Disconnected Engineering Education

Mani Mina
Department of Industrial Design
and Electrical and computer
Engineering
Iowa State University
Ames, Iowa
mmina@iastate.edu

John Heywood
Professor
Fellow Emaratus
Trinity College Dublin
Dublin, Irland
johnheywood43@gmail.com

***Abstract*— In 2003 Rosalind Williams who had been Dean of Students and Undergraduate Education at MIT published a short and controversial paper in the Chronicle of Higher Education with the title "Education for the profession formerly known as engineering". Discussion about its argument was short-lived and, apart from one paper, it has been scarcely mentioned at either ASEE's annual conferences or at the Frontiers in Education Conferences even though it focused on a major issue of concern to all engineers, namely the identity of engineering, and as an unspoken consequence, the identity of engineering educators.**

Essentially Williams argued that engineering "has evolved into an open-ended profession of everything in a world where technology shades into science, art, management with no strong institutions to define an overarching mission". Each new technology causes the development of a degree program in that area which develops its own language and identity thereby separating itself from other areas with whom it does not communicate.

This separateness is reflected in the institutions that serve engineering education. ASEE is divided into divisions which never the twain shall meet. To establish something that is new, a division must be established. Similarly, FIE is based on sessions. In both cases moving between sessions or divisions is extremely difficult and individuals tend to remain in the silos constructed for them by the organizational structure.

The purpose of this paper is first, to review Williams' thesis and show how it has impacted engineering education. Second, to review recent work on identity and the engineering profession, and third to make suggestions as to how engineering educators and organizations like FIE and university departments might respond to the challenge to engineering education implicit in William's thesis.

Keywords*— *Engineering Education, Engineering and engineering education identity, Engineering profession, new challenges and need of new approached

I. E *WILLIAMS THESIS AND ITS IMPLICATIONS FOR ENGINEERING EDUCATION AS REPRESENTED BY ASEE AND FIE*

In 2002 Rosalind Williams published a book with the title *ReTooling*: *A Historian Confronts Technological Change [1].* Her general thesis was accompanied by illustrations from the history of MIT, whereas a social historian, she was Director of MIT's program in Science, Technology and Society. Subsequently in 2003 she published a short but controversial paper in *The Chronicle of Higher Education* with the intriguing title "*Education for the profession formerly known as engineering*" [2].

Williams argued that engineering has lost its identity because it "has evolved into an open-ended profession of everything in a world where technology shades into science, art, management with no strong institutions to define an overarching mission" [3, ibid].

The consequence of this for engineering education is that there are numerous forces that pull engineering in different directions-"toward science, toward the market, toward design, toward systems and toward socialization".[4, ibid] Within each specialization these demands are reflected in increasing demands on the curriculum. As Williams puts it each one adds a log to the curricula jams. Moreover, the trend to cram more and more into programmes "runs in exactly the wrong direction, and this is likely to reduce the number of students wanting to commit themselves to an education that is nearly all consuming" [5,ibid] that is perceived to be very specialized.

One outcome of this increase in specialization is that serious debates have occurred that question whether or not certain subjects are engineering topics. Davis for example questioned whether or not 'software engineers' were engineers[6]. Williams argued that the future of engineering lies in accepting this multiplicity. She argued that engineering is expanding within its own walls rather than responding to the world outside, and this is what the ASEE and FIE conferences are doing, which is not surprising, given her thesis.

Both annual conferences are in different ways structured around specializations and endeavor to respond to new specializations. Both are being driven by research. In the case of ASEE the response is made through divisions most of which are subject based whereas FIE is more responsive to areas of research that may be relevant to more than one traditional engineering subject. ASEE's mechanism for specialization is the division which is a permanent feature of ASEE's structure. Thus, divisions are disconnected from each other. The extent to which these divisions attempt to bind their membership into a community depends on the leadership of the division: success,

which since it is voluntary and the leadership is elected for short periods, varies between the divisions. ASEE is governed by a Board of Directors which has the potential to enter into or create public debates. FIE has no linking mechanism between one year and the next and is dependent on a committee for its leadership. Like ASEE it is inward looking. Both organizations use the same approach to their annual conferences, that is, one and a half-hour sessions with the presentation of 5 or 6 papers during that session. There is very little time for discussion or debate. The plenary sessions decorate this structure.

Further restrictions are created by the FIE committee or the divisions by the rules for paper submission. Overall, these structures often prevent the discussion of topics by the general company of engineers who have a vested interest in them, as for example, whether or not there should be a professional qualification for engineering educators. This particular example raises the question as to whether or not ASEE and FIE should be concerned with the general development of engineering educators as professionals *per se*. Our view is that as things stand the primary purposes of their annual conferences which are their principal activity, as seen by those who attend them, is to meet like-minded individuals, and to justify their attendance by the presentation of a paper which in the case of ASEE is lost in monolith system. We do not excuse ourselves from this position.

