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# The Transformation and Evolution of Undergraduate Environmental Engineering Education from Its Early Inception to the Present Status\*

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Environmental engineering, from its early inception, has endured a lack of identity both as a profession and as a discipline in engineering. The field is broad and multidisciplinary in nature, and the foundation upon which it is built includes knowledge and understanding of concepts and ideas coming from the engineering and science fields. Environmental engineers are said to be a hybrid of an engineer and a scientist, thus making them the best profession to deal with environmental problems. Environmental engineering education has been undergoing substantial changes over the last few years in order to be more relevant and applicable in current times. In this article, the authors endeavour to trace the history and evolution of environmental engineering education in the context of changing societal needs and demands, discuss how it has developed into an engineering branch of its own merit and how this vital field was constructed in earlier times. The current status and future directions of environmental engineering are also elaborated on. In addition, some interesting statistics on the enrolment of students in various engineering courses and the attraction of women to environmental engineering courses are presented and discussed in this article.

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## INTRODUCTION

While environmental problems have rapidly accelerated within the last three decades, the response, in terms of environmental education for the engineering profession, is slow and has not accelerated at the same pace. Sadly, many existing engineering curricula have yet to integrate relevant environmental issues that pertain to the field of engineering. In particular, it was found that the issues have not been equally covered across all branches of engineering, especially in the field of electrical and mechanical engineering.

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\*\*As Director of the UICEE, Prof. Z.J. Pudlowski declined to accept the award, which was accepted by Ms D.Q. Nguyen.

However, the story is not all drastic as some engineering schools have responded enthusiastically by establishing and developing environmental engineering courses. There has been evidence of a growing number of environmental engineering programmes being established across engineering schools over the years; an implication, at least, that engineering is taking this environmental challenge seriously.

## PROLIFERATION OF ENVIRONMENTAL ENGINEERING PROGRAMMES

In recent years, there has been a proliferation in the number of environmental engineering courses developed worldwide. This is evident by the growing demand and importance for this disciplinary area.

Safferman et al believe that most undergraduate environmental engineering programmes have come about largely due to the response from students or the community, and the strong interest from faculty [1]. In addition, there is a high demand coming from the

environmental engineering market, which, according to Katcher, has also raised interest among engineering educators [2]. The increase in the number of environmental programmes has also come about due to the increased demand for more environmental training by students and employers of engineers [3]. Environmental engineering is, without a doubt, the most multidisciplinary of all the engineering fields and, perhaps, the most complex of them all.

Environmental engineering has emerged as a topic of interest among engineering educators since the 1970s and 1980s. This new field was still in its infancy stage during this period and very little was known about it. As time progresses, environmental engineering is slowly finding its niche in mainstream engineering. However, the interest for environmental engineering has fluctuated over the years and, more recently, has faded into the background. Environmental engineering is not receiving and attracting the same level of attention as it did when it first emerged in engineering in the early 1970s.

## **ENVIRONMENTAL EDUCATION AND ITS RELEVANCE IN ENGINEERING**

The environmental debate has been going on for over four decades now and still continues to be a burning topic on the agenda, both politically and socially. Unfortunately, in engineering, the environment has only been discussed over a short period of time. There have been major discussions and talks about engineers needing to be educated about the environment, an area that has been neglected in past education.

Engineers are not only expected to have some form of environmental education but also to take an active role in helping to solve environmental problems. This idea has come about because engineers are seen as the problem and also as the solution to the environmental problems. Travers gives a good example of how engineers can fall into both categories [4].

Travers states that many of the environmental problems of the present have been made possible by technical developments for which the engineering profession has been at least in part responsible [4]. On the other hand, many of the solutions to the same problems are also technical and, again, within the responsibility of the engineer. Although this may sound simple in theory, it is harder to achieve in practice.

Further, according to Travers, this is because environmental problems are complex and require the application of knowledge and experience from a wide range of disciplines [4]. The current curricula are still very narrowly focused and little emphasis is placed on the environmental aspects. Although most agree and

accept that engineers all need to be subjected to some form of environmental education, this requirement does not appear to be reflected strongly in existing curricula.

## **SUSTAINABLE ENGINEERING**

In addition to this, engineers of today are pressured and encouraged to think and practice along this path of sustainable development, cleaner production, greener technology, ecological design, waste prevention and recycling, energy efficiency, resource conservation and environmental protection. All of these are key topics in the future of engineering development and fall into this new study area of environmental engineering.

Environmental engineering is undoubtedly an important area and will expand in the future as the environmental problems worsen. If this is the likely scenario facing the planet in the future, there will be a higher demand for more environmental specialists, namely: environmental engineers, to find solutions to environmental problems. Such achievements can only come about with proper education and training, and through a well-structured and designed curriculum in environmental engineering.

