MAKE CURRICULUM DEVELOPMENT MORE AGILE

Thilo Harth[1], Frank Dellmann[2]

*[1] Scientific Director, Wandelwerk Centre for Quality Development,
Münster University of Applied Sciences (GERMANY)
[2] Vice-President for Education and International Affairs,
Münster University of Applied Sciences (GERMANY)*

Change in the engineering world is very rapid, especially as a result of digitalisation. Curriculum development is generally slow. It takes too long to implement new content, methods, and development in our courses. There is an obvious gap between the current requirements of engineers in the working world and the reality of engineering education at universities. On the one hand, a lot of subjects and basic competencies are necessary, durable and constant. They only need incremental changes and only single modules need to be replaced from time to time. On the other hand there is a new quality of change in the digital age. We have to face the VUCA world and represent it in our engineering curricula. At our university, we have been trying to implement a new, agile process of curriculum development for more than three years. Our first experiences, results, and ideas are visible and inspiring. This paper provides insight into a new approach to curriculum development and the creation of modules that address VUCA requirements.

Keywords: curriculum development, VUCA world, agile module, lifelong education

1   THE VUCA WORLD REQUIRES DIFFERENT COMPETENCY PROFILES

Technological change has always been a feature of working as an engineer. Engineers drive this technological change and react to society's and the working world's changing requirements and environment with new ideas, technology and approaches. Their rigorous university education has clearly always equipped them well to do this.

However, the digitalisation of society and the working world has now produced an environment which is marked by a new quality of change [1], and this is especially challenging for current and future engineering and therefore also for current education in engineering. This includes:

a) a dramatic increase in the general dynamics of change, which can be seen for example in the fields of communication and transport compared to earlier decades,

b) the importance of the principle of networking of things and people (i.e. connectivity),

c) the convergence of previously separate areas, such as people's professional and personal lives, and of whole sectors, such as banks and supermarkets,

d) entirely new business models such as mobility concepts (e.g. car-sharing, e-scooters and Uber) and price comparison portals (e.g. SWOODOO, Booking and Idealo),

e) completely changed consumer behaviour, which can for example be seen in online retailing and the sharing culture, and finally

f) a dramatic increase in global challenges, as illustrated for example by climate change and migration dynamics in Europe and North America.

The acronym VUCA summarises the challenges which this new environment poses. It combines the following four key words: volatility, uncertainty, complexity and ambiguity. In a volatile world, the environment is always changing, new and competing tasks are constantly being added, decisions are generally urgent, and information is incomplete. The result is uncertainty. One cannot often clearly distinguish an effect from its cause. Previous experiences and strategies can no longer be applied in this new situation, or only to a limited extent. Instability and uncertainty are inherent in the discussion problem and within a complex environment. The amount of available digital data and information is potentially infinite. "Many aspects are interrelated and affect each other. These are at least partially known or predictable, but it is not possible to analyse all aspects and use them for a decision." [2] Ambiguity refers to conflicting options, each of which has advantages and disadvantages. The causal relationships between individual aspects are ambiguous rather than clear-cut, because there is a lack of complete prior experiences of them [3].

Johansen suggests that leaders should respond to the VUCA world with VUCA Prime: vision, understanding, clarity and agility [4]. The quality of agility appears to be especially important for curriculum development.

Universities should indeed reflect the fundamental challenges posed by the VUCA world more clearly in engineering disciplines' curricula. There is, of course, no doubt that universities make considerable efforts to equip their laboratories and lecture theatres with state-of-the-art technology, have countless initiatives to implement digital tools in teaching, and gear their teaching content to the latest research, and that all this is reflected in their curricula. Engineering disciplines, for example, are comparatively willing to make room for programming competencies and both basic and knowledge-based data management in their curricula.

