World Transactions on Engineering and Technology Education
Vol.2, No.3, 2003

From farmers to blue-collar professionals: agricultural engineering students' perspectives on their career prospects, critical skills and discipline name change

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ABSTRACT: There is an ongoing worldwide debate and dialogue on the future of the agricultural engineering (AE) profession and academic discipline, spurred in part by declining undergraduate enrolments, reduced sources of funding for traditional agricultural engineering research and development activities, and a poor public image of agriculture and other land-based industries. The article presents the outcomes of a survey of, and focus group discussion with, final year undergraduate agricultural engineering majors at Massey University, New Zealand. The issues explored included students' reason for choosing AE, perceived career options, skills required by potential employers and adequacy of the current academic programme to meet those expectations. Students also commented on their preferred professional affiliation and discipline name. The majority of students came from a rural farming background and chose to study AE because of their personal interest in the mechanical aspects of agriculture. The study also showed that most students preferred their academic programme to be more closely aligned towards the agricultural and horticultural sciences, but on the other hand, would prefer to be considered as engineers and affiliated to a professional engineering society after graduation.

INTRODUCTION

Agriculture and other land-based industries have continued to play significant roles in the industrial development and economic well-being of humans. In addition to providing the food and feed essential for nutrition, agriculture also provides the fibre and other raw materials for many other industries. Advances in engineering and technological innovations have been essential in the transformation of agriculture into a modern industry. Among the various engineering inputs in modern agriculture, the tractor is widely acknowledged as one of the greatest innovations that have contributed to increased factor productivity.

Today, the face of engineering in agriculture can be seen beyond tractors for tillage operations to include sustainable energy systems, environmental management, post-harvest technology for value-addition, bioprocessing and biological engineering [1]. With further advances in computers, electronics, information technology and biotechnology, improved machinery and processes can now be economically applied to increase agricultural productivity, while also minimising the negative impacts on the environment and ecological systems.

In response to industry demand for professionals with technical knowledge for increased agricultural production in order to meet the food needs of increasing human populations, the agricultural engineering (AE) discipline experienced a boom during the first 60 years of the last century, particularly following the end of World War II. Many academic departments and faculties/colleges of agricultural engineering were set up in response to rising enrolments and investments by governments and the private sector. However, during the past two decades, the AE discipline has experienced considerable decline in popularity among school leavers and funding agencies for research. Agricultural and farming continue to be dominated by low-value products, and the industry is perceived as *rural* and *dirty* by young school leavers who want to get away from the *land*. More recently, this situation has been exacerbated by the emergence of a technological triad of information and computer technology (ICT), biotechnology and nanotechnology, which are having far-reaching effects on various industries, including agriculture [2][3].

With declining undergraduate enrolments and funds from governments and industry, many AE academic programmes have been forced to close down, restructure or merge with other related programmes in engineering and agriculture. AE professional societies and research journals, particularly in the developed countries, have also responded to the trend by changing their names (for instance, the *Journal of Agricultural Engineering Research* is now called *Biosystems Engineering*). Most recently, the Agricultural Engineering Branch at the Food and Agriculture Organisation (FAO) of the United Nations has been merged with the Agro-Industry and Post-harvest Management Service to form the Food and Agricultural Engineering Technologies Service. While these global events unfold, the question remains: what is the future of agricultural engineering as an academic discipline and profession?

Society is not in doubt about the importance of agriculture and food for survival, and the role engineering and technological innovations in achieving this noble goal seem apparent. And that calls for the second question: why are fewer and fewer school leavers interested in enrolling in AE majors? Obviously, the future of the profession lies in the continuous outflow of graduates from academic programmes in universities and other tertiary institutions.

At Massey University, New Zealand, the Department of Agricultural Engineering was formed in 1972 and offered various *service* courses in sustainable energy, tillage and

machinery, post-harvest technology, waste management, environmental engineering and building technology, mainly as part of faculty degrees and diplomas in agricultural and horticultural sciences. Yet it was not until 1997 that an undergraduate major in agricultural engineering was offered. Enrolments remained low at 5 or 6 from 1997 to 2000, and the programme was disestablished in 2001, despite the high output of faculty and staff in research and consultancy. During the same period, the university carried out a major repositioning exercise that resulted in the merger of the Faculties of Agricultural & Horticultural Science; Science and Technology, into the College of Science.

