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Trends which are new and related to modern engineering research and technology

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Abstract

Engineers play a key role in our societal development, contributing to and enabling initiatives that drive economic progress enhance social and physical infrastructures, innovative products and inspire the changes that improve our quality of life as well as trends of new thinking. Simultaneously, industry and manufacturing are facing unprecedented challenges of new thinking due to globalization and distributed manufacturing. As a result, the business environment of manufacturing enterprises is characterized by continuous change and increasing complexity. The challenges for companies arise not only from the need for flexible technical solutions, but also from managing complex socio-technical systems, and contribute tangibly to the sustainable development of manufacturing and the environment. Researchers and graduates with the ability to understand both complex technological processes and the creative arts and social skills are increasingly sought after in today's industrial and business world in areas of: Manufacturing Management, Health and Service Sectors, Product Engineering and Technical Sales, Transportation and Logistics. Using their strong technical and communication skills, engineering managers oversee a variety of team-based activities. By focusing on the critical role of engineering in solving our most complex global issues,we aspire to make the profession more attractive to both male and female students.

Keywords:

Engineering Education trend, Grand innovative Challenges for Engineering, Sustainability, Technology base

1 INTRODUCTION

The major global challenges we are facing today need to be addressed in the multifaceted context of economy, society, environment and technology. In recent years, the consensus of calling for sustainable development and implementation has emerged. Along with this belief, high added value, knowledge-based, competitive sustainable manufacturing has been widely considered as main enabler.

Engineering in general and engineering design and manufacturing in particular, affects virtually every aspect of our society and engages a substantial set of the population in carrying out engineers' plans and designs. But what is the role of engineering in responding to society's needs as well as in shaping them? This question is being asked with increasing urgency by a society that has benefited from great advances in technology, and at the same time, seen dislocations and experienced fears associated with technology. Often the questions about technology are confused with questions about engineering in the mind of the public despite a growing literature on the relation of technology to the rest of society. The list of impacts and side effects of technology is long and growing and has contributed to society's ambivalence about technology. While it would be wrong to blame the engineer for the apparent lack of interest by large portions of society in understanding the technological process with its constraints and possibilities, engineers can do much to reduce society's ambivalence if they could overcome their own parochialism.

ENGINEERING

Modern Engineering includes technology, but is also concerned with development and understanding of technological systems and the products, affects and appropriateness of technology. It is also concerned with non-technological approaches

Technical engineering is the activity of transforming and transporting:

1. Materials and forces of nature

2. Energy and information, which are technical measures of utility

This statement excludes reference to value and method. To complete our understanding of modern engineering, we should identify its values, its societal and environmental objectives and its tools

In a sense engineering has no values – is value neutral. Technically, engineering can be equally employed for destructive as well as good purposes. This attitude is found and bred in an atmosphere of extreme specialization and technical competition

How the modern engineering changes the view of the world.

Autonomy Everywhere

More and Better Big Data
Plug-and-Play World
More Complex Products
Old Industries Are New Again
Resilient Systems
A Changing Profession

Today, technologies like AI, IoT, big data, 5G, autonomous robots, and blockchain are stand-alone solutions

The rise of disruptive technologies such as

Augmented. Reality (AR),*Augmented reality* is the blending of interactive digital elements – like dazzling visual overlays, buzzy haptic feedback, or other sensory projections – into our real-world environments. If you experienced the hubbub of Pokemon Go, you witnessed *augmented reality* in action.

Virtual Reality (VR) experience is only complete when all of the body's senses are involved. By including transcutaneous electrical nerve stimulation (TENS or TNS/EMS) and high-precision motion tracking the Teslasuit has completely achieved the non-invasive immersion into xR. **Reality**),

Artificial Intelligence (AI),and **Additive Manufacturing**(AM) --also called 3D-printing-- are set to dominate the industry in the upcoming months.

Engineers must be at the forefront of innovation and emerging technologies as well as the new technologies that have become important **tools** for engineers and designers.

The Fourth Industrial Revolution

The rise of the factory of the future with more **automation** and **robotics** incorporated to the manufacturing process brings an integrated systems approach. Factory automation opens exciting possibilities as well as challenges in the industrial environment.