However, universities still fail to prioritise systematically adapting their curricula to the competency profiles which the digital world requires [5]. A paper entitled "Ingenieurausbildung für die Digitale Transformation" (Engineering education for the digital transformation) clearly demonstrates the need for greater promotion of digital subject matter in higher education [6]. In addition to performing a meta-analysis of relevant literature and a survey of 231 German universities, the authors surveyed 12,000 students in engineering disciplines and 16,000 career starters (in addition to university managers). The responses of the 933 students (with a participation rate of 8%) and the 652 career starters (with a participation rate of 4%) provide a relatively clear description of the gaps and needs [6, p. 21 et seq.]. 12% of the students agree with the statement "Digital subject matter is basically not dealt with in the degree programme" and 28% tend to agree with it. The career starters also clearly highlighted the need for digital subject matter, and a high percentage found that their studies inadequately prepared them for working in this area [6, p. 26]. Not surprisingly, "The vast majority of respondents in all groups ... believe that the importance of digital subject matter will continue to increase significantly over the next five years." [6, p. 28]

The value placed on non-technical competencies indicates quite clearly what this digital subject matter might be or, more importantly, which competency profiles are actually required in the digital world. Surveys of companies show, for example, that abilities to work in a team, to work independently, and to analyse and make decisions are gaining particular importance as a result of digitalisation [7]. The director of the Massachusetts Institute of Technology (MIT) Initiative on the Digital Economy has emphasised that there is an urgent need to promote teamwork, creativity and social skills [8]. Manuel Hartung has introduced the ability to feel insecure, i.e. "the ability to constantly question oneself and respond to this", into the debate as a new core competency [9]. Kreulich and Dellmann have identified three characteristic shifts under the influence of digitalisation for each of the non-technical competency areas, namely methodological, personal and social [10].

These findings are confirmed in a separate qualitative and explorative study initiated by our university. Lecturers from different disciplines at five German universities of applied sciences were interviewed about their assessments of the competency profiles needed in the digital world [11]. The 33 lecturers interviewed were especially aware of the importance of non-technical competencies, as well as of changes in specific technical requirements, due to the digital challenge. While knowledge about digital tools and technology was the most highly valued technical competency, their assessments of the required non-technical competency profiles were spread across all areas. The interviewees frequently mentioned methodological competencies such as research and evaluation skills, a social or social-emotional competency such as teamwork, and personal competencies such as reflection, flexibility, openness and lifelong learning. The lecturers appear to regard the reflection competency as particularly important for enabling students to meet the digital challenge. They particularly emphasised the need for reflection both on the use of digital technology and on oneself. This finding is consistent with the fundamental mission of universities, which Wilhelm von Humboldt himself defined as: "The essence of thinking lies in reflection, i.e. in distinguishing thinking from a thought" [12].

2   THE VUCA WORLD REQUIRES AGILE CURRICULUM DEVELOPMENT

It is not enough just to consider changed or new non-technical competencies. After all, only a certain number of credit points are available for a course and one cannot just keep loading new requirements onto the curriculum. One therefore needs to consider what is is no longer needed and how to rebalance the curriculum.

A university-wide working group on digitalisation at Münster University of Applied Sciences has been discussing competency profiles in the digital world with stakeholders from all relevant areas of the

university for more than three years. It has identified three issues, which the departments now focus on when they work on their curricula.

The first step is to review the existing modules with a view to consciously strengthening the traditional competency requirements. Digitalisation is often associated with acceleration processes and rapid, if not unduly rapid, solutions. For example, students tend to use various computer programmes or apps too early for planning, designing and constructing. The relevant programme or digital tool defines their scope for action. As a result, however, actual structured action is glossed over or even missed out during the planning, design and construction processes. The answer to this failure is to consciously slow the learning process down, to return to analogue space and to focus on basic competencies. Students should, for example, be trained, using a pencil and paper, to come up with their own ideas before they use digital tools; their ability to assess, estimate and calculate key parameters during construction should be strengthened; and they should be taught to focus on thorough research during planning. When developing curricula, care should be taken to design modules in which these basic competencies have sufficient space and can be practised and developed.

The second step is to check the existing modules to see whether they could or should take greater account of shifts in competencies due to digital change. For example, when does the ability to obtain information, to calculate many special cases exactly or to carry out identical laboratory tests lose importance, and can be used to answer discussion questions about the ability to select information, the targeted analysis of an app's calculation results, or the evaluation of a test simulation in virtual teams? What scope is there for increasingly transferring engineering activities to digital tools and aids in order to facilitate building competencies in critical questioning and meaningful use of these tools? When should the need for a basic understanding of the information technology functionality of digital tools and services replace the previous focus on a basic mechanical or electrotechnical understanding?