These events took place in an economy that continues to be heavily reliant on agriculture and other land-based industries as the highest contributor to the national income. Prior to these developments, the national Agricultural Engineering Institute (which was fully funded by the government through the Ministry of Agriculture and Fisheries) had been disestablished about a decade earlier and most of the staff and facilities transferred to a new research company owned by Lincoln University. The other agricultural engineering academic department and degree programme in New Zealand at Lincoln University underwent restructuring several times until it was also discontinued in its original form. Therefore, there was a need to re-examine the prospects of the agricultural engineering academic programme and professional discipline in New Zealand.

The overall aim of this study was to assess students' perceptions of the AE discipline as part of efforts in shaping the future of both the academic programme and professional discipline. The specific objectives were to determine the factors that affect students' choice of the AE major, their perceptions on employment prospects and the critical success skills, as well as their attitudes towards changing the name of the degree programme and profession.

METHODOLOGY

The study was carried out during the 2001 final semester with five (out of six) final year students enrolled in the Agricultural Engineering major at Massey University. Using a combination of focused group discussion and questionnaire, students' perceptions on several aspects of their programme were explored, including why they chose the AE major, future employment and the critical skills required to meet employer expectations, perceived adequacy of the academic programme in preparing them for the job, their preferred disciplinary focus (engineering versus agriculture), and preferred programme name. Notes were taken during the focal group discussion and combined with students' responses to specific issues in the questionnaire in order to determine the overall response.

RESULTS AND DISCUSSION

Reason for Enrolling in Agricultural Engineering

The majority of the students were *interested* in the *machinery* aspects of agriculture. One student did *not like working with plants/animals* and another *wanted a career in the rural sector*. Eighty per cent of the students indicated that they came from a farming background and have worked previously in the agriculture industry. These results showed that most students majoring in AE came from rural agricultural families and had particular interest in the use of farm machinery.

When the students were asked at what stage they made up their mind to study AE, 80% indicated that they had chosen the programme before entering the university. Only one student chose the major after completing a university course on machinery functions. All students who chose AE prior to entering the university made their decision in the last year of high school after completing a secondary certificate, or while working in the rural sector.

Employment Prospects

When students were asked to assess their job prospects (on a scale of 0-5; with 5 = highest), the average perceived job prospect was high (4.2). One student was completing two majors to enhance his employment prospects, another was of the opinion that the prospects was declining even though he rated it high, while another student felt that there were good opportunities for self-employment in the industry. Although students' perceptions of their job prospects were high, during the focal discussion, most expressed the view that this issue was not addressed during their period of study.

In response to the question: *What do you see yourself doing in terms of employment?*, 60% of the students indicated *consultancy* in the agriculture/rural sector. Specific sector activities that the students plan to target for employment included agricultural machinery companies, farm development, waste management and contracting.

Critical Skills Required

Regarding the *perceived skills required to enable you to meet the expectations of employment sector you've identified*, students wrote down *machinery management*, *analytical and data management* and *communication* as being critical. When asked to choose at what level (0-30, 31-60, 61-90, 91-100%) they thought that the current AE undergraduate programme would enable them to achieve those skills, all of the students chose 61-90%, indicating a moderately high perceived confidence by the students on the relevance of the academic programme towards their future employment.

During the focus group discussion, skills that the students considered most critical to the success of future agricultural engineers in the workplace were explored. When the students were asked to list up to four skills and attitudes they considered essential, the answers included the following: creativity, lateral thinking, communication, ability to work unsupervised, being open to change and up-to-date with technology, ability to improvise with limited resources, and wide knowledge of the agricultural sciences. One student considered *farming experience* as essential. It was interesting to note that none of the students included in-depth technical knowledge on any aspect of engineering or agriculture as critical for success in the workplace.

Perception of the Agricultural Engineering Programme Content

When the students were asked to list other topics not currently covered during the programme that they thought should be added to the undergraduate AE programme, the list included *practical learning – hands on machinery*, *more designing of systems*, *energy management* and *forestry*. All of the students would like the inclusion of more practical activities on basic field machinery operations, while one student went further to suggest the inclusion of more assignments dealing with *real*

client projects through industry placements, such as those undertaken by students preparing to become teachers or nurses.

