AC 2010-684: WHO WANTS TO STUDY ENGINEERING IN AUSTRALIA? MEETING THE CHALLENGE OF IDENTITY, ATTRACTIVENESS, AND OF MARKETING.

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WHO WANTS TO STUDY ENGINEERING IN AUSTRALIA: MEETING THE CHALLENGE OF IDENTITY, ATTRACTIVENESS, AND OF MARKETING

Abstract

The reluctance of senior secondary students, and more importantly females, to choose engineering as a preferred course of study in higher education combined with relatively high attrition rates in engineering schools at Australian universities can be traced to two fundamental sources. These relate to the marketing of the engineering profession and its professional status, and the image with an overemphasis of the educational professional engineering discourse on big science. Despite an acute shortage of professional engineers in Australia, the profession has not marketed itself well in the public eye. It is yet to find its end product and professional standing other than being a subset of big science. The lack of definition of engineering as a unified and a unique profession carries over to engineering education. This paper identifies the lack of unity and ideology in educating for engineering professions as a key reason for its lack of attractiveness. It argues for a more diverse approach to professional engineering discourse both in marketing the profession to the public domain and in its application in engineering education. It suggests that developing engineering curricula that depart the singular notion of professional engineering as that of applied science to one with an emphasis on more vocational elements as means to produce engineering as a more attractive course of study and more likely to enhance engineering professional standing in the community as a civic profession.

Keywords: Innovative curricula, education research, professional education issues

Introduction

Increasing demand for professional engineers in an occupational environment of an estimated shortfall of 20,000 professional engineers in Australia is great current concern [1]. The current national annual output of 6000 engineering graduates is inadequate for replacing professional engineers leaving the profession for other careers or due to retirement as well as meeting projected demand. It is thus not surprising that the recent growth of domestic enrolment in engineering courses at Australian universities had a positive impact on engineering schools, and faculties, government agencies and industry bodies[2]. Yet, despite the optimism among engineering educators, the reality is that the domestic enrolment in engineering represents only 6.8 percent of the total commencing university enrolment in Australia. This enrolment figure does not reflect sudden interest in engineering and represents the middle of historical fluctuations in engineering enrolment which have traditionally been somewhere between 5.1 and 7.2 percent of total higher education enrolment. The gender imbalance in engineering enrolment is of particular issue. Though 13.4 percent of males commencing bachelor degree choose engineering as their preferred choice of study, the corresponding figure for females has been declining from 2 to 1.87 percent. Females constitute 15.4 percent of the commencing enrolment and 14.6 percent of the total engineering enrolment. This figure has been constant for the past 10 years.

The lack of attractiveness of engineering as a course of study at university is not limited to Australia despite a high demand for professional engineers across the developed world. A shortfall of engineering graduates in the United States and Britain has become a major issue for maintaining current infrastructure, let alone developing innovation [3, 4]. Engineering studies account for less than 3 percent of tertiary enrolments in the Unites States [5]. The female participation in undergraduate engineering enrolment in the United States, though respectful by Australian standards, is still only 20.1percent [6]. The inability of engineering to attract students is also mirrored among many developed nations such as Britain and Finland [4, 7]. In Sweden the domestic applications for engineering courses have dropped from 11700 in 1998 to around 6000 in 2007 and forced engineering schools to rely on foreign student enrolments to retain their viability [8]. Not only students are not attracted to engineering but many leave without completing their engineering studies. The average Australian attrition rates in engineering are around 55 percent with female students having lower attrition rates varying from 33 to 47 percent [9]. These relatively high attrition rates in engineering are not confined to Australia. It is reported that the attrition rates in the United States[10] of students enrolled in engineering vary from 39 to 61 percent for males and 54 to 70 percent for females and in Finland the overall attrition rates are of the order of 40 to 60 percent [7].

Student perceptions and expectations about engineering and engineering studies must play a role in both the lack of attractiveness of engineering studies and the attrition rates. Though many of these perceptions are justified, many are still based on myths and inadequate knowledge and as such need to be subject to further inquiry. The perceptions that are justified are based on a mismatch between student expectations and the knowledge base required in engineering education, and a mismatch of skills and knowledge between engineering graduates and industry and societal expectations. It is thus imperative that the current engineering educational paradigms ought to be tackled and revised.

