Cross Institutional Comparison of Curricular Change in Dutch Engineering Bachelor Programmes

[1]Dr. R.G.Klaassen[1]
Coordinator
TU-D 3TU.CEE
Delft, The Netherlands
r.g.klaassen@tudelft.nl

Drs. C.H.T.A. Brans
Coordinator
TU/E 3TU.CEE
Eindhoven, The Netherlands
c.brans@tue.nl

Drs. E.M.Gommer
Coordinator
UT 3TU.CEE
Enschede, The Netherlands
e.m.gommer@utwente.nl

Key words: Curriculum Development, Engineering Education

1. INTRODUCTION

The Netherlands has three Universities of Technology. Delft University of Technology (TU-D) in the West of the country, the University of Eindhoven (TU/e) in the south of the country and Twente University (UT) in the East of the country. All these Universities started a bachelor innovation process more or less independently and at the same time. These innovations were instigated under the pressure of governmental measures to improve success rates and educational quality. Reasons why this happened were among others the need for shorter study duration; higher pass rates and retention rates. In addition, at least two of the technical Universities were losing market share. More importantly, the programmes were not yet adequately geared towards the big challenges of the future and the engineering skills students need to solve these big challenges. The national academy of engineering education for example stated in its' 2004 report that the explosion of knowledge, globalisation of the economy and the way of working will change the engineering profession in the future [1]. Students should be better equipped for this future.

[1] R.G. Klaassen
e-mail: r.g.klaassen@tudelft.nl

The Bachelor curriculum innovations are studied by the 3TU.CEE[2] in three different phases of the renewal process (1) the design of the intended curricula, (2) the implemented and (3) the perceived curricula [2] of the three Technical Universities. [2] In this paper the results of the first study on the intended curricula of the Universities are discussed. We tried to capture the rationale behind the curriculum change and the intentions as specified in policy documents and focused specifically on the drivers of Change, the change approach and the characteristics of change.

The leading research question in this research is "In what way did the three technical Universities realise their bachelor curriculum innovation objectives?"

Curriculum changes in Universities tend to be very difficult as it involves the need for change from the highest management levels to the lowest employee level, their students and external stakeholders. Ideally, all the stakeholders become co designers and change agents of the new programmes, as participation is the best predictor of co-ownership [3]. This is the very reason, motivation and will to change should be infused into the veins of the university community [4] and provide a change approach that will sustain the change [6]. However, it is not as simple as it seems; most university structures and staff tend to be resistant to change, if only for accountability and work stress reasons.

We tried to capture the level of success and the sustainability indicators of Graham [6], Stolk [7] and Fullan [8] for incremental programme/curriculum change, as highlighted in figure 1.

