing inter-connectedness of the global economy will require graduates to have a greater understanding of food systems and technology from around the world.

Graduates from our universities over the next decade cannot expect a career of one or two employers. Rather, they will experience career shifts two or three times per decade. Education at the university must provide them with communication skills (written and oral), management skills, political skills, and entrepreneurial skills in order to meet these challenges. One of the means by which this can take place is by greater cooperation between universities and the constituencies they serve. Cooperative education programs will be one means by which they can occur; other, less structured inter-action will be necessary for the communication between university and industry to be maintained. Practising professionals will need to be pro-active in their involvement with the university education experience; that is, practising engineers must volunteer to be part of the education system; the onus cannot be entirely on the university to initiate joint ventures.

Lifelong changes in employment will require lifelong educational experience. Universities will be required to cooperate with industry, government, and the provincial professional associations to provide

relevant and timely continuing education experiences for professionals moving through a multi-faceted career.

These changes will not be without some growing pains. Much of the traditional *modus operandi* of professors will be called into question. Professors are likely to have careers inside and outside the university. Deans and university presidents will need to be re-educated about the engineering education process; the present system of promotion and rewards for performance will need to be reevaluated to reflect the new way engineering professors will operate. These promise to be truly interesting times.

Actions

The Agricultural Engineering education system in the first decade of the 21st century will show marked changes through the following actions:

- Ensure that graduates will be well versed in the biological and bio-technological bases of the food system and the environment within which it operates.
- Make graduates comfortable with the use of the "information super highway" and their educational experience to encompass the use of this technology.
- Weigh the curriculum more strongly with humanities and social sciences with special emphasis on ethical issues.
- Make international aspects of the agro-environment-food system an important part of the training.
- Place greater emphasis on the development of communication, management, political and entrepreneurial skills.
- Provide greater interaction between the education systems and practising Agricultural Engineers to provide students with more practical experience during the undergraduate experience.
- Universities, industry and professional associations collaborating to provide lifelong education experiences.
- Ensure that the University engineering professor will have greater industrial involvement and have the university expectations placed upon professors evolve to accommodate this changing role.
- Make much greater use of distance education and remote classroom techniques, as well as “just-in-time" education principles at the Agricultural Engineering Departments of Canadian universities.

4. 3 Research and Technology Development

The technologies used by the industries that Agricultural Engineers serve come from virtually every sector of science and technology.

Research and technology development is the engine that propels our industries forward. Much of the work in engineering research and technology developments for the agri-food and other resource-based industries has been done by Agricultural Engineers and will continue to be done by Agricultural Engineers in the future. However, in the future, a greater portion of the technology employed by Agricultural Engineers will originate from other sources and will be adapted to suit our applications.

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge

without any particular application or use in view. It is creative work carried out on a systematic basis to increase the stock of scientific and technical knowledge and to increase the knowledge of society, enhance its culture, and to use this knowledge to develop new applications. The main players are universities and public sector research institutions. In the foreseeable future, a declining amount of basic research in Agricultural Engineering will be done due to diminishing funding availability

Applied research is original investigation directed primarily towards a specific practice, problem, or objective. Some of this work is done by universities and public sector research institutions, but the majority of it is done by industry on its own as well as by some extension agents, or through cooperative efforts.

Impact studies show that basic research has a higher long-term impact than applied research, company funded research is more productive in the short term than publicly funded research, and research and development focused on new production processes have a higher rate of return than research and development focused on new products. Although it is estimated that research represents only about 1% of GNP or 6% of the total cost in Canadian manufacturing, it is the fundamental basis of an industry's ability to remain competitive.

The responsibility for much of the basic and some of the applied research will continue to lie in the university and public sector domains because of the high risks, and long terms involved. Industry and its market orientation needs to be integrated into the process early to maximize returns from applied research and technology development.

Larger firms are increasingly capable of carrying out research and development to meet their needs. However, most small and medium sized firms do not have the ability to carry out their own research. Therefore, the need for public sector sponsored research and development will continue to be an important factor in industry development for some time to come.

More than technical issues affect the destiny of individual researchers and research institutions and organizations. Society is increasingly interested in having a greater voice and influence over the activities and directions of the scientific and research world. All ways of doing things will need to be examined to ensure that "sacred cows" are not limiting effectiveness or working counter to societal and industry expectations. As well, structural constraints and perceptions within organizations need to be examined to foster a better response to public expectations.