Perceptions about Engineering

Student perceptions and beliefs about engineering are shaped by complex information from sources such as:

- Students' parents;
- Students' peers;
- Beliefs concerning the nature of professional engineering work;
- The social status of the engineering profession. This has a wider dimension which embeds the social as well as industry evaluation of engineering as an occupational group and touches upon issues of professional autonomy, social orientation and inclusion of ethics in the course of professional practice;
- Knowledge base and intellectual abilities required prior to undertaking studies in engineering; and
- Teaching and Learning in schools and faculties of engineering. Prospective students often rely on indirect information from their peers, friends and siblings who are or have studied engineering. These opinions are influenced by engineering academic beliefs and perceptions of engineering knowledge and discourses.

Parental Views

The effect of parental pressures on students choosing engineering as a course of study has not been widely investigated. In a limited American survey, Dubie[11] shows that 33 percent of parents encourage their sons to consider engineering as a course of study and the corresponding parental encouragement for girls is less than 10 percent. It is no wonder that the same survey shows that 24 percent of boys and only 5 percent of girls consider engineering as a course of study. Hutton and Gerstl[12], in an inquiry into why students in the United States chose engineering as their discipline of study, found that a third of the students chose engineering due to the influence of a role model who often was a parent or very close relative.

Perceptions of the Engineering Profession

Social and employer perceptions of the engineering profession as an occupational group will undoubtedly affect students' choice in their course of study. There have been a number of studies of the engineering profession and its discourse. The public perception of the engineering profession has long been problematic. Surveys conducted, in the United States, by the National Academy of Engineering[13] showed that the engineering profession in the 1980's lacked identity, and that many people could not distinguish between engineers, technicians and scientists. These public attitudes towards professional engineers were confirmed by latter surveys [14]. Engineers were perceived as having poor social skills, being self-absorbed, loners and rigid in mind.

The engineering profession's relatively poor status, and this view, has been carried into the self-perception of its members. Wilenski [15] found that professional engineers had negative perceptions of themselves. He called the engineering profession an "alienated profession". Amongst all the professions surveyed, professional engineers exhibited the highest dissatisfaction with their occupation, though not with their work. These self-perceptions of engineers were widespread across the fields of employment of professional engineers: in industry, engineering consulting firms and academic departments at universities.

In terms of public perceptions, the engineering profession in Australia has not marketed itself well. Yates, in a discussion paper on the status of engineers in Australia, notes that professional engineers have failed to market themselves as a profession. He noted that they must take much of the responsibility for much of perceptions of engineering as an alienated technical and scientific occupation that is sometimes associated with technical trades[16]. Professional engineers as an occupational group are essentially invisible and lack social profile though through their work there is a distinct social engagement. Beder[17] refers to a survey conducted the Institution of Engineers, Australia (I.E.Aust) which shows that the Australian public could not distinguish between the activities of different engineering disciplines . This was borne out by subsequent surveys[18], conducted by I.E. Aust., which showed that beyond the construction of machines and buildings, the Australian public had little knowledge and appreciation of what engineers did. The public profile of the engineering profession in Australia, shown in Table1 is one of public ambiguity.

Table1. Perceptions in Australia of the engineering profession[17]

Positive Perceptions	Negative Perceptions
Trustworthy	Conservative, pedantic and aloof
Copes well with weighty responsibility	Too theoretical, lack practical skills
Translate ideas into reality	Tends towards rigid, outdated management style
Represents a source of ideas and technologies	
Act as a bridge between management and workers	Have problems communicating with workers
Keep government and big business honest	Not senior management material