The field of environmental engineering can make a huge contribution to the overall engineering profession. Some of these benefits include: developing environmental technologies to solve environmental problems, improving the quality of life by conserving resources, improving efficiency for industry through recycling initiatives, raising the public image of engineers, contributing to global sustainability and finally, which is also very important, increasing the number of female engineers [5].

## **THE SUSTAINABLE MODEL**

A model outlining the challenge of sustainability for engineers was proposed by Roberts. He pointed out the essential components requiring urgent attention by engineers if sustainability is to play an important role in engineering. These include issues ranging from resource development and recovery, processes, modification of resources and consumption patterns, environmental restoration, energy use, and production and the transportation systems [6].

He also suggests two ways in which environmentally friendly approaches and sustainability can be achieved in engineering education. One way is to give all engineers some exposure to general education in the environment while retaining their specialist field of practice. The other suggestion was to take 25% of

future engineers and train them as environmental generalists by providing them with a broader education, ranging from environmentalism, engineering, law, economics, humanities, etc [6].

Roberts' model of sustainability is shown in Figure 1 [6]. Thom stated that a new technical culture has emerged in engineering and this requires a major transition towards cleaner production, energy efficiency and sustainable technologies in engineering [7]. In his work, Messerle has also emphasised the importance of sustainable development in engineering education [8].

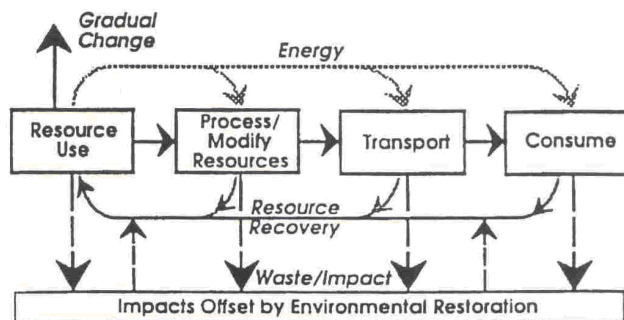


Figure 1: The model of sustainability proposed by Roberts [6].

Varcoe elaborates on the important issue of global sustainability and how engineers can contribute to this new challenge [5]. To achieve this, engineers need to take the following issues into consideration:

- Resource consumption/process efficiency;
- Energy resource availability – renewable versus non-renewable;
- Material resource availability – recyclable versus consumable;
- Life of the item or project;
- Ultimate disposal, completion or closure;
- Future use;
- Impact on the present community;
- Impact on future generations;
- Pollution and waste products;
- Recyclables [5].

## THE INCEPTION AND RECOGNITION OF ENVIRONMENTAL ENGINEERING

Unlike other conventional engineering disciplines, environmental engineering has only been truly recognised and accepted as a separate engineering field in the last decade or so. Most environmental engineering programmes in the USA began in the mid-1970s and much later in Australia. In fact, the very first environmental engineering programme was introduced in Australia in the early 1990s.

Most programmes in environmental engineering stem from civil engineering or sanitary engineering; this is the main reason why it is so rare to find an environmental engineering programme without reference or linking it back to the civil or chemical engineering discipline. Unfortunately, as a result of this, many environmental engineering programmes suffer because most of the time, essential environmental subjects are overshadowed by subjects mostly from the civil engineering field. It is suggested that one way to overcome this problem is to design environmental engineering courses from scratch. This means not building it or relying on any existing civil/chemical engineering curricula. This particular approach helps to keep a programme independent and prevents it from being biased by one particular speciality or department [1][9].

## NATIONAL STATISTICS OF ENROLMENTS IN ENGINEERING COURSES FROM 2001-2004

Figure 2 presents the national enrolments of both domestic and international students in five main engineering disciplines in Australia during the academic years from 2001-2004 [10]. According to this chart, it is seen that the enrolments in these engineering disciplines are steady, although with minor fluctuations in the number of enrolments observed in some areas of engineering. It should be noticed that mechanical engineering is the most attractive among students, drawing in the highest number of students, with chemical engineering attracting the second highest number of students.

## HISTORY OF ENVIRONMENTAL ENGINEERING

There was a series of environmental engineering education conferences held between the 1960s and 1980s at various universities. The very first conference was held at Harvard University, a prestigious university in the USA, to mark the importance and open up discussions concerning this new discipline in engineering. This so-called new discipline was known at the time as *sanitary engineering* and, by 1973, this term was officially changed and renamed to environmental engineering. The changing of the name was necessary in recognition of the rapid evolution of undergraduate programmes in environmental engineering and also due to the broadening of the scope of the underlying field [11].