Research and technology development programs will need to deal with a number of overriding societal requirements. First and foremost is the need to undertake work directed at preserving and enhancing our natural resources and reducing environmental hazards. The second area is the need to provide safe food products and by-products. Research should also address the concern for the safety of workers and the safety and welfare of animals. The final requirement is the need to help create wealth and jobs by meeting the needs of the market place and the need for tradeable goods in the global economy.

Agricultural Engineering is well placed to undertake much of the work in these broad areas. This work will require training and skills in engineering related to mechanical systems, natural resources, biology, biotechnology, environmental systems, food production and food safety. Clearly, the field is wide open to the Agricultural Engineering fraternity if our efforts are properly directed.

Actions

To maintain our relevance as a profession and to effectively meet the future needs and expectations of society and industry, agricultural engineers must:

- Actively involve the agricultural community, the industrial community, and society in general in identifying and prioritizing research and development requirements.
- Ensure that we carry out research and development that is both relevant and innovative and do so in concert with other professional disciplines.
- Develop and foster more research partnerships, joint ventures, alliances and exchange programs that involve universities, governments and the private sector.
- Support the development of advanced technologies and ensure their appropriate use in our research efforts.
- Improve the timely dissemination of research results to the end user.
- Examine the reward system for researchers to encourage the commercialization of innovative research and development.
- Strive to promote a climate that recognizes and promotes an adequate level of research and development to ensure a competitive agri-food industry.

4.4 Technology Transfer

Agri-business and the agri-food industry need the services of engineers with expertise in the biological sciences. The best combination of technical and biological expertise for this is likely to be most readily available from persons trained as Agricultural Engineers.

The agri business sector of the Canadian economy covers a broad range from agri-food production through crop processing to food processing and environmental systems. Thus the sector needs a wide range of specialized equipment and associated structures but also a high level of technical support in systems design and operational procedures to insure high quality product output at a competitive cost.

A recent Canada wide survey of Agricultural Engineers prioritized the sector components requiring Agricultural Engineering expertise. The top five components in descending order of priority were found to be environmental systems, agri-food production, water management, food processing and crop processing. The survey results indicated that some system components such as machinery and structures could be engineered equally well by mechanical or civil engineers respectively.

However, the need is clearly evident for the specialized services of Agricultural Engineers in providing technical support in many areas of the agri-food sector. Most sectors require significant technology transfer. This technology often comes from applied research or experimental development (research & development) carried out by agricultural scientists working at Canadian or United States colleges and universities of Agriculture but might require specific in-house or contract research & development.

Technology transfer to the agri-food industry and its allied sectors has been and continues to be affected by two separate mechanisms and groups. Almost all assistance to the processing sector and to large firms and corporations has been provided by private sector engineers, while the majority of assistance to the farming community and some of the smaller firms has been delivered by public sector extension

personnel at little or no cost to the client in the past.

As a result of restructuring and/or restraint measures, publicly funded Agricultural Engineering services for technology transfer and applied research have been eliminated or severely reduced in many jurisdictions. There are usually more Extension Engineers per million dollars of farm gross income in Provinces where the agri business infrastructure is less developed.

While this reduction is publicly funded Agricultural Engineering services would indicate a significant opportunity for self employed Agricultural Engineers, and private sector employee engineers, the demand for their services by primary producers has not kept pace with the need. The traditional farm level producers have become accustomed to a "no direct cost" system. At present they are still reluctant to pay on a "fee for service" basis. Processing firms, on the other hand, are accustomed to fees.

In every segment of the agri business sector there is a clear need for technical expertise that is not biased by the economic need to sell hardware systems. Specific equipment supplier support often falls short in competency and duration to get the total production processing system up and operating efficiently. Many owner/managers would also benefit from third party plans or specifications that would encourage competitive supplier bids for structures, equipment or complete systems.

By contrast, some enterprising Agricultural Engineers have recognized a specific segment need and developed a system, or package of services/components, to satisfy that need. These entrepreneurs are filling a marketing niche not supplied by larger manufacturing firms. Many users, primarily in the production and crop processing segments, are likely to be more receptive to buying a product and obtaining the technical expertise of Agricultural Engineers without "direct" cost. Unfortunately, not all sector needs can be delivered in this manner.

The role of technology transfer will continue to involve both public and private sector engineers. Each group has a unique set of skills and perspectives to bring to the agri-food sector and to an even broader public at large.

Private sector engineers will most likely work with individual clients on tangible, specific needs that have an immediate economic benefit. Publicly funded engineers will work more with the educational and emerging technological needs of individual clients, groups of clients and innovators that are of a more long-term economic benefit. As well, publicly funded engineers will focus more on the intangible needs of the general public in natural resource and environmental issues.