Student Perceptions

Given the relatively poor public image and the work of the engineering profession, it is not surprising that engineering as a course of study exhibits little attraction. One student in response to a question, "What is an engineer"?, wrote[19]…*An engineer is someone who uses math and science to mess with the world by designing and making things that other folks can use(pause)..And once you mess with the world, you're responsible for the mess you made .* This view had little to do with the engineering curriculum and education, but rather with ignorance concerning the final destination of engineering graduates. Skobrook[20] examined students' views of engineering prior enrolling in the course at University of Hull, and found that students' preconceptions of engineering and engineering studies were at odds with reality. This is not surprising since studies[21] in Britain showed that most sixth form students had little or a wrong perception of engineering as a career option. Peter Durchholz [22] in a study of engineering students commented that…. *As I continued to interview students, it was clear they were puzzled about what their chosen career would lead them to in the way of work.* A survey performed in Britain, by Industry Ventures[23], of 2700 final year and engineering undergraduates, showed that the majority of students had no idea what engineers did . An earlier United States study[24] also showed that the majority of engineering students had only vague notions of engineering work. Hutton and Gerstl[12] similarly observed that student perceptions of engineering did not show common themes, reflecting a general confusion about the nature of engineering work.

Professional Engineering Discourses and Engineering Education

Engineering curricula and teaching methodology is constructed by professional academics on the basis of their beliefs concerning engineering practice epistemology and the epistemology of engineering education. Unlike academic members of the medical and law faculties, engineering academics are generally not practitioners of the profession and often have never practiced it. They may be said to be alienated from the professional mainstream. Anecdotal evidence suggests that only one third of engineering academics at Australian universities are members of engineering professional bodies. In the United States 30 percent of engineering educators were registered as professional engineers despite a relaxation of criteria for the registration of engineering academics [25].

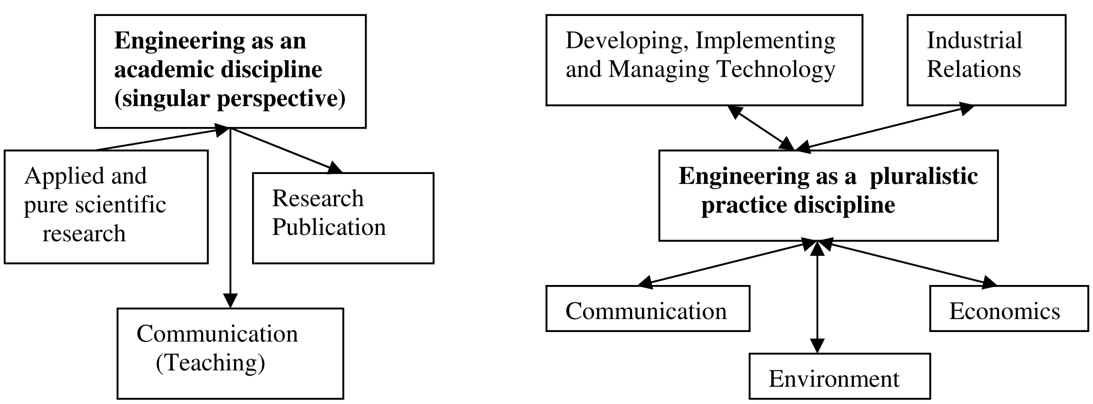
Engineering curricula, at Australian universities, are largely based on the notions of engineering as an applied science. Though, admittedly, science had a strategic unifying function for the engineering profession, it also (in engineering education) captured engineering discourses and has became its narrative. As a dominant narrative, in the academia, it has relegated professional engineering discourses into a discipline of science. This is a fixed world-view of engineering practice and is at odds with workplace discourses where judgements are often made on knowledge and skills bases not derived from science. It has been suggested that such a positivistic view brought about by excessive scientism is not only detrimental to the engineering profession but it also de-professionalizes it to a point where it reduces professional engineers to mere celebrants of technology without a social, environmental, political, cultural and economic context renders the (engineering) profession invisible in terms of social status and recognition [26].