Support for this view is that neither conference at the plenary level has held any discussion of William's thesis which had, and continues to have, profound implications for the profession known as engineering. Neither conference represents engineering educators as a profession either to themselves or to the outside world. There is nowhere that a discussion can be implemented about what it is to be an engineering educator or for that matter an engineer. Neither is there a place for vision generation. For example, we knew that this submission would create difficulties for the reviewers, and it did. This was no fault of the reviewers, one of whom thought that it did not belong to the innovative practice or the research/practice categories, and the other who thought it better fitted the research track.

While a case may be argued for a "professional practice" category that is to miss the point because papers would be presented to small groups of people which should be the concern of all, a proposition that may be illustrated by Pryan Dias's discussion of the engineer's identity crisis [7]. He identified the three crises shown in the box. The first belongs to the branch of ethics and is easily accommodated by either conference. The second (relating to ontology) and third (relating to epistemology) are easily accommodated by ASEE's TELPhE division. Apart from dividing up the whole they become separated from the profession as a whole in spite of the fact that the question of identity is central to what a profession and a professional is [8,9]

"First, there is a crisis regarding the engineers *influence* […] the technological society and environmental crisis have raised the question as to whether *engineers are doing more harm than good*".

"Next there is a crisis regarding the engineer's *role*. Most students who enroll in engineering undergraduate programs have a strong background and interest in science. They are good at analysis. Practicing engineers on the other hand have to produce something or make something happen. That involves integrating products processes and people. In other words, they must be good at management, and synthesis. The question then arises as to whether *engineers are scientists or managers*" […].

"Finally, there is the crisis regarding engineering knowledge (which overlaps the crisis regarding role). Most university programs in engineering are filled with theoretical subjects that are largely 'mathematics in disguise'. Engineering practice on the one hand is predominantly practical in nature, and great reliance is placed on established procedures (or rules of thumb), specified guidelines (or codes of practice), and that indefinable element called 'engineering judgement'. Therefore, we can ask whether *engineering knowledge is theoretical or practical*. In some situations engineers have difficulty in explaining how their knowledge differs from that of a technician or even craftsmen, because of this reliance on rules of thumb".[…]

"The above questions are valid for engineers in most if not all societies. It is the duality posed in the questions that creates the angst. It is the undermining of self-worth or social value inherent in the questions that constitutes the crisis".

Extract from Pryan Dias (2013) The Engineer's Identity Crisis. Homo Faber or home sapiens? In D. P. Michelfelder et al (eds) *Philosophy and Engineering. Reflections on Practice, Principles, and Process.* Dordrecht. Springer Science +Business media [7].

Much of the research that is being reported to these conferences is likely to be relevant to these issues. Indeed, that would be its justification. But, as things stand there is no mechanism either for a synthesis of research on particular topics, or for a discussion of the curriculum, or for a vision of the future, which these issues surely predicate.

In the past FIE has had a profound influence on developments in engineering education. For example, at the 2011 conference it enabled, with the support of ERM and the IEEE Education Society, NSF to sponsor a one-day conference that explored the philosophies of engineering and engineering education. Preparation included a pre-published review of developments in the subject matter to date,[8] and the publication of a substantive bibliography [10]. The result was the inclusion of philosophy under the umbrella of one ASEE's divisions and the publication (to date) of four handbooks on the topic. It is evident that this is but one of a number of possible models that FIE should consider as a means of enhancing the profession and giving it a public face.

REFERENCES

[1] Williams, Rosalind. *Retooling: A historian confronts technological change*. Cambridge MA, MIT Press, 2003.

[2] Williams, Rosalind. "Education for the Profession Formerly Known as Engineering." *Chronicle of Higher Education* 49.20 (2003): B12-B12.

[3] *Ibid*

[4] *Ibid*

[5] *Ibid*

[6] Davis, Michael. "Will software engineering ever be engineering?" *Communications of the ACM* 54.11 (2011): 32-34.

[7] Dias, Priyan. "The Engineer's Identity Crisis: Homo Faber or Homo Sapiens?." *Philosophy and engineering: Reflections on practice, principles and process*. Springer, Dordrecht, 2013. 139-150.

[8] Brown, George, Edmunds, Sahra, "Changes of academic identieis in the UK universities" in

[9] Identity in UK universities **(2021)** in Ellis, R and Hogard,E. (eds) *Professional Identity in The Caring Professions*(2021) London: Routledge/Taylor and Francis

[10] Heywood, John. "A historical overview of recent developments in the search for a philosophy of engineering education." *2011 Frontiers in Education Conference (FIE)*. IEEE, 2011.

[11] Heywood, John, Carberry, Adam, Grimson, William "A select and annotated bibliography of philosophy in engineering education." *2011 Frontiers in Education Conference (FIE)*. IEEE, 2011.