The adverse effects of environmental pollution on human health were first identified and found to be

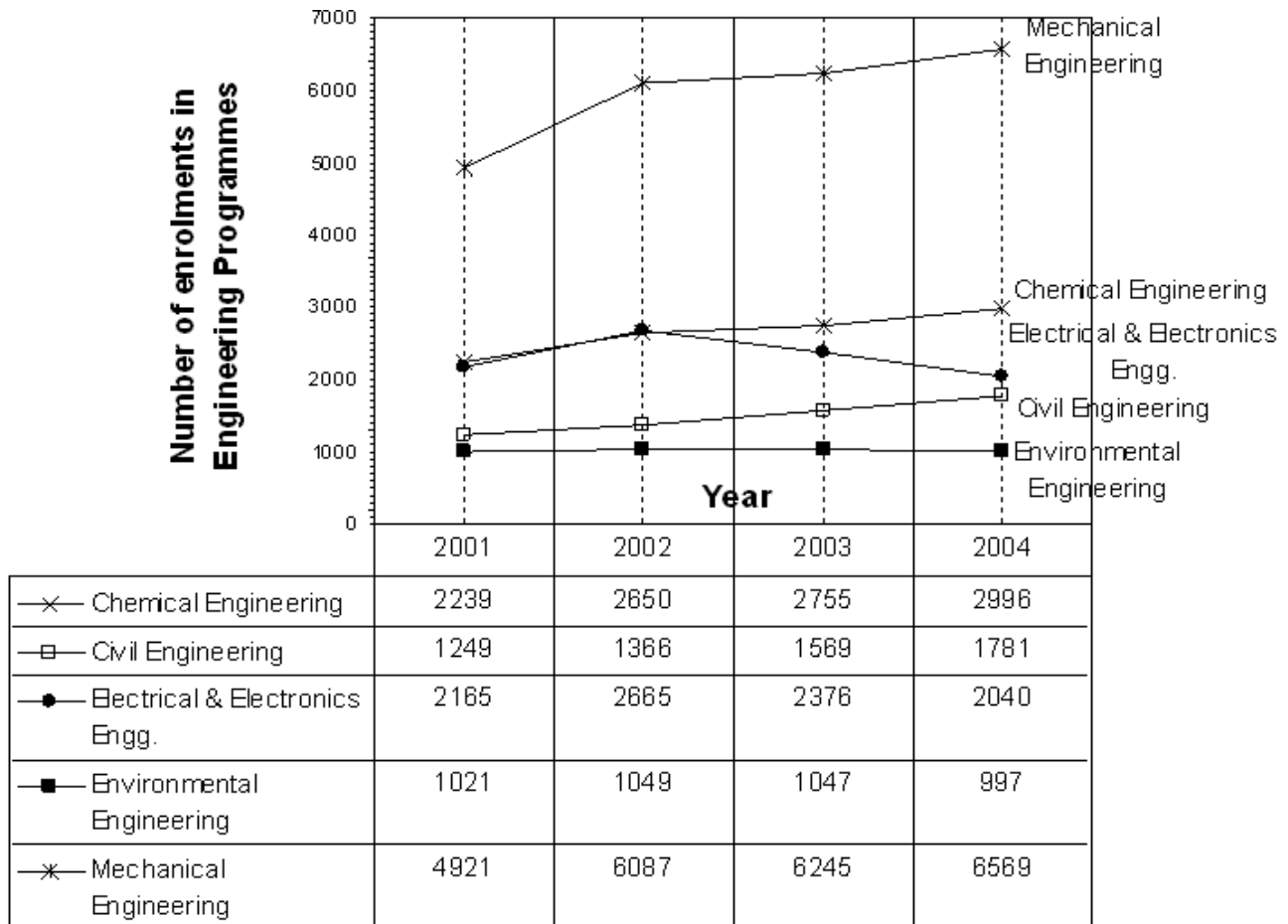


Figure 2: The changes in the national enrolments in five engineering disciplines (2001-2004) [10].

linked to water-borne pollutants. Civil engineers during this period were the professionals responsible for building sewers and public waterworks to improve the sanitation and hygiene of those cities affected by the spread of these water pollutants. The practice of this area was then called *sanitary engineering* and it is more commonly known today as water quality engineering [11]. Due to the early work performed by civil engineers in sanitation, the study area of sanitary engineering still remains a strong part of civil engineering education and programmes.

The environmental engineering profession and discipline were basically non-existent in the past and therefore civil engineers were assumed as fulfilling the role of environmental engineers.