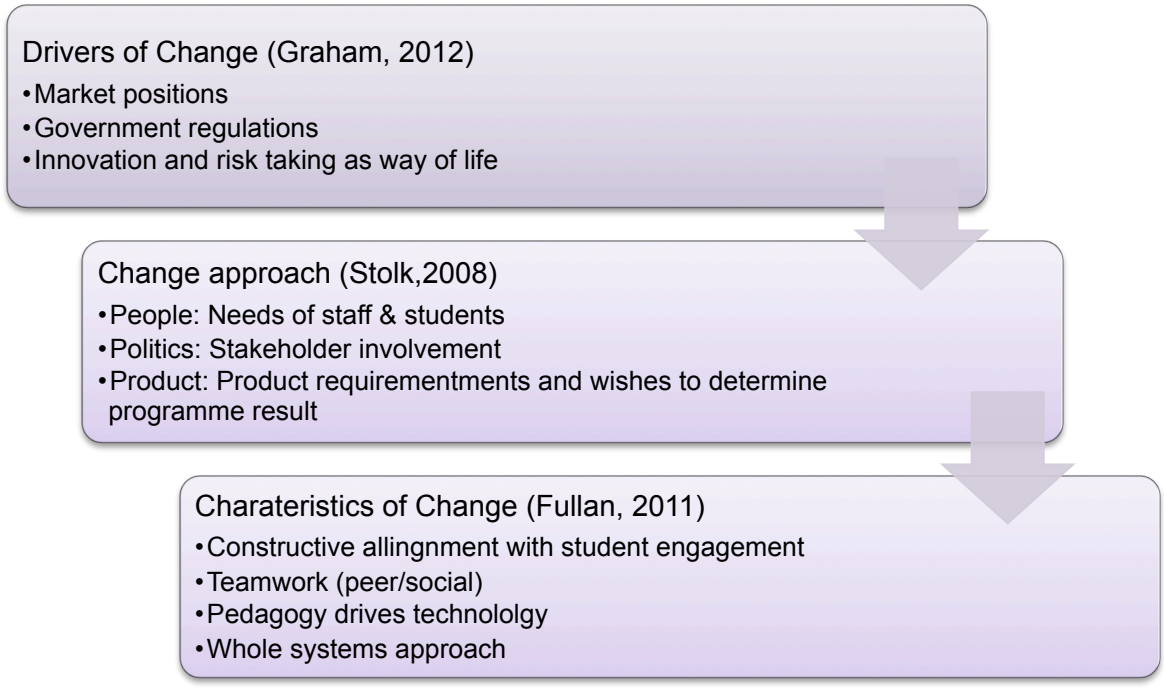


Figure 1

[2] 3TU.CEE is a research and expertise centre for engineering education in the Netherlands. More information http://www.3tu.nl/cee/en/

2. DRIVERS OF CHANGE

Drivers of change (Graham, 2012)
- Government regulations
- Market positions
- Innovation and risk taking as way of life

Innovation in higher engineering education is not a goal in itself, it origins in a problem and seeks a solution for this problem [9]. Drivers of Change find their origin in a crisis. According to Graham drivers of change in educational context are governmental regulations, the market position of an institution, and an innovative and risk taking profile of an institution [6]. These drivers create a sense of urgency for change within the organisation, such as educational innovation. In the following paragraphs we will look at the first two of these elements for the three Universities in our study.

Governmental regulations

Obviously, since the research is done in the Netherlands, governmental regulations were a driver for all three institutes. Another driver was the decrease in market share due to demographic developments with shrinking budgets as a result.

In 2010 a governmental issued research [10] showed amongst other quality issues that the success and retention rates of the Dutch technical universities were far below the expected results. A quarter to a third of the students in 2010, who passed the first year, achieved a bachelor diploma within four years after starting their programme. The nominal study duration in the Dutch Bachelor of Science is three years. New institutional performance agreements with the Ministry of Education, Culture and Science (OC&W) resulted in a focus on the improvement of retention, and success rates of students.

An increase in study success rates was a common target and driver for change in the three institutions. The other targets were for example better guidance of dropouts in the first year through matching activities, an increase of and more diversity in the student population, or a larger percentage of students participating in an excellence track and better qualified teacher staff.

Market Position

Delft University of Technology has a very strong market position and thus this was not an immediate driver for change. For the other universities, the market position is weaker.

As stated in paragraph 2.1, ambitions to grow in total population as well as in variation of types of students (i.e. more female students) and future-proof bachelor graduates were goals of the TU/e bachelor innovation. Particularly aiming at giving each engineer multidisciplinary skills/knowledge besides in depth knowledge and skills in one mono-discipline. The point of departure is strengthening the link between technology and society and positioning the bachelor programme as the beginning of a career path.

The UT developed a wish for a broadly educated and flexible engineer; the T-Shaped Professional [11] and the need to stand out with online and demand driven education. This new engineer needs depth as well as breadth, is able to integrate technology in a societal context and is a continuous learner. The aim is to educate experts that can make a difference in the competition with automation and well-educated engineers from abroad.