Engineering Curriculum Issues

The traditional model of engineering curriculum has well outlived its relevance and usefulness in a post industrial era. The scientific positivism in engineering curricula was already one concern in a number of inquiries and reviews into engineering and the profession in Australia and elsewhere[27]. Moorehouse[28], Williams29, the Australian Government Review into Engineering Education[30] and minor other reports since then, were concerned with an overemphasis on scientific knowledge and method in engineering education at the expense of vocational elements and imparting students' with social , economic and environmental awareness. The recommendations that resulted from these inquiries identified that the overemphasis on scientific positivism in engineering curriculum not only provided major hurdles in attracting students to engineering studies and retaining them once they were there, but also did not meet professional needs and blurred the boundary between professional engineers and scientists working in an applied field. Every inquiry and review into engineering education called for the augmentation of vocational elements and social sciences in engineering curricula at Australian universities to parallel professional curriculum in other major professions such as medicine and law.

Reconstructing Engineering Education

When comparing engineering educational discourses to the world of professional engineers' workplace and professional practice an epistemological deficit (Figure 1) is observed. Engineering education in Australia is singular and focuses on applied scientific matters in comparison with the pluralism found in professional engineering practice.



(a) Academic engineering (b) Engineering practice
Figure 1. Distinctions between academic engineering and engineering practice.

The epistemology in contemporary engineering discourses is a multi-disciplinary one. The strictly technical focus, a past feature of engineering education, is still important but only as one aspect of the preparation process of professional engineers. An American survey[31] showed that only 60 percent of working professional engineers had any direct connection with the technical aspect of engineering work. Engineering graduates need to be flexible and work in a more diverse environment. The trend of engineering education, as evidenced by the Bologna Declaration and the American Board for Engineering and Technology (ABET), is towards a broader and more encompassing engineering curriculum [32]. A review into engineering education[29] classified professional engineers into four categories and implicitly implied a need for a diversity of engineering education graduates. These categories were:

1. Engineering managers;
2. Technical specialists who are found in the areas of research and development and often function as technical experts;
3. Systems engineers who focus on system specifications and design, and who participate in integrating technical and non-technical matters; and
4. Generalist engineers who posses a broad technical knowledge base and have the ability to work across specialist boundaries.

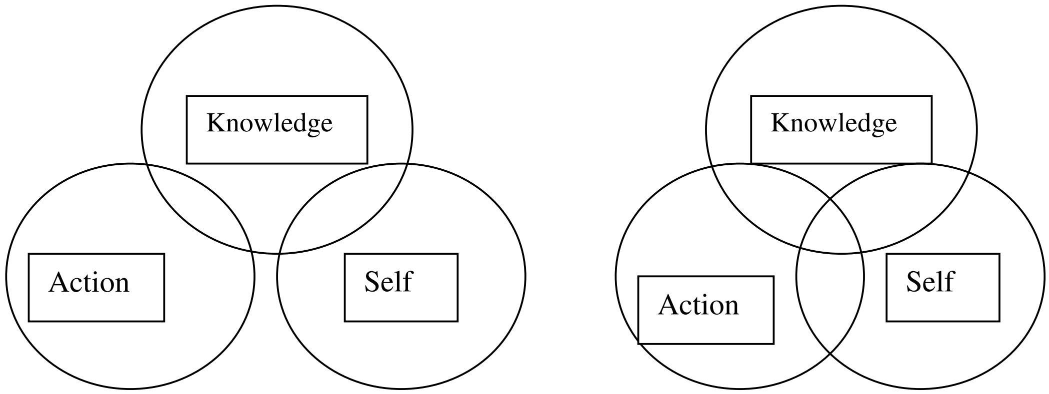
The existence of these categories suggests possible future directions for postgraduate courses, or specialist streams within current educational structures.

Introducing Diversity into Engineering Education and Curricula

A lack of a single discursive focus in engineering has led Turns et al[33] to reflect that there is no universally acknowledged and accepted characterization of engineering knowledge. However each engineering discipline is characterized by a well defined engineering science which defines the disciplinary discourse. Layton[34], Bucciarelli[35]and Davis[36] observed that engineering academic discourse must be defined by engineering design, which not only distinguishes engineering education from that of science but also relates to the real world of engineering practice through students' exposure to the vocational elements of the engineering profession. Though the essential place of engineering design in the engineering curriculum cannot be denied, it needs to be considered that even engineering design is also underpinned by tacit knowledge. Engineering education needs to undergo both pedagogical as well as curriculum assumption transformation.