The **Fourth Industrial Revolution**, a term coined by Professor Klaus Schwab and introduced in Davos, Switzerland at the World Economic Forum in 2016, brings digital, physical, and biological systems together.

Some believe that new and emerging technologies such as Artificial Intelligence (AI) will eleiminate some jobs. Yet, **AI** is going to **create** a huge **demand** for new skills that many engineers don't have today.

The Fourth Industrial Revolution is going to bring all sorts of change at a speed, scale, and force unlike anything you have seen before. Preparedness becomes crucial.

5G connectivity

5G connectivity is going to make possible the **Vision 2020** we have been talking about for the past years.

Engineers have to keep an eye on **5G network** developments and 5G adoption around the wrold. 5G connectivity is what is going to power everything that the different engineering branches are going to be working with starting in 2019 and onward.

From the manufacturing assembly line to how to illuminate smart cities to city infrastructure and **machine-to-machine** (M2M) connectivity, the 5G network is going to change the way we work, live, and interact with people, cities, and machines.

Internet of Things (IoT) sensors

By 2009, we had already been talking about the **Internet of Things** (IoT) for at least a few years. It took well over 10 years for the IoT to reach today's maturity.

Before, it was not possible to connect everything to the Internet because the networks were not ready. Now, thanks to 5G connectivity all the technologies that depend on it are going to advance at a much faster speed.

The Internet of Things (IoT), sometimes referred to as the **Internet of Everything** (IoE), demands fast communication between **sensors** in order to work properly. Industrial engineers, for example must also watch closely the security of manufacturing applications such as sensors that monitor constantly the status of the assembly line.

This means that no matter the field, every engineer needs to watch for security alerts. But we are going to discuss this in more detail later.

All in all, engineering for IoT is one of the trends all engineers must definitely watch in 2019.

Smart city planning and design

In 2019, Smart City design is going to take a longer view into the future. The first step into building toward the future is through building a **smart infrastructure** that can support all **Smart City applications** today and tomorrow.

Otherwise, the city has to dig up the same streets over and over every year in order to add infrastructure for the new applications. This represents an unnecessary waste of resources, time, and tax money.

incorporated into the infrastructure.

Smart city planning and design is a space engineers much watch closely this year.

Doing things in the right way from the beginning is the smart thing to do, so existing **applications** such as surveillance cameras (CCTV), traffic sensors, smart lighting, smart parking, and others can be easily updated at the same time others are

Automation, M2M (Machine-to-Machine), and H2M (Human-to-Machine)

Automation in the Fourth Industrial Revolution is going to take the central stage in **smart manufacturing** and **digitaltransformation**. In order to remain relevant, manufacturers need to embrace change, automation, and offer training to their traditional workforce in order to fill the skills gap existing today.

A recent report found that in the next three years automation is going to take over manufacturing. IoT and AI are going to make manufacturing more agile and smarter. Engineers are going to be tasked to supervise the machines with the help of smart devices.

Traditional workforces are going to see change due to automation, yet they need to develop skillsto execute the digital transformation that automation brings to the manufacturing sector.

Forward thinking **leadership** is going to be in high demand in this sector with humans driving the change that it is needed for success.

Human-to-Machine (H2M) is the emerging collaboration between humans and machines.

Engineering design with AR, VR, and MR

The adoption of Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) technologies in the manufacturing sector is closing the gap between the digital and the real world.

Automotive engineering designers are going to experience a positive boost thanks to the help of new advances in AR, AR, and MR and more practical applications of the R+ technology (AR, AR, MR) powered by 5G.

This means that engineers are going to work with more powerful **toolsassisting** them in their job.

Augmented Reality is going to grow exponentially and is going to help engineering designers and many others work and collaborate across **multiple geographies.**

Cyber security engineering and risk management

Last but not least, one of the most important spaces **security engineers** must watch this year --if not the most important-- is advancements in **cybersecurityresearch** and how to stay ahead of the game before vulnerabilities turn into serious breaches.

Ensuring that networks and security systems are updated has to always be a priority. Designing systems to deal with disruptions such as natural disasters or malicious **cyber-attacks** must be done with vision into the future and updated often.