3. CHANGE APPROACH

Change approach (Stolk,2008)

- People: Needs of staff & students
- Politics: Stakeholder involvement
- Product: Product requirements and wishes to determine programme result

Next to the market position and the governmental regulations, the leadership of change and the change strategy are very critical factors for sustaining change ([8],[6],[12],[13]) Graham [5] states that key in change leadership is the communication and defence of the vision and principle of change to stakeholders to gain acceptance and broad support. In the process of curriculum change Stolk [7] proposes that a clear implementation strategy and a strategy for sustainability should be discussed during the design of the intended curriculum [14]. Stolk [7] describes engineering innovation approaches from the paradigm politics, people or product. The political perspective focuses on the interest of stakeholders in the change as the key to success ([6],[7]). A more people oriented approach says the needs of particularly the students and teaching staff in these cases are key to success [7]. Last, a more pragmatic perspective of product results and requirements is leading ([15], [7]). Naturally, all three people, politics and product are needed, but often one of these approaches is emphasized in the change approach. Each of the three Universities in our research chose a different start.

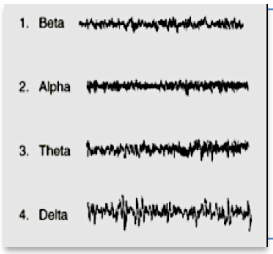
The TU/e used the most people oriented approach of the three universities. Student's needs, interests and ambitions were at the heart of the design process. Primarily, by (a) having customer surveys amongst students, alumni and labour market and by (b) trying to discern what teaching staff needed to make the necessary renewal to the curriculum. Thus, they strengthened the intrinsic motivation of the users to make the change a success. It translated itself together with the drivers for change, market position/governmental regulations to a broad scope and entirely new curricular and organisational structure for education. They created a bachelor college in which the multidisciplinary engineer and a strong link between technology and society are key features of their curricular change.

At Twente University requirements were set, after which the design was handed over to the organisation, following a more politics type of approach. The approach involved a lot of consultation with a large number of staff to shape and reshape the vision for a new curriculum. They even established a separate institute, in which experimental teaching approaches can be piloted, to assess whether the new teaching methods work. Teaching staff is not only challenged within these boundaries to become owner of the new curricular vision and principles, but even to experiment with new ways of shaping the curriculum, increasing their levels of interest and participation, while all of them are focused on creating a broad, flexible and T-shaped engineer.

TU-D applied a more product-oriented approach. They used a predefined framework and requirements all aiming at the realisation of the target retention and success rate. The programme director played a key role in using a top-down approach forcing ownership of the requirements[3] or a bottom-up approach in which teaching staff were challenged to seize the opportunity to create within boundaries their new curriculum. As the framework was simple and direct, programme and cohesion in structure were more or less achieved throughout the institution. Additional bottom up changes were left to the insights and needs of the departments themselves. Many of who took this as an opportunity to change their vision on education on departmental levels.

[3] Naturally, this is an exaggeration as it will always be informed and negotiated consent.

4. CHARACTERISTICS OF THE CHANGE



Charateristics of change (Fullan)
Constructive allingnment through student engagement
Teamwork (peer/social)
Pedagogy drives technololgy
Whole systems approach

As shown in the previous paragraphs, slightly different drivers led to slightly different change approaches. When we compare the characteristics of the change itself, we find differences as well, even though for all three Universities constructive alignment [16] and student centred teaching and learning are core values in the curricular change.

Student engagement

Student engagement is typically increased by the amount of formative feedback and assessment and a limitation of summative assessment [17]. The institutions all striving to work in an evidence-based way prescribed this type of engagement as a principle for better results. Different measures were, however, implemented with the same goal in mind. For example, all three cases aim to stimulate active study behaviour with active teaching methods and regular feedback by for example formative assessment. Two universities try to achieve this by more self-study and less contact hours, one focuses on a full-time study programme with more project or group work.