Regarding courses in the current AE programme that they thought should be discontinued, the students listed *Food and Agribusiness*, *Marketing Management* and *Project Management*. The reasons for this included students' dislike of the way these courses were taught or administered and the perceived lack of relevance of the courses to their expectations of the major in AE. Given the strong interest of this cohort on the mechanical aspects of agriculture and farming, it is plausible that the food and marketing courses might have been considered by them to be outside (off-farm) the realms of AE.

During the focus group discussion, one student suggested that final year students could be sent on industrial attachment to a local engineering company, such as those dealing with agricultural water supply systems or machinery dealership. All of the students supported the view that this would enable them to make useful contacts and to gain experience in working with people *high up in the industry*. To emphasise their desire for more practical oriented courses, particularly in relation to agricultural machinery operation, one student lamented that he had only *hopped on the tractor once* throughout his studies, and had *not done any practical in areas of interest (to him) in agricultural engineering*.

Students were asked in the questionnaire to indicate how important they felt it was to include more content of a combination of academic areas in the AE programme, based on their experience in the current programme and their perceptions about the future roles of AE in the 21st Century (see Table 1). Overall, the students placed least importance on biology and chemistry, followed by the combination of mathematics and physics. The combinations of agriculture and horticultural science, or engineering and technology, were considered by the students to be highly important. This perception contradicts the ongoing trends among many universities, particularly in North America, to strengthen the emphasis on biology as the fundamental science underpinning the AE discipline [4][5].

Table 1: Students' perceptions on the importance of key contents/themes of the AE programme (1 = most important, 5 = least important).

Content	Mean score
Agriculture and horticultural science	2.0
Biology and chemistry	4.0
Engineering and technology	2.0
Mathematics and physics	3.3

During the focus group discussion, students expressed a lot of despair about the mathematics courses in the degree programme. Eighty percent of the students perceived their background in mathematics and physics to be *poor* and inadequate; only one student considered his background in the subjects to be *good*. Accordingly, only one student admitted that he had negligible difficulty in handling the mathematics courses in the AE programme, while the others felt the course on calculus, in particular, presented the greatest difficulties for them. One student stressed this difficulty further by suggesting that *addition and subtraction would have been better*. One student would like the situation where students are given the choice between *hard* and *soft* mathematics courses, while another student commented that he *hated calculus and algebra!*

When the students were specifically asked if they would be interested to do an AE major that had a greater focus on technology and engineering, rather than the current alignment towards agricultural and horticultural science, all of the students answered *NO*. The reasons given by each student can be explained by the fact that they were firstly and mostly interested in agriculture/horticulture rather than engineering.

During the discussion session, one student preferred that the AE programme be aligned more towards the sciences rather than agr/hort or eng/tech. This issue was of particular interest in this study because the AE programme was offered under the Bachelor of Applied Science by the former Faculty of Agricultural and Horticultural Science, while an alternative was to offer the programme through the Engineering and Technology degree programmes offered by the former Faculty of Technology. Nonetheless, the students felt that AE students must have a *genuine interest* in agriculture and thus the alignment of their degree programme with other agriculture and horticulture programmes was perceived to be beneficial to the student. One student commented further that he would prefer to employ a graduate with BApplSc (Ag Eng) instead of BTech because of the preferred alignment referred to earlier.

Preferred Name of Agricultural Engineering Degree, Professional Discipline and Affiliation

One of the actions undertaken by many AE programmes in an attempt to increase the appeal to undergraduate students and increase enrolments is to change the name of the department and/or degree awarded. While the discussion and debate to change the name of the AE Department at Massey University was still ongoing, the names of some of the core courses for the AE major had already been changed to include the prefix Bio- (eg the course on project management was called *Bioengineering Systems Management*, while the 200 and 300 level courses in engineering science were called *Bioengineering Science I* and *II*, respectively).

When the students were asked to choose a degree name awarded from a list of options that described a major in AE, only one student chose the current name [BApplSci (Ag Eng)]. The other students chose Bachelor of Agricultural Technology [BAgrTech (Ag Eng)] or Bachelor of Engineering (BEng (Ag Eng)]. This response was surprising given the students' unequivocal preference for a greater affinity towards other degree programmes in agriculture and horticulture than engineering and technology.