In the early 20<sup>th</sup> Century, air pollution from combustion processes and the production of chemical smog became a major concern, which resulted in the increased involvement of other engineering professions, particularly chemical and mechanical, in tackling air quality problems. During this period, a few institutions began establishing and offering programmes in air pollution control in chemical engineering departments [11]. It should be quoted at this point that:

*Thus, in the early evolution of environmental engineering education, the civil engineering component predominated, with program enrichment resulting from cross-over, primarily from chemical and some mechanical engineering faculty [11].*

As a result of this early evolution of environmental engineering education, the same ideology has also been followed and embraced in today's environmental engineering programmes. It is true to say that most environmental engineering programmes today are predominantly created from existing civil engineering programmes, which is not always the best option as many problems have derived from this association. It is also noted that current environmental engineering education is not only limited to studies relating to air or water quality engineering, as was the case in the past, but has expanded to be much wider in scope. This is evidence that environmental engineering is growing and expanding into a field of its own.

Between 1971 and 1977, there was a rapid increase in enrolments in undergraduate environmental engineering degree programmes and also in the number



of institutions offering environmental engineering programmes across the USA [11]. It was not until the 1990s that environmental engineering became renowned and found its niche in engineering schools at Australian universities. Patterson stated that several earlier programmes offered in institutions across the USA shared many common characteristics [11]. The opposite finding is noticed in today's environmental engineering programmes. There appears to be no uniformity or consistencies with the content matter and development of environmental engineering programmes at the global level.

According to Patterson:

*... the past two decades, 1960-80, have been a period of transition for the environmental engineering profession and for university programs in environmental engineering [11].*

### ENVIRONMENTAL ENGINEERING EDUCATION CURRICULA IN THE PAST

The mean distribution of subjects obtained from 15 institutions in the USA in 1977 that offered baccalaureate degrees in environmental engineering is presented in Figure 3 [11]. It is clear from the data gathered in this study that there was very little emphasis on environmental science and study on the environment. It could be concluded that environmental engineering in the past was more science/engineering orientated when compared to current environmental engineering education. It demonstrates that for the most part of the curriculum about 70% of the content is comprised of science studies and the remaining part is dedicated to non-technical studies.

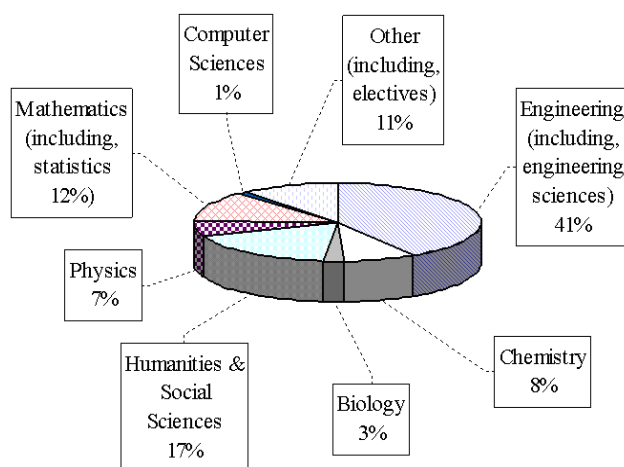


Figure 3: The mean distribution as a percentage of specific subject areas in environmental engineering education programmes in 1977 [11].

The mean distribution as a percentage of subject areas listed in ascending order includes:

- Engineering (including engineering science) (41%);
- Humanities and social sciences (17%);
- Mathematics (including statistics) (12%);
- Other (including electives, thesis) (11%);
- Chemistry (8%);
- Physics (7%);
- Biology (3%);
- Computer science (1%).

In order to acquire a better understanding of other subjects included in past environmental engineering curricula, the pie chart shown in Figure 4 is a combination of specific subject areas, including those listed under the general category of *other areas*, which gives a total of 48%.

### ENVIRONMENTAL ENGINEERING EDUCATION TODAY

It would be fair to say that the scope of environmental engineering education in the past was more narrowly defined and the curricula appeared to be more compact, whereas the scope of environmental engineering today is much more diverse and broader.

The common environmental engineering specialties, as expressed by representatives from academia, the government and industry in a study conducted in the USA, include:

- Wastewater, storm water and water treatment;
- Solid waste management;
- Air pollution control;
- Hazardous waste remediation;
- Waste minimisation and pollution prevention;
- Risk assessment and safety engineering [1].

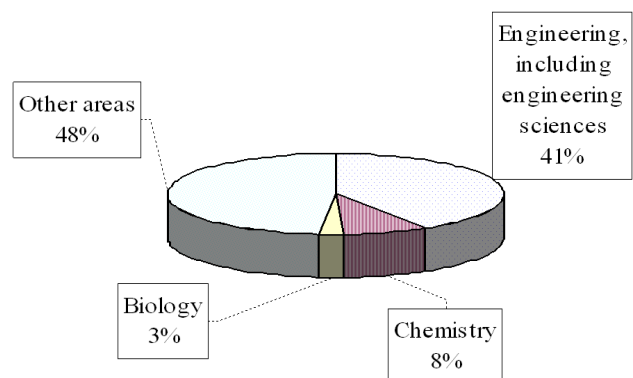


Figure 4: The mean distribution as a percentage of general subject areas in environmental engineering education programmes in 1977 [11].