When we look at summative assessment, all the institutions have limited the possibilities for taking re-sits of exams. However, one University made an explicit choice not to limit re-sits in the first year whereas the others apply this limitation to their entire bachelor curricula. Compensatory assessment is something all three are interested in, with the difference that TU-D and UT only allow for compensation within modules and at the TU/e also for compensation between modules or programme components is stimulated.

When we focus on the embedding of student engagement to realise intrinsic motivation, we see some major differences between the universities. The UT chose a modular thematic structure across the institute including projects in each module. This model was chosen to engage students with authentic real world problems working in multidisciplinary teams in a project oriented way. This way they aim to stimulate meaningful learning for both students and staff through active, self-responsible and cooperative principles.

The TU/e added a lot of free and or restricted electives. Within the restricted electives the students are enticed with an multidisciplinary module to become a 21st century engineer who is able to apply technical and ethical issues to a wider context and in a multi-disciplinary team [18]. The university engages students by allowing for more personalised learning trajectories supported by intensive coaching, building their own unique professional profile throughout their studies.

At TU-D, student engagement is primarily a planning issue in which it recommended to sustain students by making a realistic study planning. This does not mean student engagement is not or has not been addressed at the departmental level; it is, however, not explicitly stated in the intended curriculum change and the set of requirements, which means it may have been present already and did not need any

upgrade. At the departmental level more intensive coaching and tutoring, strict deadlines and flexible learning methods have been introduced to sustain student engagement.

Team Learning and Teaching

The second intrinsic driver for change is social engagement in which team teaching and team learning are at the heart of the change. Team teaching is especially strong in the UT, where before mentioned institute is an explicit and experimental environment for the exploration and dissemination of new teaching methods. Team teaching teams across the institution reinforces this teamwork and capacity-building approach. At the TU-D, team teaching is specifically mentioned as a recommendation to realise integration of topics into a coherent units of 5 or 7.5 EC.

The UT and TU/e mention interdisciplinary learning of real world problems as a feature of their new profiles. At the TU/e they focus on students contributing, with their individual passions, to society as a whole. The aim is to create a reciprocal learning cycle in which teachers are challenged by the learning path and passions of the students and vice versa.

Emphasis on reflection and teamwork as professional skills is mentioned and implemented by the TU/e and the UT.

Pedagogy driven Technology

The third intrinsic driver; Pedagogy-driven technological innovation is only mentioned at the UT as an aspect to pay attention to. Although, blended learning and online education are nowhere mentioned as features of the bachelor renewal, technological innovation is a very strong feature of the TU-D, driving many educational innovations. The UT and TU/e both have programmes to stimulate teachers' use of ICT-tools in their educational practice, but this is not an explicit part of the bachelor innovation.

Whole Systems approach

Last but not least is the intrinsic driver of using a whole-systems approach. At each institution to varying degrees, the whole system is affected. Whether the systemic changes challenge the teacher and the student to grow in their learning and/or promotes continuous passion for learning and capacity building is largely a result of the approach taken toward change. 100% influence of student and staff towards change is extremely hard. Extrinsic drivers for change such as those mentioned by Graham [5] help to influence students and staff and get a grip onto the whole system to change.

5. CONCLUSION AND DISCUSSION

The practical relevance is scaling mutual problems and professionalization through diverse approaches and input of the 3TU Federations' tacit knowledge.

What is needed in terms of drivers, leadership and characteristics of change to actually make it a success? Consistency is often mentioned, yet has a flexible pattern. Does the driver "market position" by definition lead to more people and politic oriented curriculum design?

Do the people and politic process approach by definition realise more team learning and teaching and student engagement or whole system approaches? Or is building them into the product requirements also a strategy that works? And which one works better in terms of framing the quality, sustainability and success of curriculum reform.

We would like to debate these propositions with our audience, as this input is only a starting point for discussion.