Actions

The CSAE survey results identified positive actions that might be taken to enhance technology transfer activities and show prospective clients what Agricultural Engineers have to offer:

- Promote our achievements and capabilities, and create an awareness of the value and benefits of advisory services to agri business sector by both public and private sector Agricultural Engineers.
- Review the cost of delivering services If the government continues to withdraw free services, then the farming community must be conditioned to pay on a fee-for-services basis.
- Foster better industry/education partnerships to improve our ability to meet client needs.
- Forge stronger linkages with other Engineering and Agricultural disciplines to enhance

capabilities and to encourage applicable multi-disciplinary research for the benefit of industry.

- Voice technical opinions on public issues related to Agricultural Engineering concerns in the agri business sector (Engineering has long been known as the silent profession!).
- Play a more active role in government policy formulation to insure that our views are acted upon by policy makers.
- Take a proactive role in developing industry standards with issues of public concerns such as environmental and resource issues.
- Work more closely with the non-farm rural population to foster a better understanding of and confidence in the agri-food industry.
- Foster stronger relationships between agri business and consultants and other private sector engineers.

Some of these actions must also be directed to government policy makers to insure that action is taken expeditiously. If continuity of service is not available to the agri business sector in Canada the demand for Agricultural Engineering expertise will drop temporarily. Meanwhile the infrastructure to train and the supply of experienced practitioners would quickly deteriorate to a level where rejuvenation would be difficult.

4.5 Professional Development

Professional development must take place for the betterment of the profession as a whole and the individuals within it as well as for the protection and enhancement of the image of the profession.

Professional development in the context of this document includes both technical and personal development on both an individual and collective basis.

When one graduates in a technical degree program, the expected half-life in technical skills is in the order of four years This helps us to put into perspective the importance of continuing professional development and continuing education. There is a familiar saying that states "when you're green, you grow - when you're ripe, you rot" It certainly has application in the context of professional development.

Agricultural Engineering in Canada has many strengths to build on from a professional development point of view. Members of the profession still have a good image with primary producers in agriculture. The profession has an active professional society in the Canadian Society of Agricultural Engineering that provides a very good forum for technical exchange. A number of excellent technical conferences have been sponsored by the society through strong individual efforts of its members.

The majority of practising Agricultural Engineers in the country are involved with Professional Engineering Associations through mandatory memberships. All of these Associations offer continuing education opportunities. There are also many universities that offer continuing education courses relevant to the profession.

Having stated these strengths, however, we need to be aware that we have a number of weaknesses and deficiencies that we must address.

The name of the profession has been discussed at length, and in the eyes of some people, it is felt that a name change could enhance our image. There is a real danger that we will find ourselves being guided by

an allegiance to the name. We do not have the luxury of moulding the future of the profession to fit a name. We must continue to mould the profession's goals, activities, and ways of working to fit the ever-changing needs of the society we serve and its industrial and commercial sectors that can use our skills.

While the profession has an active Society with very good technical exchange capabilities it is lacking in personal and leadership training. There is also a lack of private sector involvement in the Society.

A major impediment to the profession's ability to provide continuity and quality to its professional development is the small size of the professional community and its resulting lack of a critical mass.

Having stated that the majority of the members of our profession belong to professional engineering associations, we must also acknowledge that very few members become actively involved in those associations and, therefore, miss many professional development opportunities.

As a discipline, Agricultural Engineers have failed to cultivate strong linkages and partnerships with other professions and disciplines. This is true within agriculture as well as within the field of engineering.

The profession has not been proactive in a political sense through such forums as position papers on current issues. This lack of proactivity opens the door to other related disciplines to speak for engineering in agricultural and biological systems.

Geography to some extent is an impediment to many of the activities that would enhance professional development. However, the obstacle of geography can be overcome with the modern information highway, and through appropriate regional activities.

Actions

There are many opportunities to grasp and directions to pursue with respect to professional development. Building on the strengths that have been noted and taking appropriate actions to overcome the known weaknesses and deficiencies could lead to the following actions:

- Enlarge the vision of all Agricultural Engineers beyond traditional agricultural and food production systems to include biological production and process systems. At the same time, this vision must be a balanced one, recognizing that Agricultural Engineers cannot be all things to all people with respect to biological systems.
- Review and broaden the mandate of the Canadian Society of Agricultural Engineering, and to enhance its appeal to a broader scope of professionals by adding an appropriate tag line under the society name and providing more member services.
- Strengthen and diversify annual conferences of the Society by broadening the technical scope and adding opportunities for personal and leadership development activities.
- Develop and foster strong partnerships and linkages with other professional groups within and outside the agriculture and agri-food industry.
- Organize and promote more specialty conferences using multi-disciplinary teams.
- Promote and sell our profession to students and employers through both society efforts and individually. As well, the society could become more actively involved in student education issues.