Pedagogical Transformation

Though models offered by education in other professions could serve as a model for pedagogical transformation from traditional academic to a professional curriculum delivery, the multi- variant nature of engineering discourse would indicate education in creative arts or music as possible models outlined in Figure 2. The professional pedagogy integrates learning and scholarship (self), action and knowledge leading to a constant conversation and reflection upon the latter.



(a) Science and Technology Pedagogy (b) Professional Pedagogy

Figure 2. Distinction between traditional academic and proposed professional pedagogies

Figure 2 expresses an educational model composed of three dominions: Knowledge, Action and Self. The knowledge domain encompasses epistemology, academic and professional communities as well as students, corporate world and the state. In other words it defines a university. Action relates to comprehension and doing, whereas Self describes educational identity and reflective practices. Both Action and Self represent the act of learning, Action being more vocational and Self being more cerebral. The traditional engineering curriculum is described by figure 2a where the Knowledge dimension informs both Action and Self. It can be argued that in a traditional academic curriculum Action and Self intersect to some degree in engineering laboratory classes. However many of the laboratory classes involve prepared experimental exercises to confirm theoretical knowledge and require little reflection. Furthermore the overcrowding at Australian universities combined with the shedding of technical staff and occupational health and safety issues have reduced, what once were hand-on laboratory sessions, to group demonstrations and computer simulations.
The professional curriculum, shown, in figure 2b, illustrates the ideal professional education with all its feedbacks. In overlapping the three dimensions, it embodies vocational elements. The professional curriculum is grounded in a kind of conversation between the epistemology, doing and learning. The blurring of the hierarchical boundaries between the canon of knowledge and application resembles more closely the study of art or medical internship.

Curriculum and Knowledge-based Models

It has been noted that if engineering education is not to be seen as a discipline of science, its engineering curricula needs to be based on new theories of technology where technology is a subject of the practice that incorporates human and social dimensions such as environmental ethics [37].

Professionalizing of the engineering curriculum requires the shedding of the traditional positivist conservative model and replacing it with a vocational model in which knowledge and skill are integrated, shown in Table 2. Like in the education for professions such as law or medicine, the vocational model allows professional engineering education to take an ideological stance of social as well as technical practice.

Table 2. Comparisons of the two models

Conservative Model	Vocational Model
Committed to teaching knowledge, skills and attitudes.	Learning as a life-long learning experience. Skill formation occurs at work. The emphasis is on vocationally oriented knowledge that is related to work, social and sustainability involvement.
Knowledge as a theory paradigm. The curriculum is scientifically oriented.	Knowledge in action. Emphasis on design and social practice with ethical considerations.

Engineering curricula must be transformed to converge with the new theories of technology and professionalism. The orthodox view of technology as one of technological determinism, where technological applications force the society to adapt in its transformation, is replaced by one where the society applies technology for its own benefit. The new professionalism is based on client needs, and requiring the use of tacit knowledge as part of a reflective process, replaces the old view of a professional as an expert ready with the solution.

<u>Australian Context</u>

Professional engineering education in Australia is located at universities. There is very little Diversity in engineering educational programs in similar disciplines despite relaxation criteria of course accreditation by the accrediting body, Engineers Australia. The diversity of employment in which engineers find themselves requires engineering graduates to possess a diversity of knowledge and skills. There is no acknowledged blueprint for the engineering curriculum and professional engineering education can marry the features of university-derived education with other education and training without detracting from its professionalism. There are five possible approaches to educating professional engineers. These are:

1. Retaining the current four-year degree programmes at universities with the professionalization of pedagogy. Less emphasis needs to be placed on scientific elements but more on vocational elements such as design, with perhaps 40 percent of the engineering course allocated to these aspects. Poor environmental, social and economic literacy and poor communication skills among engineering graduates in Australia have been identified as problematic in meeting the needs of employers of professional engineers. These elements must be enhanced in engineering curricula and up to 30 percent of the curriculum allocated to them.
2. Professional engineering education through articulation programs from the Technical and Further Education (TAFE) Colleges to Universities with full exemptions and recognition of previous learning: the completion of a two year associate diploma at a TAFE college in a specific discipline of engineering would provide the student with a two year exemption of the university engineering course in the allied engineering discipline. The two-year TAFE engineering diplomas are followed by two-year courses at universities in either technical aspects of engineering or engineering science. It is essential that the prescriptive knowledge of how be augmented by the tacit knowledge of *what* and critical skills of *why* found at

universities.