Cybersecurity engineers must be alert and carry out frequent **threat analysis** and **risk assessment** at an early stage during product development ensuring that security is a strong feature of every product and device.

With the global broad adoption of the Internet of Things (IoT) taking a front seat this year, analysts have anticipated thatIoT is going to create new security risks for enterprises and also for consumers. By using tools such as Artificial Intelligence (AI) and Machine Learning (ML) enterprises can sooner predict and protect from cyber attacks.

2 INSOCIETY

Engineering is an integral part of society. Unfortunately some people, including engineers by training, regard engineering as simply Applied Science. What is needed is an education that emphasizes engineering and society, or better yet, engineering in society or "Engineering Arts", as opposed to the more traditional Engineering Science. In universities, it is something exotic and mysterious that goes on by itself in the Faculty of Engineering. Engineers, in general, have tended to focus on the development of new technologies rather than the Social setting - government bureaucracies, school systems, and public service.

As engineering functions inseparably from the society of which it is a part, to operate within that reality, we need to comprehend better than we do what requirements and constraints are put on engineers by the rest of society and what role the engineer realistically can or should play in that society.

2.1 Socio-Technical Systems

The complexity of the interactions between society and engineering is at the root of unrealistic expectations about traditional engineering, as social entities are often inadequately organized to develop and use engineering effectively. It is also at the root of the frustration of engineers unable to bring their capabilities to bear on the solution of social problems or the effective organization of the engineering enterprise.

A more realistic possibility, which engineers should find congenial, is that has been termed the socio-technical system. As Engineers, and particularly Industrial and Manufacturing Systems Engineers, have to deal with systems—technical systems—all the time and are familiar with how they need to be designed, analyze dand managed.

In the socio-technical model, the entire society is visualized as a vast integrated system, with the varied social and technical areas of human activity as major interacting subsystems. In this context engineering does appear as one of the subsystems. To analyze the subsystems they must be divided in turn into sub-subsystems and sub-modules and components; these must then be examined individually with an eye towards reassembly of the overall system. Systems engineers are comfortable with such a systems approach, also called System of Systems (SOS).

Engineers, unfortunately, have not had much experience in analyzing even adaptive technical systems; that limited art is only now at the early stages, although significant progress has been made lately within CIRP and other professional organizations by researching Emergent Synthesis, Engineering Design as Collaborative Negotiation [Lu, ElMaraghy, et al. 2007], etc...

The image of engineering as an adaptive socio-technical subsystem functioning within the adaptive socio-technical system of society presents an ever greater complex model to implement. It certainly comes closer to reality, however, than the model of engineering and society as distinct and separate entities.

2.2 Why a Socio-Technical System?

It is by now a truism to say that any single technology can be used in multiple, and sometimes unexpected, ways. But we need to add to this observation that, in each different use, the technology is embedded in a complex set of other technologies, physical surroundings, people, procedures, etc. that together make up the socio-technical system. It is only by understanding this system that we can parse out the Environmental and societal and ethical issue and impacts. Many of the ethical issues are intimately related to the social and environmental systems. They are socio-technical systems, and the ethical issues associated with them are based in the particular combination of technology and social systems. It is the technology, embedded in the social systems that shape the ethical issues. The dilemma is to balance society's rights with individual rights and freedoms.

2.3 Trends in the Socio-technical System

Great technologies have over the ages created social revolution. Note how technology made possible the industrial revolution, how the automobile has affected the sprawl of cities and suburbs. In this century the computer-inspired age of information and wireless communication has changed everything all over the globe. The global village seems more a reality than a tired Canadian cliché. We are increasingly dependent on computers as more and more information is coming on-line. When the industrial revolution made the mass production of standard goods possible, it also took away the consumers freedom of choice. Henry Ford, who was striving for utility, simplicity, and low cost, stated: "You can have any color you want, as long as it is black". Computers in the information age promise to give us back individuality, through flexible, reconfigurable computerized manufacturing that allow large varieties of individualize the products.

However, a fundamental residue of the information age is the increase in complexity — complexity of technological systems, of business systems, and of social systems. They seem to demonstrate a form of the second law of thermodynamics. Entropy is always on the rise. We see this particularly in large- scale systems.