There is no clear 'right or wrong' here. Along different lines of reasoning, the three universities have chosen different ways to implement their curriculum change and to structure their modules. For further research, a recommendation is to find out from the literature in combination with evaluation of experiences what combination of measures works well and what doesn't, thus allowing the transfer of successful models to each other.

Naturally, there are many implications of this study we will discuss during the presentation

6. REFERENCES

[1] National Academy of Engineering, (2004), The Engineer of 2020: Visions of Engineering in the New Century. National Academy press, Washington.

[2] Akker, J. van den (2003), Curriculum perspectives: An introduction. In J. van den Akker, W. Kuiper & U. Hameyer (Eds.), Curriculum landscapes and trends (pp. 1-10), Kluwer Academic Publishers, Dordrecht.

[3] Tagg, J. (2012), *Why does the Faculty resist Change*? Change;the magazine of higher learning, http://www.changemag.org/Archives/Back%20Issues/2012/January-February%202012/facultychange-full.html

[4] Goldberg, D.E., Cangellaris, A.C., Loui, M.C., Price, R.L. & Litchfield, B.J. (July 2008), iFoundry: Engineering Curriculum Reform Without Tears, http://www.slideshare.net/deg511/ifoundry-curriculum-reform-without-tears.

[5] Graham, R. (2014); Creating Engineers for the 21st Century; The challenges and opportunities for systemic change in engineering education, Presentation at the Kick off Event of the Centre of Engineering Education. http://www.3tu.nl/cee/en/events/cee-kick-off-event/summary-kickoff/

[6] Graham, R. (2012). Achieving excellence in engineering education: the ingredients of successful change. London: The Royal Academy of Engineering.

[7] Stolk, J., Somerville, M., Chachra, D. (2008) , Drowning in method, thirsty for values: a call for cultural inquiry IEEE Computer Society, ISBN S3G-3-S3G-7, http://www.computer.org/csdl/proceedings/fie/2008/1969/00/04720360-abs.html

[8] Fullan, (2011) CSE (n.d.) Choosing the wrong drivers for whole system reform, Seminar Series 204, Centre for Strategic Education,(CSE) is the business name for IARTV, www.cse.edu.au

[9] Waslander, S. (2007). Leren over innoveren. Overzichtsstudie van wetenschappelijk onderzoek naar duurzaam vernieuwen in het voortgezet onderwijs.

[10] Veerman (2010). Toekomstbestendig Hoger Onderwijs Stelsel Retrieved from http://www.rijksoverheid.nl/documenten-en-publicaties/rapporten/2010/04/13/advies-van-de-commissie-toekomstbestendig-hoger-onderwi.html

[11] Harris, P. (2009). Help wanted: 'T-Shaped skills to meet 21st century needs'. Technology and Development 63(9), 42–47.

[12] Haanaes, K., Balagopal, B., Arthur, D., Kong, M. T., Velken, I., Kruschwitz, N., Hopkins, M. S. 2011. First look: The second annual sustainability & innovation survey. MIT Sloan Management Review, 52(2): 77-83.

[13] Rooke D. and Torbert W. R., 2005. Seven Transformations of Leadership, Harvard Business Review April 2005, Harvard Business Publishing, Harvard, USA.

[14] Hassi, L., Peck, D., Dewulf, K., Wever, R. (2009). Sustainable Innovation, Organization and Goal Finding, in Joint Actions on Climate Change, Aalborg, Denmark.

[15] Rogers, E. M. (2010). Diffusion of innovations. Simon and Schuster.

[16] Biggs, J & Tang, C (2011), Teaching for Quality Learning at University, Society for Research into Higher Education

[17] Gibbs, G (2010), Using Assessment to support Student Learning, Leeds Metropolitan University, http://www.uea.ac.uk/learningandteaching/documents/newacademicmodel/UsingAssessmenttoSupportStudentLearningbyProfessorGrahamGibbs

[18] Meijers, A., & Brok, P. den (2013). Engineers for the future: an essay on education at TU/e in 2030. Eindhoven: Eindhoven University of Technology