The third step is to specifically address the dynamics of change in the VUCA world. Volatility, uncertainty, complexity and ambiguity require:

- Overcoming the traditional silo mentality of individual disciplines and replacing it with the trans- and interdisciplinary collaboration of different disciplines, in order to find creative, new and different answers and solutions. New didactic-methodical settings, such as design thinking [13], support this multi-perspective view. A study by the Association of German Engineers briefly and succinctly states the need for an interdisciplinary approach: "Topics such as digital transformation must be integrated across disciplines." [6, p. 31]

- Discussion of real world problems [14]. The classic way of thinking in didactics is to process and transfer discussion questions and problems into learning content which is manageable and straightforward or simplified and therefore easier to understand, but in future it will be more about the ability to solve VUCA discussion problems comprehensively. These can no longer be meaningfully broken down into individual aspects without losing the special quality of their requirements: "educating a generation of solutionaries" [15].

- Cooperation from different perspectives with players from outside the university. Our teaching should, whenever possible, "take advantage of opportunities to cooperate with companies that have successfully shaped changes in digital transformation into change processes and implemented them in their business models or products" [6, p. 31].
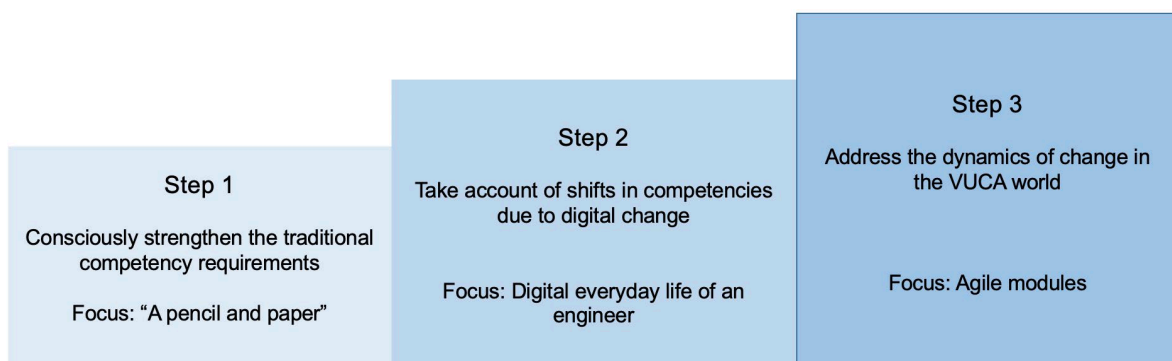

Figure 1: Agile curriculum development

We should therefore identify specific free spaces in existing curricula, or create them for modules, that challenge students to deal with volatility, uncertainty, complexity and ambiguity and are redesigned in terms of content and didactics in line with the new competency requirements.

3   FIRST IDEAS ABOUT IMPLEMENTING AGILE MODULES AT MÜNSTER UNIVERSITY OF APPLIED SCIENCES

Agile modules focus on complex, real engineering discussion problems, deal with them in an interdisciplinary and collaborative way (ideally in close connection with professional practice), and are unbiased, i.e. promote new, unconventional approaches rather than allowing preconceived learning paths to be traced. The learning goals and contents in the module description for an agile module could read as follows [16].

Learning goals: After successful completion of this module, students will be able to identify the challenges that a VUCA world poses to the participants in this environment and to record the characteristics and complexity of constant change in such a world using an example. They will be able to describe a complex and interdisciplinary discussion question which arises from these requirements, and then to analyse it in a multi-perspective way. They will also be able to formulate this complex discussion question in a new and more precise way from within a team of different technical experts, to grasp the discussion problem more specifically (having delved into it more deeply) and to work out the first steps for agile and flexible interdisciplinary solution scenarios which even experienced technical experts such as their lecturers did not previously have. They will organise their personal learning process and their learning process in the group itself and will be able to profitably integrate their individual strengths, abilities and skills into the group work process and to continuously reflect, question and adapt to the work process. They will also be able to answer the question when change is necessary and when continuity is the better option. They will use agile and mobile working methods and environments in a way which is targeted and suits the relevant context.

Learning content: The content of this agile module is the interdisciplinary treatment of a complex discussion question that reflects the requirements of a VUCA environment and is related to the central challenges of the real world. The course provides basic strategic tools for identifying complex discussion questions in an interdisciplinary and professional context and for analysing them from different perspectives. Students work with agile methods such as design thinking in a working environment which is both mobile and agile (a coworking space).

The relevant content reference can be made more specific depending on the subject, for example: "Creative needs analysis of ...", "Energetic optimisation of a ...", "Sustainable use of materials in ...", and "An emissions-reduced mobility concept for ...".