3. An articulation into TAFE colleges. Holders of science degrees would undertake 2-year existing diploma courses combined with a major engineering project, though some universities will accept science graduates into their Masters program in engineering which further emphasizes the science narrative and eschew the practicality of knowledge how.
4. A horizontal articulation in which holders of science degrees would undertake an existing two-year TAFE engineering course with minor modifications. In combination with engineering projects such a course could lead to a professional recognition. This path would lead to producing a scientifically oriented engineer.
5. This educational path by-passes university education and is based on the author's discussion with industry managers, in the course of professional consultation, who valued highly staff members with two associate diplomas in engineering and business/management from TAFE colleges. Professional engineering qualification, in this instance, is obtained through education at TAFE Colleges. Combined with a major industrial-based engineering project, such an educational path would produce a vocationally oriented professional engineer. This educational path would, undoubtedly, touch upon sensitive issues of the nature of vocational and professional education, and the academic and intellectual abilities of the entrants into the engineering profession from TAFE colleges. The problem of this model that it would require the TAFE Colleges to transform their educational programs from prescriptive knowledge in educating how to the critical approaches found at universities. The American Board for Engineering and Technology, in its accreditation criteria for a vocationally oriented four year professional engineering technology degree, does not mention the development of critical skills as the main objective of the course. This is addressed more implicitly through an allocation of 24 credit points out of total 128 credit points to humanities, social sciences and communication studies: a broader engineering curriculum than is found in most Australian universities[38].

The view that engineering education can be composed of different co-existing models is not unique. Bifurcation of engineering education is common in many OECD countries. In the United States the bifurcation of engineering education is observed in the provision of engineering and engineering technology degrees. Germany and Holland also have a dual system of engineering qualifications which are either science or practice oriented. Italy and France have instituted university engineering diploma courses of 2- 3 years duration with the specific aim to produce engineers competent to tackle technical problems and implement innovation [39]. These academic programs could be extended by a further 2- 3 years through laurea (licence) degrees in engineering, which address other professional engineering issues.

Conclusion

The process of sea change from the scientific orientation of engineering curriculum is a challenge. The scientific orientation is reproduced through academic staff recruitment based on the criteria of scientific research rather than vocational experience. Research performed in schools of engineering could quite easily be accommodated in schools of science. This scientific orientation is further compounded by the fashion of integrating faculties of science and engineering in the faint hope of finding some synergism. This situation is neither beneficial to science nor engineering. Science increasingly focuses on applied knowledge eschewing fundamental or curiosity led research, whereas academic engineering becomes increasingly dominated by scientific rather than professional norms.

The professionalization of the engineering curriculum needs first the assertion of professional

identity of the academic staff and the engineering profession. There is also an issue of the type of research that can be incorporated into the research activities of engineering schools. If a more vocational model is to be accepted, then vocational research would include new areas such as engineering design, engineering practice and engineering ethics as research cores.
If engineering is to meet the needs of employers, society, and students it not only must gain control of professional education, but like medicine and law it must also ensure that engineering education remains independent of university whims and beliefs.