Large-scale, interconnected systems include global distributed manufacturing, transportation, the environment and the earth's ecosystem, and the strategic defense and security systems. In his best-selling book Megatrends, John Nesbit observed that the computer is a tool that manages complexity, and as such, just as highways encourage more cars, the computer invites more complexity into society. The question is whether the ability of computers to manage complexity and information and decision systems can keep up with the continuous increase in complexity. There is considerable hope, because the power of modeling, simulation and availability of supercomputers may be brought to bear on socio-technical problems, giving us new understanding and ability to manage our societal problems.

As the social and business systems have also been adapting to the information age, intellectual property has become an important branch of law, and has contributed its own ambiguities to an increasingly litigious society. The financial system has new problems of stability and control, as exemplified by program trading and the increasing volatility of the market. Moreover, the recent savings and loan crisis has shown the vulnerability of the banking system. The time constraints and turbulence in the economic system have also worked against the development of new science and technology, as business leaders have focused more and more on the short-term profitability rather than the long-term investment required for stable research.

3 SOCIETY AND EDUCATION OF ENGINEERS

To understand how engineering responds to the needs of society, we must examine its social structure and its function. Most people who study engineering in North America have higher physics, biology and mathematics skills and some communication and social ones. This appears to limit their involvement in politics and their success in communicating with the rest of society. Society, in turn, often views the engineer as a narrow, conservative, numbers-driven person, insensitive to subtle societal issues. The systematic study of socio-technical problems is rarely included in the engineering curricula as an important sphere of engineering activity. The curricula usually focus on man-made artifacts to the exclusion, except for specialized cases at the graduate studies level, of biological systems and organisms. This narrow focus has kept engineering away from not only a rich source of inspiration for specific technical feats and lessons offered by systems of great subtlety and complexity, but also a deeper understanding of environmental change.

Most high school students today do not view an engineering education as a path to success and prestige worthy of the sacrifices of a rigorous curriculum. Even bright young engineering students, upon graduation, switch to careers in business management, law, and medicine. On the other hand, engineering continues to be a powerful instrument for social mobility and advancement for immigrants and the poor. But is well recognized by most governments that in order for a country to prosper and compete globally, we need to graduate more scientists and engineering, as they contribute immeasurably to the nation's wealth creation.

This situation accentuates the perceived social gap between engineers and other professions in society. In different societies engineering provides most of the same artifacts: shelter, energy and communications, manufacturing, water supply, extraction and use of resources, and disposal of waste. There are societies where engineers carry out broader functions by virtue of the position they hold. In several European and developing countries, they head state organizations and major industry conglomerates, participate in government, and enjoy high social prestige. By contrast, engineers in North America are absent from major positions of societal leadership, and only a handful serve in government, in Congress, in Parliaments, or at the cabinet level.

The profession is, in a sense, handicapped in terms of serving society in a broader way by a pecking order that prizes activities connected with the design of tangible products above the challenges of manufacturing, operations, and maintenance, or public service at large.

3.1 Social Needs And Responsibility

Man-made products, albeit often extensions of our body, have not generally evolved through the gradual process that has shaped man and other biological species. Thus, we constantly face the question of whether the technology we develop enhances the long-range survival of our species. It should be mentioned however, that there is increasing body of research that use biological evolution as a metaphor for developing products and systems, ElMaraghy[2008].

An important determinant of how well engineering satisfies its social purpose is the breadth of engineering. Engineering today continues overwhelmingly to focus on inanimate products or machines, as engineering school curricula worldwide continue to bypass socio-technological. This lopsided orientation grew out of obvious historical origins that have had major consequences for society. The factory environmentsosingle-

mindedlyrationalizedbytheengineer
F.W.Tayloroverlookedtheeffectiveintegrationoftheworker
- the biological unit - and the machine in the production process. This is the case almost everywhere in the world, with the notable exception of Japan, where a different social ethos has produced a more effective integration with the human, as well as the artificial version, known as intelligent robots.