The above response was also reflected in the students' choice of a name for the AE discipline in order to enhance appeal to prospective students and employers, and that they considered most appropriate in the 21st Century. During the focus group discussion, the students overwhelmingly (80%) said that they were happy with the current name (AE). One student was of the view that the name was misleading (*not really Ag-based*), and suggested that he would prefer the adoption of a new name *Environmental Rural Technology*. When this question was explored further in the questionnaire, the students who were happy with the status quo in discipline name wrote down *Agricultural Engineering* or *Agricultural Engineering Technology* as their preferred name. The students also indicated that they would professionally consider themselves as agricultural engineers or agricultural scientists after graduation, with 80% specifically indicating *agricultural engineers*.

Sixty percent of the students preferred a 3-year academic programme, with a maximum duration of four years. Only one student indicated that he would be daunted or overwhelmed by a 4-year degree programme. One student who preferred a 4-year programme of study explained that he wanted a more in-depth coverage of the course contents. It should be noted that the Bachelor of Applied Science degree, under which the AE major was offered, is a 3-year programme, while the duration of a Bachelor of Technology (BTech) degree is four years. This suggests that the BTech degree appeared to be a more suitable avenue to offer the agricultural engineering major, given the students preference to be considered *engineers* after graduation. However, their poor and inadequate background in mathematics and physics will present them with considerable obstacles in gaining admission into these programmes in technology and engineering.

When the students were asked to choose from types of professional societies/identity and affiliation that they would prefer after graduation (agricultural scientists, engineers, technologists, and any others), only one student chose to affiliate with agricultural scientists, while the rest chose engineers. Among the latter, one student specifically noted the American Society of Agricultural Engineers (ASAE) as his preferred professional society for affiliation, perhaps indicating the greater visibility of this society among many others that focus on agriculture and related industries.

CONCLUSIONS

The evolution of the agricultural engineering (AE) discipline and profession is at a crossroads. Declining undergraduate enrolments have forced many academic institutions to restructure, merge or close down their AE degree programmes. A study was carried out at Massey University, New Zealand, to assess the perceptions of undergraduate final year AE students on several aspects of their programme, including the motivations for choosing AE, employment prospects and skills required for success in the workplace, and preferences for discipline name and professional affiliation.

This study revealed the following:

- Most of the students came from rural backgrounds and had experience in working in the agricultural sector prior to entering the University.
- Interest in the machinery aspects of agriculture was an important factor that influenced students' decision to choose the agricultural engineering major.
- The decision to choose AE was often made during the last year at high school, but one student made up his mind only after completing an AE course on machinery functions.
- Students considered their job prospects to be very high, but they also felt that this issue was not adequately addressed by the institution during their period of study. Providing consultancy services in the agricultural and rural sector was the most commonly identified future employment activity by the students.
- Most students considered good analytical, communication and machinery management skills to be critical in meeting the expectations of their future employers. All of the students indicated a moderately high confidence regarding the appropriateness of their academic programme in enabling them to acquire these critical success skills.
- High importance was accorded by all students to *hands-on* practical experience during their study, but they also felt that this issue was not adequately covered, particularly in field machinery operations. It was suggested by the students that implementing an industry placement programme, such as those undertaken by student nurses and teachers, would be beneficial in linking students with potential employers.
- Students perceived the biology and chemistry courses to be of less importance for their degree programme, but rated both the agricultural and engineering components to be highly important. Nearly all of the students expressed despair about their competences in mathematics and physics, and considered their background in these subjects to be poor.
- Students preferred their degree programme to be aligned towards agriculture and horticulture than engineering and technology. However, an overwhelming majority of the students preferred to retain the programme name, *Agricultural Engineering*, and the degree awarded as Bachelor of Agricultural Technology or Bachelor of Engineering, instead of the current Bachelor of Applied Science.
- The majority of students preferred to be recognised as engineers and affiliated to a professional engineering society after graduation, even though they preferred closer alignment of their degree programme to agriculture, rather than engineering.

ACKNOWLEDGEMENTS

The author is grateful to the 2001 final year undergraduate agricultural engineering majors at Massey University for their participation during the focus group discussion and for their willingness to complete the questionnaire. The assistance of Mrs Lisa Valenzuela (Secretary, the Institute of Technology and Engineering, Massey University), who word-processed the students' responses, is also greatly appreciated.

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