References

1. P. Taylor, "*Fixing Australia's Engineering Skills Shortage is an Urgent and Shared Responsibility",* Canberra, Australia: Engineers, Australia Publications (2008).
2. Department of Employment, Education and Workplace Relations "Higher Education Statistics", http://www.gov.au, (2008).
3. National Science Foundation, "An Emerging and Critical Problem of the Science and Engineering Labor Force: A Comparison of Science and Engineering Indicators", 2004. http:// www.nsf.gov/sbe/srs/nsb0407/start.htm., (2004).
4. Department of Education and Employment [DfEE], "An assessment of Skill Needs in Engineering", Nottingham, England: DfEE Publications., (2000).
5. F. L.Huband, "A better World through Engineering", Prism. Summer, p.6., (2007).
6. E. D.Chubin,. G. S. May, & E. L. Babco, "Diversifying the Engineering Workforce". Journal of Engineering Education, January, pp.73-86., (2005).
7. S. Lehto, "Reforming Engineering Education for Meeting the Requirements of the Global Industry- Using the System Approach for Preventing the Crisis of Engineering Educatrion", Proceedings of the ASEE Annual Conference, June 24-27, Honolulu, Hawaii, (2007).
8. A. N.Pears, S. Fincher, R. Adams, & M. Daniels, "Stepping Stones: Capacity Building in Engineering Education", Proceedings of the 38th ASEE/IEEE Frontiers in Engineering Education Conference, October 22-25, Saratoga Springs, NY. (2008).
9. B. King, "Addressing the Quality of Engineering Graduates for the New Century", The Carrick Institute for Learning and Teaching in Higher Education. Strawberry Hills, NSW, Australia, (2008).
10. M. A. Hutchinson, D. K. Follman, M. Sumpter, & G. M. Bodner, " Factors Influencing the Self-Efficacy Beliefs of First Year Engineering Students", Journal of Engineering Education, January, pp.39-47. (2006).
11. D. Dubie, "Mommas don't let thyeir babie grow up to be engineers", IT World. February 9. . (2009).
12. S. P. Hutton, and J. E. Gerstl, "The Effects of Background and Training on Success in Engineering",in Semler, G.E.(ed) The Engineer and Society, London: Institution of Mechanical Engineers, p.142. (1995).
13. G. Ahlstrom, "Engineers and Industrial Growth", London: Groom Helm. (1982),
14. J. Braham,. "The Silence of the Nerds?", *Machine Design,* Volume 64, No 17, p.77, [1992].
15.H. Wilenski, "Varieties of Work Experience", in Borrow, H. (ed) "Man in a World of Work", Boston: Houghton-Miffin., (1964).
16. A. Yates, "Discussion Paper on Raising the Status of Engineers", The Institution of Engineers Australia, Sydney., (2000).
17. S. Beder, "The New Engineer: Management and Professional Responsibility in a Changing World", Melbourne: Macmillan Education. (1998).
18. G. Dietrich, "Getting People's Perceptions Closer to Reality", Civil Engineer Australia, May, (1996).
19. Shulman, S.L (2005). "If Not Now, When? The Timeliness of Scholarship of the Education of Engineers", *Journal of Engineering Education,*January, p.11.
20. S. Skobrook, " The role of pre-entry practices and induction strategies in relation to student retention", Strategy Guide Resource of the PROGRESS Project, the University of Hull. (2006). http://www.engsc.ac.uk/downloads/progress/skobrook.pdf
21. E.Bowen, S.Lloyd, & S. Thomas, " Broadening Access Among Lower Socio-economic Groups in Higher Education", Journal of Widening Participation and Lifelong Learning, Vol.5, No 2, pp46-49., (2003).
22. P. Durcholz, "The Hidden Career: How Students Chose Engineering", Engineerng Education, Volume 69, No 7, p.721., (1979).
23. J. Richards, "Poor Image Prevails" , Professional Engineering, January 9, Southampton: Mechanical Engineering Publications, (1992).
24. R.R.Ritti, "The Engineer in the Industrial Corporation", New York: Columbia University Press., (1971).