Another reason for the difficulty engineers encounter in dealing with social issues has to do with the various, and often conflicting, needs of social groups (educational, economic, environmental, health, public service, spiritual, and government) that engineering and technology may be expected tosatisfy.

The recurrent conflict between advocates of independent and targeted research is an example and an inevitable result of the tension between short-and long-range needs. If pushed to the extreme, however, such conflicts may cross the boundary between what is socially useful and what is out of control. Most governments that fund research, including in Canada are on the brink with regards to this issue. There must be a balance between short- and long-term needs. They both serve a purpose. You cannot have Strategy without implementation and application. Similarly operating without a long term "discovery" research base can be disastrous in the longrun.

The health care system for instance has absorbed an ever- greater portion of our gross national product, regardless of the state of our economic prosperity. At the same time, it has priced itself outside the financial reach of millions of north Americans. Technology has abetted the situation, not only by favouring the higher-cost, high-repair segment of the system, but also by not addressing the structure of the system. Similarly the problem of hunger remains endemic in many parts of the globe despite advances in agricultural technology. Even when production is high, in many countries grain supplies rot for lack of effective storage and distribution systems. It may be argued that engineers need to question their cultural responsibility to society as they contribute to its change. This effort must begin in the universities, in educating future engineers, our researchers, and in professional societies [Duderstadt, 2008], such as CIRP and SME[2008].

In the following paragraphs, Bugliarello [1991] offers five guiding principles, some of which are already deeply embedded in the conscience of engineers.

1) ***Uphold the dignity of man.*** This is a fundamental value of our society that never should be violated by an engineering design. This happens could happen when the design or operation of a technological product fails to recognize the importance of individuality, privacy, diversity, andaesthetics.
2) ***Avoid dangerous or uncontrolled side effects and by- products.*** This demands a rigorous development of a design or a technology considering all the functional requirements and constraints - be they political, economic, popular, or intrinsicallytechnological.
3) ***Make provisions for consequence when technology fails.*** The importance of making provisions for the consequences of failure is self-evident, especially in those systems that are complex, pervasive, and place us at great risk if theyfail.
4) ***Avoid buttressing social systems that perform poorly and should be replaced.*** This runs much against the grain of most engineers. Short -run technological fixes can put us at much greater risk in the long term. In the case of energy, for instance, technological or commercial fixes cannot mask the need to rethink globally the impact of consumerism and the interrelationship of energy, environment, and economicdevelopment.
5) ***Participate in formulating the "why" of technology.*** At present the engineering profession is poorly equipped to do so both in this country and elsewhere. Few engineers, for instance, have been involved in developing a philosophy of technology. This separation of engineering and philosophy affects our entire society. Engineers, in shaping our future, need to be guided by a clearer sense of the meaning and evolutionary role oftechnology.

The great social challenges we face require a rethinking of the human-artifact-society interrelationship and the options it offers us to carry out a growing number of social functions using quasi-intelligent products to instruct, manufacture, inspect, control, and soon.

4 ENGINEERING AND RESEARCH INTO THE FUTURE

The current generation of students is much more attuned to global issues and the need for new approaches than their predecessors. Duderstadt [2008] has discussed the future of engineering in detail. By focusing on the critical role of engineering in solving our most complex global issues, we aspire to make the profession more attractive to both male and female students, especially the latter. The new definition of engineering, by the Montreal Engineering Summit [Engineers Canada, 2009] will assist in this regard. The summit defined engineers as: "The enablers of dreams".

Engineers play a key role in our societal development, contributing to and enabling initiatives that drive economic progress, enhance social and physical infrastructures, and inspire the changes that improve our quality of life.

As a profession, we are committed to helping provide the best possible quality of life for all Canadians. "It is our aspiration that engineers will continue to be leaders in the movement towards use of wise, informed and economical, sustainable development. This should begin in our educational institutions and be founded in the basic tenets of the engineering profession and its actions. We also aspire to a future where engineers are prepared to adapt to changes in global forces and trends and to ethically assist the world in creating a balance in standard of living for developing and developed countries alike." [Engineering 20/20, NAE].

The following Montreal declaration [Engineers Canada, 2009] expresses the profession's resolve to help ensure Canada anditscitizensthriveandprosper—todayandintothefuture.