Agile modules have the following essential characteristics:

- Unbiased results: The result of the discussion problem, and even its result type, are not pre-determined. This can result in lecturers themselves not yet knowing solutions to the discussion problems and not being able to anticipate them. They must always remain flexible in the learning process with regard to content, methods and strategies.
- Unbiased methodology: The appropriate methodology or strategy for dealing with the discussion problem is neither known nor fixed in advance.
- Flexible content: The subject matter which needs to be used during the analysis is open, interdisciplinary and dependent on the chosen methodology.

This can result in lecturers themselves not yet knowing solutions to the discussion problems, or even how to approach the solutions, and not being able to anticipate them. They must always remain flexible in the learning process with regard to content, methods and strategies. The lecturers and the students work equally on generating impulses and ideas and on solving problems. Supporting the learning process is a key part of our teaching [16].

Agile parts of the curriculum can naturally vary in size and be arranged differently in the course in discussion with everyone who is responsible for offering it. Agile modules may, for example, be designed as one-off or ongoing offerings, and they may be consciously omitted at the beginning of a course and only introduced once the students have acquired a basic knowledge of and an interest in the subject. Universities may wish to make agile modules mandatory, so that all students have an opportunity to achieve the above learning goals in the digital world. Or they may prefer to make them optional, in order

to allow other priorities to be set in the course. Structuring the module as a project week is just as conceivable as a regular seminar during the whole semester.
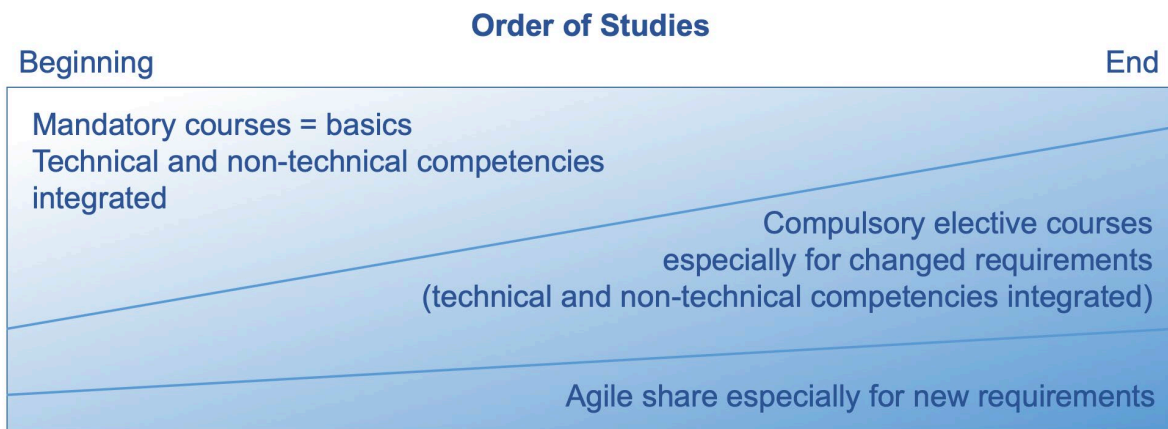
Order of Studies

Figure 2: Order of studies, including agile modules

Putting this into practice at Münster University of Applied Sciences:

- We are currently achieving promising results using the design thinking approach in a creative learning environment (using a co-creation lab as a makerspace). Student teachers of different engineering subjects are working together with student teachers of general subjects on creative answers to the question how professional classroom learning can remain relevant in the digital age [17].

- Architecture students who are specialising in Digital Design and Construction are being encouraged to research computer-generated forms and structures and digital fabrication, and to develop rapid prototyping. They can use an equipped digital laboratory for this, and for conducting independent prototype development together with students of electrical engineering. The discussion questions are complex, multi-perspective and interdisciplinary in content dealing, for example, with new traffic plans for Münster, with managing the housing shortage in a student city in a cost-effective and sustainable way or with developing districts in response to an ageing society. This is done with close practical support from Zaha Hadid Architects in London and with students from engineering disciplines.

- All professors in chemical engineering are currently developing complex and practice-oriented discussion questions that are to be dealt with independently in small groups in a cross-laboratory manner, both chemically and procedurally, in the fifth semester of the bachelor's course. This involves, for example, producing ibuprofen including sustainable packaging and feasibility studies. The learning process should at the same time be reflected in relation to other module contents. The results will be prepared as posters and presented by the students to pupils in a public event in order to arouse interest in this course and to improve their own presentation skills.