25. K. Madhavan, , & S. Malasri, “Forum: Professional registration of engineering faculty”, Journal of Professional Issues in Engineering Education and Practice, 129 (3), pp122-124., (2003).
26. Fawcett, & P. Roberts, “The Institution of Engineers, Australia- At the Turn, Remaking for Relevance”, Transactions of Multi-disciplinary Engineering, Vol.25, pp.51-63, (2001).
27. M.Finniston, “Engineering Our Future”, Committee of Inquiry into the Engineering Profession, London: HMSO, (1980).
28. E. C. Moorehouse, “Engineering Courses in Australian Universities” , The Australian University, 2., (1964).
29. B. Williams, “Review of the Discipline of Engineerig”, Canberra: AGPS, (1988).
30. P. Johnson (chair), “Changing the Culture: Engineering Education into the Future”, Barton, ACT : Institution of Engineers, Australia, (1996).
31. C. S. Florman, “Non-Technical Studies for Engineers: The Challenge of Relevance”, European Journal of Engineering Education, Volume 21, No1, p.249-258, (1996).
32. European Commission “Employment in Europe”, Luxembourg: EC., (1999).
33. J.Turns, J. C.Altman, R. S.Adams, & T. Barker, “Research on Engineering Student Knowing: Trends and Opportunities”, Journal of Engineering Education, January, pp27-40, (2005).
34. E. T. Layton, Jr., “The Revolt of the Engineers: Social Responsibility and the American Engineering Profession”, Cleveland: The Press of Cape Western University, Chapter 2, (1971).
35. L.L. Bucciarelli, “Designing Engineer”, Cambridge, Massachusetts: The MIT Press, (1994).
36. M. Davis, “Thinking Like an Engineer”, New York: Oxford University Press, (1998).
37. M. Green, “Educating the New Engineer”, Transactions of Multi-Disciplinary Engineering, Vol 25, pp39-50, (2000).
38. ABET (Accreditation Board for Engineering and Technology), “Criteria For Accrediting Engineering Programs: Effective for Evaluations During the 2001-2002Accreditation Cycle”, (2000)., http://www.abet.org
39. G.Augusti, " Development and Re-organization of Engineering Studies in Italy", in Duggan, T.V. (ed) "International Quality and Environmental Issues", Proceedings of the 3rd World Conference on Engineering Education, Portsmouth, 20-25 September, Southampton: Computational Mechanics Publications, Vol. 1, p.345-350, (1992).

Your paper titled AC 2010-684: WHO WANTS TO STUDY ENGINEERING IN AUSTRALIA? MEETING THE CHALLENGE OF IDENTITY, ATTRACTIVENESS, AND OF MARKETING. has been accepted pending changes.	
Reviewers comments	Responses
Reviewer Comments # 1________________________________ The paper presents a very interesting overview of engineering profession and its perceptions in Australia. The paper however will require significant proofing and corrections. There are several spelling errors, missing words, misplaced punctuation marks and spaces. There are also several statements that are unclear. The list of references is quite adequate.	ADDRESSED
# 2________________________________ [None Provided]	
# 3________________________________ The paper is organized, easy to read, and informative. The subject matter is interesting. There are several words that are incorrectly spelled: enrolment, acadmic are examples. More bothersome is the use of the term 'girls' to refer to female undergraduate students. The authors do not use the term 'boys' which would be equally inappropriate. The choice of terms does matter and, in this case, does send a negative message that may or may not be intended.	Addressed Addressed
# 4________________________________ Need some rewriting. The first sentence in the introduction is 75 words, far too long and it gives a poor start to the paper. Follow format guidelines. Title and Figures should be capitalized when referring to a specific figure in the text of the paper. Page 2 - separate the two words, students enrolled elsewhere27 - the e is in the small font of the superscript Figure 1a Academic, not Acadmic	Shortened

Proposed curriculum would work only if the students had the proper depth of fundamentals of scientific elements, mathematics and writing skills, but these topics are poorly covered in most high school programs and most universities need to make certain all students have a strong level of the basic fundamentals. Most Master's Programs require, via the thesis or problem report, a demonstrated application of theory or design and not just "knowledge". In Figure 2a, the Action and Self do intersect when students have laboratory experiences and thus I question the validity of the figure. An extra t between curriculum and requires in the paragraph prior to Table 2.	
5________________________________ 1. "Girls" and "Boys" seem better identified as female and male students 2. Advisory Boards could have been factored into the mix along with current ABET changes for the topic at hand. 3. University tenure and promotion guidelines were not mentioned yet play a definite role in the Engineering vs. Applied Engineering programs. How do you return comments I made on the paper structure and suggestions that would be helpful to the authors?	Done
# 6_______________________________ A well-written paper with some genuine suggestions. Definitely publish and present.	