1. Deliver Canadian engineering innovation domestically and to the globalcommunity
2. Deliver specific engineering capabilities that will be needed in the future to improve health and safety, provide for a cleaner environment, and enable more sustainable development
3. Address areas in which advocacy by the engineering profession can lead to public policy development and directly contribute to Canadians' quality oflife
4. Make educational enhancements that will encourage broader participation in the profession by all segments of the population and fosterinnovation

At a high level, we acknowledge that we must:

- Pursue greater collaboration across disciplines and professions
- Increase engineers' influence inpolicymaking
- Re-examine our accreditationprocess
- Transform engineering education andpractice
- Encourage the greater participation of underrepresented groups such as AboriginalPeoples
- Attract and retain women in much greaternumbers

It appears that the Faculty of Engineering at McMaster University [2009] has also been paying close attention to the Sustainability and Globalization issues. They recently announced their 2009-2014 Strategic Plan, that includes very similar engineering educational objectives.

"Amongst the most important trends that will help define the future of the Faculty, we identified the following:

- Challenges in developing secure and sustainable forms of resources, including energy andwater
- The need to develop more sustainable practices in all branches ofengineering
- Increased opportunities for technology to improve human health
- Globalization and its impact on industrial supply chains, education, research and the humancondition
- The challenge of demographics that will see an unprecedented wave of retirements in the western industrial world over the nextdecade."

The Guiding Principles and Core Professional values are also very similar to what was discussed in the proposed University of Windsor "Bachelor of Engineering Arts- Management Engineering" (BEA-ME) articulated as follows: To provide an innovative and stimulating learning environment where students can prepare themselves to excel in life; To achieve the next level in research results and reputation by building on existing and emerging areas of excellence; To build an inclusive community with a shared purpose; To be honest, mutually respectful, fair and inclusive; To foster a collegial, interdisciplinary and innovative work environment; To respect and reflect diversity in our opinions, our recruitment and the community we build; To conduct ourselves according to the highest standards of professionalism, acting ethically and with integrity; and to expect no less of our students; To instill in our students a love of learning ; To inspire our students to see themselves as global engineers; To be stewards of the environment and exercise social responsibility in our research andeducation.

Goals that were discussed include the following:

1. Develop a vertically and horizontally integrated curriculum following the "Versatility TModel".
2. Develop clear and achievable learning objectives and student outcomes for eachcourse
3. Offer high level team work and practical experience in all courses.
4. Enhance the multi-disciplinary educational experience of students as well as outreachopportunities
5. Increase the level of student engagement in all engineeringprograms
6. Increase Faculty involvement formal international exchange (e.g. Stanford University d-Lab inDesign)
7. Develop a coordinated approach to Outreach Activities and internationalnetworking.
8. Increase our engagement in public policy and debates related to engineering and technology as well as their relation to socio-technicalissues.
9. Develop a new undergraduate Minor in Management EngineeringwiththeFacultyofArtsandSocialScience.

5 SUMMARY

In the past 25 years, several major trends have emerged that magnify the social impact of engineering and the challenge to engineering to address pivotal social issues.

These trends are too well known and documented to be further underscored here: the sharpening of engineering prowess in the creation of products; the broadening of the social needs that engineering is called to address; geopolitical and economic shifts that are placing new demands on engineering; the coming to the fore of a series of issues of wide societal impact —such as the environment— that stem at least in part from engineering and technology themselves and demand urgentattention.

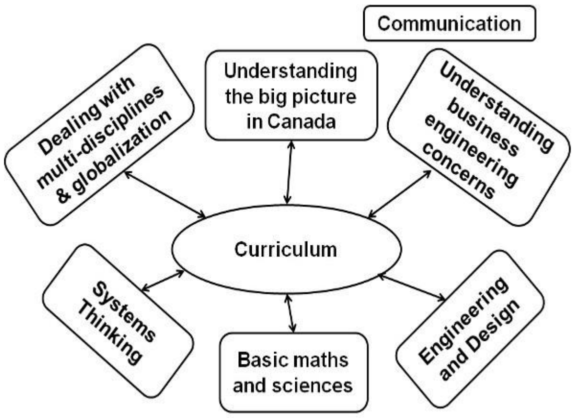
Engineering has contributed to this situation by its failure to emphasize manufacturing and production in formal engineering education and in the system of professional recognition. That emphasis is being developed, laboriously, only now and engineering has been slow also in responding to the immense challenges of globalization, and of the environment. The greatest challenge that globalization presents engineers and engineering education is how to increase throughout the world the rate of technological, economic, and social progress through the creation of new and more adaptable technologies and better socio-technical integration. Figure 1illustrates the new paradigm for engineering education and research.