These specialties mentioned in the survey are commonly found in most environmental engineering programmes. However, since its inception, environmental engineering has expanded in scope and it has become necessary to include issues like sustainable development, recycling, cleaner production and Life Cycle Analysis (LCA) in the curricula.

When again referring to Figure 2, which illustrates the enrolments of students in engineering programmes in Australia during the academic years of 2001 to 2004, the following points can be drawn from this line graph:

- Engineering appears to be a reasonable choice of study at universities among school leavers;
- The national number of intakes in engineering courses in recent times has been steady;
- There has been a slight decline in the number of enrolments of some engineering disciplines over others, but overall, the enrolment numbers in engineering courses are stable;
- Enrolment numbers in mechanical engineering, chemical engineering and civil engineering have steadily increased;
- There has been a slight drop in enrolment numbers in electrical and environmental engineering courses observed over the consecutive four years, but this is not a significant number [10].

## THE ATTRACTION OF WOMEN TO ENVIRONMENTAL ENGINEERING

As stated earlier, environmental engineering has evolved from sanitary engineering, which is a field predominantly found in civil engineering. Figure 5 shows the national enrolment of females in engineering courses in Australia (2001-2004). What is surprising about Figure 5 is that civil engineering programmes have not been particularly successful in attracting and retaining female students to its course [10].

It is highlighted in Figure 5 that environmental engineering courses appear to be more successful in attracting female students when compared to the intake of female students from other classical engineering disciplines, such as courses in mechanical engineering. The field of environmental engineering, closely followed by chemical engineering, is the preferred choice among female students. As shown in Figure 5, environmental and chemical engineering attract approximately 40% of the female population to their courses [10].

What is the reason behind this attraction? Perhaps environmental engineering is more appealing to the female gender because it touches on the softer issues of engineering or so-called *soft engineering* as opposed to *hard engineering*.

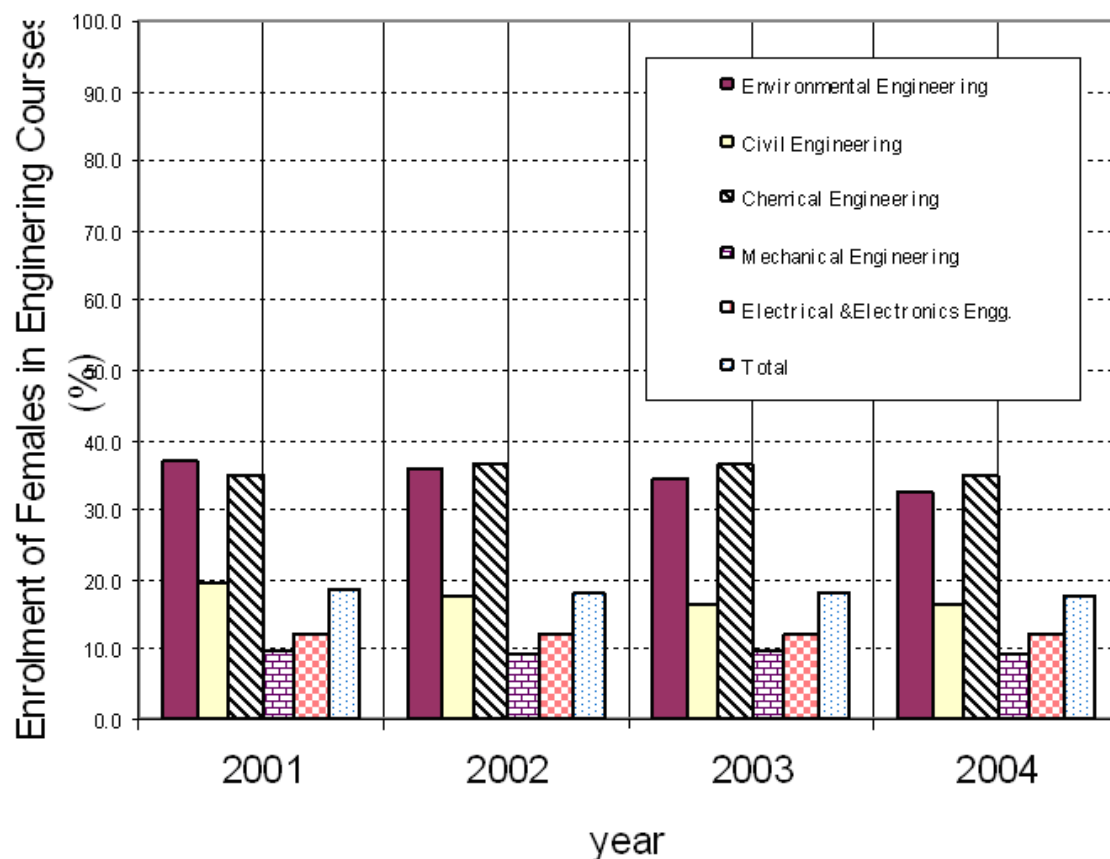


Figure 5: The national enrolment of females in engineering courses (2001-2004) [10].