- Cooperate with professional Engineering Associations and universities in promoting and developing a system of continuing education units for practising agricultural engineers.

4.6 New Opportunities

As the technological world around us and the various professional communities around us grow, so, too, must the profession of Agricultural Engineering. To do this, we must do two things. First, we must recognize those sectors of our domain which are mature or in decline under present circumstances, and, second, we must recognize and respond to each opportunity to accommodate, support, and actively participate in technical and commercial activities where our training and experience provide us a role to play.

If we succeed in finding a relevant place in the future, the profession will not look or act the same as it has in the past. We will have had to change to respond to the circumstances around us. We must continue to develop and use the best technologies available to us and we will have to do so in a manner that the economics of the business world, and society in general, will support. We will have to work much closer with professionals from other fields, both within the agricultural sector and in the broader technical and industrial base. We must recognize that the business world and the professional world are becoming more "action and results" oriented, and less "domain or territory" oriented. We will have to be more interdisciplinary in our development and more cooperative in our approach.

The Agricultural Engineering profession has a strong base on which to build its future activities. Our broad, solid base in the biological sciences and the biological production systems is unique. We are, therefore, well positioned to continue to play a major role in agriculture and agri business, and also to contribute to the wider range of technical activity. And indeed, to provide leadership in these sectors This involves applying our problemsolving abilities to all aspects of the design and operation of systems for biological production, from family farm operation to genetically manipulated bio-technological production systems.

Our role in the agri business field will remain relatively constant, but the role, which is open to us in the broader field of biological systems, offers us opportunity to enhance both the stature and the size of the profession. To grow and remain relevant, the profession can and must involve itself in all areas, which will have an input to, or impact on agricultural and biological production systems. Our profession is qualified to join this field as a full-fledged participating team member. It is clear that professionals from other disciplines will increasingly be involved in elements we consider to be primarily agricultural. For example, mechanical engineers will continue to design farm machinery and chemists and biologists will establish criteria for waste-handling facilities. It follows that our profession, as long as competence is maintained, ought to actively involve itself in engineering for the full range of existing and emerging technologies relating to the production and processing of biological products

The evolution of new technologies continues to change our working environment. Pressure from such factors as advances in biotechnology, environmental technologies, social sciences, and the variety of activist groups has greatly diminished the opportunity for compartmentalized or elitist participants. We will also have to be more aware of the economic impact of our work and the market forces that dictate the viability of our work.

Technology is advancing at an ever-increasing pace, and the range of things we can accomplish with new

technologies is expanding even faster. Along with this, the demarcation lines between the disciplines and between the professions are rapidly blurring. Development and application of technology is, of necessity, becoming a multi-disciplinary team activity and the individual tasks involved are being handed to whoever has the ability and interest to do them, regardless of their professional discipline. We can treat this as either a threat or an opportunity.

The profession will have to overcome the perceived and real inabilities to articulate its views or knowledge in both oral and written form. And, the profession will have to earn itself a place in the forum of policy issues in both the corporate and government domains if it is to retain and build its role in society.

To summarize, we cannot predict all that is in store for us, but the profession can address future opportunities with the following expectations.

- Unique and valuable technological tools will continue to become available to Agricultural Engineers and we will have to make full use of them to stay competitive.
- The environment in which we work will continue to change from social, financial, political and technical pressures, and the profession must stay abreast of these changes and apply its skills in keeping with the times.
- Agricultural Engineering will always have a role to play in agricultural production, but agricultural engineers can and must playa role in the broader field, which encompasses all biological production and processing systems.
- The profession will, of necessity, find itself more and more involved in multidisciplinary tasks and teams, and its work will become more action and results oriented and less domain and territory oriented.
- The profession will find it necessary to improve its communications among peers and to society in general, and will also have to involve itself in policy issues, both at the corporate level, and at each level of government decision-making.

5 Summary - Ensuring Our Future

Agricultural Engineering has a proud heritage in the development of the Canadian agri-food industry. It has been vitally involved in the industry through the eras of settlement, expansion and industrial mass production.