Furthermore, North American engineering has not participated to any major extent in the development of strategies for the reform of the health care and education systems as two key service activities that together absorb well over 15 percent of NA GNP. Engineering also has been absent from the attack on some of the most vexing problems of urban areas. Poverty, drugs, and alienation are all interconnected socio-technological problems of our cities, with their deteriorating infrastructure and the loss of easily accessible jobs inmanufacturing.

This creates an added dilemma between societal values and individual values to simultaneously achieve technical excellence, manufacturing competitiveness and quality of life. To address these challenges of the future, the Industrial and Manufacturing Systems Engineering Department (IMSE) at the University of Windsor, Canada is proposing to introduce an innovative, the first in Canada, "Bachelor of Engineering Arts" (BAE) in the field of Management Engineering. Like Industrial Engineering, Management Engineering is concerned with the design, installation, operations and improvement of integrated systems consisting of equipment, materials, information and energy flows, and people. Unlike other engineering disciplines Management Engineering is concerned with the entire system, and especially the role people play in such systems. The educational approach is, therefore, more multi-disciplinary and includes the study of human factors involved in industrial operations, service industries, the health sector, and indeed any business, organization or government. The Structure and themes of the BEA-ME program are illustrated in Figures 1 and2.

Figure 2 Structure of the BEA-ME Program

Figure 3 Main Themes for the BEA Curriculum



This paper was an opportunity to explore the connection between Engineering and other disciplines, such as the Arts, Sciences, Engineering, Humanities, Social Sciences and Business. The context and objectives from developing a new curriculum and delivery methods for the proposed BEA (Bachelor of Engineering Arts) program have been discussed, with particular emphasize on breadth across engineering subjects and exposure to technology management and communication, as well as the humanities and arts. Our vision is to offer a world-leading integrated, interdisciplinary undergraduate education for students interested in an educational experience that offers a rich mixture that balances technical subject with a deep understanding of the role of an engineer in addressing sustainability and the other grand challenges and key socio technical issues affecting our globalvillage.

The most obvious applications of the proposed BEA curriculum relates to sustainability and the development of eco-effective designs, human networks, processes and products. The sustainable processes and practices will provide greater applications in the goods and services businesses, as well as in health care, communications technologies, and public service. We aspire to graduation.

Leaders who can develop engineering methodologies that can sustain societies anywhere, leading to the concept of a Global RenaissanceEngineer. This is a rare opportunity for educators, researchers and students from everywhere to discuss the merits of a strategic decision to integrate a technical education with the humanities, business, arts, etc.. The timing of this proposal fits well with the University of Windsor construction underway of the new "Centre for Engineering Innovation" (CEI). Such events, activities and projects, as well as the accompanying publicity, will hopefully help in the efforts to increase the bread than depth of the education of engineers in the future.

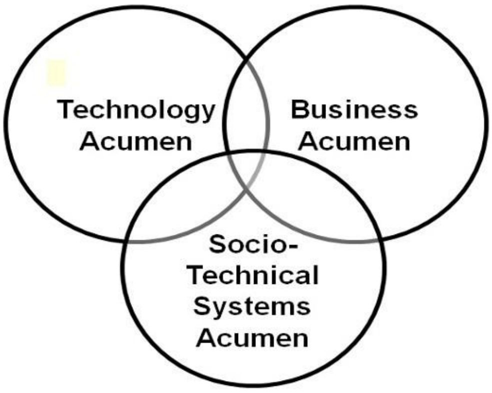


Figure 1 A New Paradigm for Engineering Education and Research