As the statistics confirm, engineering is predominantly a male occupation. Hence, it is not surprising to find that 80% of the students enrolled in engineering courses in Australia are male. Women, who are in the minority, will always have difficulties fitting into the male-dominated and oriented structure. Therefore, something has to be done in order to remedy this situation.

There have been many discussions over the years among engineering educators, particularly female educators, on how to increase the population of women in engineering courses and make it more appealing for women. One option to consider may be to integrate the environmental aspects into general engineering curricula. The challenge here, of course, is finding the availability of space in the already limited and overcrowded engineering curricula.

Although the Australian national data has revealed that chemical engineering is a popular choice among females, the opposite finding was surprisingly reported in most countries of the European Union (EU) [12].

In Australia, of the five classical engineering fields, programmes in mechanical engineering appear to be the least appealing to female students, attracting less than 10% of the female population. On average, engineering courses attract about 20% of the female population. This reaffirms the statement made earlier in the article about engineering being a male-oriented discipline.

Similar findings were also reported in most countries of the EU. It was reported that females represent about 25% of the total number of enrolments in engineering courses [12].

This number is still very small in comparison with the number of women enrolling in science courses, especially in the humanities and social sciences courses. It is clear that more work is needed to increase the participation of women in engineering.

## ISSUES OF CURRICULA DESIGN

The task of designing curricula, particularly engineering curricula, is not a simple one, but is essential in the formation of professional engineers. What academics should remember in designing any engineering curricula is that most undergraduate degrees must be developed within this confined period – usually within four years in many parts of the world. Hence, in order to design a curriculum for such a short and restricted period, it is imperative that the fundamental core modules be identified and included in this four-year structure.

As a general comment, academics must not fall into this trap of including everything into environmental

engineering curricula because a bit of everything could result in absolutely nothing. This is a typical case of too much of everything and not enough of anything. This is one of the prevailing problems noted with most environmental engineering curricula today [13]. Moreover, it is unrealistic and overly ambitious to think that everything can be covered in detail in a four-year programme. Apart from the issue of the balance of content in the curriculum, several other problems associated with environmental engineering have been discussed and highlighted by the authors elsewhere [9][14].

Environmental engineering, like any other engineering discipline, should have its own identity and merits, and the content of an environmental engineering curriculum should facilitate the establishment of a solid foundation in relevant studies pertaining to the field of environmental engineering. It should not be developed as a derivative of civil or chemical engineering as this evidently was the case in past times.

The first stage in designing environmental engineering curricula is to identify and determine the fundamental core modules to be included in the curriculum. Once those main modules are identified, it is relatively easy to build a curriculum by adding other relevant modules. It should be emphasised that the difficult part is to identify those core modules and arrange them, for instance, by the use of a modern methodology, eg the Modelling Method [15].

In this endeavour, the optimum objective is to design a curriculum that will produce graduate environmental engineers with the appropriate skills, knowledge and attributes to enable them to work, function and carry out their duty as professional engineers.

## THE RELATIONSHIP BETWEEN ENVIRONMENTAL ENGINEERS WITH OTHER PROFESSIONS

It has been asserted that environmental engineers are of a hybrid of an engineer and a scientist, thus making them the best profession to deal with environmental problems. Indeed, this view is illustrated by Reible, where he forms a relationship and the connection of environmental engineers with other professions in similar roles (see Figure 6) [3].

Therefore, the work of an environmental engineer involves comprehensive knowledge and understanding of both the engineering (eg chemical, civil, materials, mechanical engineering, etc) and science (eg biology, chemistry, environmental science, etc) disciplines. This just emphasises the broadness of this field. This multidisciplinary requirement may be viewed as a serious problem in the environmental engineering