In summary, the current focus is on collecting and testing suitable new discussion questions and experiences in order to cope better with the demands of the VUCA world, even during the courses themselves. We must at the same time maintain the balance between proven modules and contents, actually changed digital working conditions, and the integration of digital competency profiles and realistic, yet completely new, elements in the courses (the agile modules).

REFERENCES

[1] B. v. Stamm (2017). Innovation: A Necessity, Not Nicety, in: Rob Elkington, Madeleine Van Der Steege, Judith Glick-Smith, Jennifer Moss Breen (ed.) Visionary Leadership in a Turbulent World, pp. 107 – 131.

[2] J. Moskaliuk (2019). VUCA-World: Was die Digitalisierung wirklich verändert hat. In: Beratung für gelingende Leadership 4.0. essentials. Springer, Wiesbaden.

[3] N. Bennett and G. J. Lemoine (2014). What VUCA Really Means for You. Harvard Business Review, Vol. 92, No. 1/2, 2014. Available at SSRN: https://ssrn.com/abstract=2389563.

[4] B. Johansen (2012). Leaders Make the Future: Ten New Leadership Skills for an Uncertain World, Berrett-Koehler Publishers, 2nd ed., San Francisco.

[5] T. Harth (2019), Kompetenzprofile in der digitalen Welt, Münster.

[6] Study by the Association of German Engineers (VDI) (2019). Ingenieurausbildung für die digitale Transformation, Düsseldorf, April 2019.

[7] Stifterverband für die Deutsche Wissenschaft (donors' association for the promotion of humanities and sciences in Germany) (2016). Hochschulbildung für die Arbeitswelt 4.0 – Hochschul-Bildungs-Report 2020, Jahresbericht 2016, Essen; available online at: https://www.stifterverband.org/medien/hochschul-bildungs-report-2020-bericht-2016, retrieved 05.12.2019.

[8] E. Brynjolfsson (2016). „Es läuft nicht mehr wie früher", in: Die Zeit no. 15 dated 31 March 2016.

[9] M.J. Hartung (2017). Wer braucht Designpädagogen? In: Die ZEIT Campus, 25 October 2017; available online at: http://www.zeit.de/2017/44/hochschule-studiengaenge, retrieved 05.12.2019.

[10] K. Kreulich and F. Dellmann, and others (2016). Digitalisierung – Strategische Entwicklung einer kompetenzorientierten Lehre für die digitale Gesellschaft und Arbeitswelt, Berlin UAS7 e.V.; available online at: http://www.uas7.de/fileadmin/Dateien/UAS7_Broschuere_Digitalisierung.pdf, retrieved 05.12.2019.

[11] J. Lilienthal and C. Schroeder (2018). Reflexionsfähigkeit 4.0 – Wie die Digitalisierung einen zentralen Bildungsauftrag von Hochschulen stärkt. Empirische Begründung und Schlussfolgerungen. In: Neues Handbuch Hochschullehre, Book 85 (2018), pp-69-84.

[12] W. von Humboldt (1795/96). Über Denken und Sprechen. In: W. von Humboldt, Werke in fünf Bänden. Published by A. Flitner & K. Giel. Darmstadt: WissBG. Bd. V (J981) (pp. 97-99).

[13] T. Harth and S. Panke (2018). Design Thinking in Teacher Education: Preparing Engineering Students for Teaching at Vocational Schools, in: Association for the Advancement of Computing in Education (publisher), E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Chesapeake, VA.

[14] M. Prensky (2016). Education To Better Their World, New York.

[15] Z. Weil (2016). The World Becomes What We Teach. New York.

[16] T. Harth and F. Dellmann (2019), Den Anschluss nicht verpassen: Wie ingenieurwissenschaftliche Curricula von Hochschulen in der digitalen Welt agil werden können, in: Neues Handbuch Hochschullehre, Book 92 (2019), pp. 95-11.

[17] T. Harth and S. Panke (2019), Creating Effective Physical Learning Spaces in the Digital Age – Results of a Student-Centered Design Thinking Workshop, in: Association for the Advancement of Computing in Education (publisher), E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Nov 04, 2019 in New Orleans, Louisiana, United States.