Agricultural Engineering has made its contributions using mechanization and related technologies through education, research, technology development, technology transfer and industrial development. These contributions met and responded to real and vital needs of the times.

The profession is not a static one. The industries that the profession serves are not static either. A continuous evolution is taking place. Where much of our history has been intertwined with the development and evolution of the agri-food industry, so will our future be intertwined with the agrifood industry and other natural resource and biological industries as they evolve through the next eras.

There are many new forces at work, which will change the nature of the industries the profession deals with and the climate in which this work is undertake.

Within the agri-food industry for example, trade liberalization, a global economy, structural changes and changing consumer demands will have profound and far reaching impacts on the industry. This will result in changing technologies required by the industry. This opens up new frontiers for professionals.

Societal pressures and influences will also have an impact on the future. The green revolution will continue with a resulting emphasis on preservation and sustainability of natural resources, food quality and safety, worker health and safety, animal care and welfare, and a reduction of environmental hazards. Many past and present practices, particularly in production agriculture will be challenged. New alternatives will be the order of the day.

The profession may, in fact, be at a crossroad. The response to these new opportunities and influences will determine the health, viability, relevance and indeed the very destiny of the profession.

The horizons of the profession have broadened since its early beginnings and will of necessity continue to broaden into the future.

There are several areas where changes should occur.

Education:

- Biology and biotechnology will form a stronger base in the students' curriculum.
- The curricula will be more strongly weighted with humanities and social sciences as well as ethical issues.
- Continuing education and lifelong learning experiences will be more important.
- Co-op programs will become more important and more prevalent.
- New communication technologies will provide for distance education opportunities and electronically linked classrooms.

Research and Technology Development:

- Research priorities will need to be established with more client/industry input.
- Multi-disciplinary research teams will be much more necessary and prevalent.
- More emphasis will be placed in the areas of natural resources, environmental safety, food safety, and biotechnology.
- The reward system for researchers will undergo changes to encourage innovation and relevance.

Technology Transfer:

- Communicating to the client the nature and role of agricultural engineering services will be of utmost importance.
- Communicating innovative, relevant research results in a timely fashion and helping the client to understand and adapt this information will be key to the success of the profession.
- Voicing technical opinions on public issues in our areas of expertise will be of more importance in the future.
- Multi-disciplinary teams that deliver client services will be more prevalent.

Professional Development:

- The profession will need to become more active in promoting and selling the profession to students.
- Practising professionals will need to continue to enlarge their vision of the profession.
- Forging new and stronger linkages with other professions and disciplines will be important to the vitality of the profession.
- New thrusts for continuing education, upgrading and training of members of the profession will need to be developed.

It is not possible to accurately predict the future, or to know exactly what is in store for the profession of Agricultural Engineering. We can safely assume, however, some of the expectations we will face as a profession.

We know that new and valuable technological tools will become available and we will need to make full use of them to remain competitive. The environment in which we work will continue to change from social, financial, political and technological influences.

The profession will play a role in a broader field, which encompasses all biological production and processing systems. As a result, the profession will find itself more involved in multidisciplinary tasks and teams. Work will become more action and results oriented and less domain and territory oriented.

Because of the unique training and the valuable experiences of its members, the profession is very well positioned for entering the twenty-first century.

Only a framework for developing directions and actions has been presented. The nuts and bolts of how to move forward is left for individuals, groups, and organizations to develop.

Our future will be as bright as the thought and effort we put into developing it.

Appendix 1

Canadian Agricultural Engineering Programs

UNIVERSITY	PROGRAM NAMES	NON ACCREDITED PROGRAM**	ACCREDITED PROGRAM*
Alberta	***Agricultural Engineering***	***1971-1982***	***1983***
British Columbia	***Agricultural Engineering*** ***Bio-Resources Engineering***	***1949-1964***	***1965-1978*** ***1979***
Guelph	***Agricultural Engineering***	***1946-1967***	***1968***
Laval	***Genie Rural***	***1962-1972***	***1973***
Manitoba	***Agricultural Engineering***	***1953-1970***	***1971***
McGill (Macdonald)	***Agricultural Engineering***	***1946-1970***	***1971***
TUNS (DalTech)	***Agricultural Engineering***		***1974***
Saskatchewan	***Agricultural Engineering*** ***Agricultural & Bioresource Engineering***	***1925-1964***	***1965-1991*** ***1992***

* Year of first graduating class for which accreditation applies.

** Program which led to a Bachelor of Science Degree.