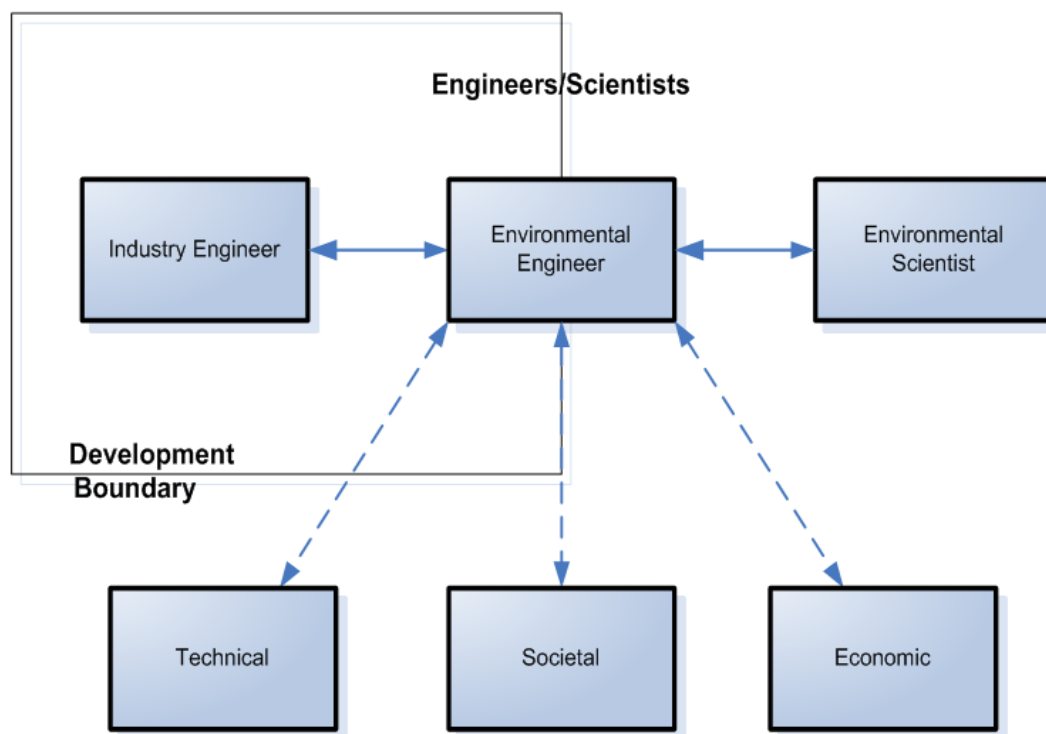


Figure 6: The relationship of environmental engineers with other professions working within the technical, societal and economic constraints [3].

profession as those engineers may be expected to acquire and display similar knowledge and experience of practising engineers of other fields namely, chemical, civil and mechanical engineers, as well as be knowledgeable in the science field [3].

## CONCLUSION

Environmental engineering has grown, expanded and evolved into quite a unique area of engineering since its inception in the early 1970s. The curricula content and the distribution of subject matter have changed substantially since then. The scope of current curricula is more diverse, multidisciplinary and complex, and perhaps is presently lacking consistency when compared with past curricula.

The other special feature of environmental engineering is that it can be successful in recruiting women to its courses, which helps break down this gender barrier found in other engineering courses, such as mechanical and electrical engineering. Generally speaking, the number of women studying engineering is still a record low at 20% in Australia and 25% in most countries of the EU.

What is then the future status of environmental engineering? It is the authors' strong conviction that environmental engineering education firstly needs to be internationalised or globalised to resolve this imperative issue of accreditation and recognition of qualifications. For environmental engineers to be truly recognised,

being able to move freely across national settings and work across national borders, recognition and accreditation need to be resolved by establishing some form of standardisation and/or harmonisation in the education system so that it fits into global education standards. One way of achieving global standards may be through the use of a global curriculum [9].

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## BIOGRAPHIES



Dianne Q. Nguyen graduated with a Bachelor of Applied Science, majoring in chemistry and environmental management, from Deakin University, Australia, in 1994, and then completed her Honours year in 1997 and Masters in Engineering Science (Research) at Monash University, Australia, in 2000.

She has spent time working in research laboratories before entering academia. Since December 1995, she has been with the UNESCO International Centre for Engineering Education (UICEE) in the Faculty of Engineering at Monash University, Melbourne, Australia.

She is currently a Research Fellow and finalising her PhD in environmental engineering education.

Her special research interests include environmental engineering, engineering education, sustainable engineering, global education, curriculum analysis and design, statistical analysis, research methods, and women in engineering. Also, she has external interests in Web design and programming in Java and Javascript. In her spare time, she enjoys doing high impact aerobics, weight training, tae-box and reading. Her hobbies include fashion, shopping, computers, travelling, playing music, playing golf and watching movies.

Her awards include: UICEE's *Women in Engineering Education Scholarship* (1997-2000); the UICEE Silver Badge of Honour for her contribution to engineering education and to the operation of the UICEE (1998); the UICEE Best Paper Diamond (First Grade) Award for a distinguished contribution in delivering an outstanding paper to the *Global Congress on Engineering Education* (July 1998); the UICEE Best Paper Silver (Fourth Grade) Award at the 8<sup>th</sup> *Baltic Region Seminar on Engineering Education* (September 2004); the UICEE Best Paper Diamond (First Grade) Award at the 9<sup>th</sup> *UICEE Annual Conference on Engineering Education* (February 2006); the UICEE Best Paper Gold (Third Grade) Award (first place) at the 10<sup>th</sup> *UICEE Annual Conference on Engineering Education* (March 2007); and her latest award, the UICEE Best Paper Diamond (First Grade) Award at the 11<sup>th</sup> *Baltic Region Seminar on Engineering Education* (June 2007). She is also a recipient of the prestigious *Australian Postgraduate Award* (October 2000-October 2003), Monash Departmental Award (October 2000-October 2003) and Monash Travel Grant (October 2001).

She has also served on several national and international engineering education conference organising committees. She has already published close to 50 conference and journal papers.

Ms Nguyen is the current Treasurer of the International Liaison Group on Engineering Education (IL-GEE).



Zenon Jan Pudlowski graduated Master of Electrical Engineering from the Academy of Mining and Metallurgy (Kraków, Poland), and Doctor of Philosophy from Jagiellonian University (Kraków), in 1968 and 1979, respectively.

From 1969 to 1976, he

was a lecturer in the Institute of Technology within the University of Pedagogy (Kraków). Between 1976 and 1979, he was a researcher at the Institute of Vocational Education (Warsaw) and from 1979 to 1981 was an Adjunct Professor at the Institute of Pedagogy within Jagiellonian University. From 1981 to 1993, he was with the Department of Electrical Engineering at The University of Sydney where, in recent years, he was a Senior Lecturer.

He is presently Professor and Director of the UNESCO International Centre for Engineering Education (UICEE) in the Faculty of Engineering at Monash University, Clayton, Melbourne, Australia. He was Associate Dean (Engineering Education) of the Faculty of Engineering between 1994 and 1998.

In 1992, he was instrumental in establishing the International Faculty of Engineering at the Technical University of Lodz, Poland, of which he was the Foundation Dean (1992-1995) and Professor (in absentia) (1992-1999). He was also appointed Honorary Dean of the English Engineering Faculty at the Donetsk National Technical University in the Ukraine in 1995.

His research interests include circuit analysis, electrical machines and apparatus, implementation of computer technology in electrical engineering, software engineering, methodology of engineering education and industrial training, educational psychology and measurement, as well as human aspects of communication in engineering. His achievements to date have been published in books and manuals and in over 350 scientific papers, in refereed journals and conference proceedings.

Professor Pudlowski is a Fellow of the Institution of Engineers, Australia, and of the World Innovation Foundation (WIF), UK. He is a member of the editorial advisory board of the *International Journal of Engineering Education*. He is the founder of the Australasian Association for Engineering Education (AAEE) and the *Australasian Journal of Engineering Education* (AJEE), and was the 1<sup>st</sup> Vice-President and Executive Director of the AAEE and the Editor-in-Chief of the AJEE since its inception in 1989 until 1997. Currently, he is the Editor-in-Chief of the *Global Journal of Engineering Education*

(GJEE) and the *World Transactions on Engineering and Technology Education* (WTE&TE). He was on the editorial boards of the *International Journal of Electrical Engineering Education* (1993-2005) and the *European Journal of Engineering Education* (1993-2005). Prof. Pudlowski was the Foundation Secretary of the International Liaison Group for Engineering Education (ILG-EE) (1989-2006) and is currently its Chairman.

Professor Pudlowski was a member of the UNESCO International Committee on Engineering Education (ICEE) (1992-2000). He has chaired and organised numerous international conferences and meetings. He was the Academic Convener of the 2<sup>nd</sup> World Conference on Engineering Education, the General Chairman of the East-West Congresses on Engineering Education. He was also General Chairman of the UNESCO 1995 International Congress of Engineering Deans and Industry Leaders, and General Chairman of the Global Congress on Engineering Education, to name a few.

He received the inaugural AAEE Medal for Distinguished Contributions to Engineering Education (Australasia) in 1991 and was awarded the Order of the Egyptian Syndicate of Engineers for Contributions to the Development of Engineering Education on both National and International Levels in 1994.

In June 1996, Prof. Pudlowski received an honorary doctorate from the Donetsk National Technical University in the Ukraine in recognition of his contributions to international engineering education, and in July 1998, he was awarded an honorary Doctorate of Technology from Glasgow Caledonian University, Glasgow, Scotland, UK. He was elected a member of the Ukrainian Academy of Engineering Sciences in 1997. In 2002, he was awarded the title of an Honorary Professor of Tomsk Polytechnic University, Tomsk, Russia, and was an External Professor at Aalborg University, Aalborg, Denmark (2002-2007). He is listed in 14 *Who's Who* encyclopaedias, including the Marquis *Who's Who in the World*. He has been recently appointed to the Register for External Reviewers of the Oman Accreditation Council (OAC).