# Development of a project-oriented and transnational master course for training the engineering competencies required in an increasingly demanding work-life in Europe

**T. Stock**[1]
Research Assistant
Chair for Sustainable Corporate Development, Technische Universität Berlin
Berlin, Germany
E-mail: stock@mf.tu-berlin.de

**C. Haskins**
Associate Professor
Department of Production and Quality Engineering,
Norwegian University of Science and Technology
Trondheim, Norway
E-mail: cecilia.haskins@ntnu.no

**B. Gładysz**
Postdoc Researcher
Institute of Production Systems Organization, Warsaw University of Technology
Warsaw, Poland
E-mail: b.gladysz@wip.pw.edu.pl

**M. Urgo**
Assistant Professor
Mechanical Engineering Department, Politecnico di Milano
Milan, Italy
E-mail: marcello.urgo@polimi.it

**H. Kohl**
Professor
Chair for Sustainable Corporate Development, Technische Universität Berlin
Berlin, Germany
E-mail: holger.kohl@tu-berlin.de

**J. O. Strandhagen**
Professor
Department of Production and Quality Engineering,
Norwegian University of Science and Technology
Trondheim, Norway
E-mail: ola.strandhagen@ntnu.no

[1] Corresponding Author
T. Stock
stock@mf.tu-berlin.de

**E. Jarzębowska**
Professor
Power and Aeronautical Engineering Department, Warsaw University of Technology
Warsaw, Poland
E-mail: elajarz@meil.pw.edu.pl

**T. Tolio**
Professor
Mechanical Engineering Department, Politecnico di Milano
Milan, Italy
E-mail: tullio.tolio@itia.cnr.it

Conference Key Areas: Curriculum Development, Students Cooperation, Sustainability and Engineering Education

Keywords: Multi-cultural teamwork, multidisciplinary teamwork, trans-national cooperation, blended learning in higher education

## INTRODUCTION

Mobility, multi-locality, and transnational migration are current social developments among the population of the European Union induced by the dynamic European economy. The human cohabitation within the European society will become more and more characterized by intercultural and cross-border interactions between European citizens. This development is already observable within the activities of European companies. Cross-border project work between different productions sites as well as transnational cooperation is essential for ensuring competitiveness in increasing globalization. These social developments in society and companies lead to new forms of living and new requirements for working in the European Union. The teaching and learning in higher education has to adapt to these developments. Young engineers graduating from universities must be capable of working in international teams. In their future career, they will have to be able to work with colleagues, suppliers, and customers from different cultural backgrounds and in different countries, master the challenges of virtual cooperation in specific engineering tasks and within international value chains. Currently, standard university courses rarely provide adequate knowledge, structure, or content for developing and imparting competencies required for these tasks. As a result, new and innovative teaching and learning concepts in higher education must provide the competencies for transnational teamwork in the curriculum of tomorrow’s engineers in order to ensure a competitive advantage in their future careers.

With the intention of closing this aforementioned gap, a new inter-university master course focusing on action-based as well as on blended teaching and learning in transnational and interdisciplinary project teams has been developed and implemented on the university level. The objective of the course is the development of a sustainable, technology-oriented entrepreneurial initiative. This master course called “European Engineering Team” (EET) has been jointly established by four different European partner universities. It includes virtual cooperation between the students combined with intermediate physical presence phases in order to train mobility, individual, and intercultural competencies while working on the project.

The course is supplemented by an eLearning phase for training the relevant methodological and professional competencies of the students. Cooperation between the students and their supervisors is realized by a novel web-based teaching and learning platform built using WordPress plugins. This platform provides the functionality required for efficient and effective transnational project work as well as for presenting eLearning contents using open-source solutions.

After giving a state-of-the-art review for transnational and project-oriented teaching and learning approaches, this paper will outline the concept of the new inter-university master course. In addition, the development and the functionality of the web-based platform for virtual cooperation will be described. Lastly, a specific implementation of the inter-university master course addressing the development of sustainable innovations as well as first results of the implementation process will be provided.

## 1 STATE OF THE ART AND RESEARCH

Traditional teaching is inefficient, as was observed by Confucius, who stated: "I hear and I forget. I see and I remember. I do and I understand." (citation attributed to Confucius). Reich [1] stated that conventional teaching methods do not prepare graduates to deal with problems which require them to apply their knowledge to new domains.

Graduates should be prepared to perform in a turbulent, European- and world-wide, transnational and multicultural environment, which is continuously coined by new social, economic, and environmental trends promoted by globalization. As a result, it is necessary to prepare graduates for dynamic labour market demands. Thus, the requirements for teaching and learning in production and engineering management and mechanical engineering are derived from socio-economic and socio-technical changes, observed in Europe and the world.

EU’s strategy EUROPE 2020 reflects the importance of economic growth and creating new jobs, energy and climate changes, welfare and social security [2]. Vernon concluded that an effective learning program in engineering education should be (1) student-centred; (2) project- oriented, and (3) include some elements of economics and management [3]. The Manufacturing Institute and Deloitte Consulting LLP publish on a regular basis a Skills Gap Report that assesses the difficulties for manufacturing companies to fill critical positions [4]. When these companies were asked what they considered to be the most serious skill deficiencies in their current employees, inadequate problem-solving skills was the most frequent and relevant deficit. Skills such as critical thinking and problem solving are a key competitive factor to model, analyse, and communicate information, and also serve as a critical platform on which leadership and entrepreneurial skills can be developed. The report also identifies a set of actions to be taken in order to reduce these gaps, when considering the needs of manufacturing industries, e.g., more internships and mentorships to align higher education with industry competency and skill requirements; and more competency-based post-secondary pathways [5].

There are a number of initiatives relating to new forms of collaboration with industry [6], including the education of future engineers. However, there are not so many multi-university and education-oriented initiatives. Ziemian and Sharma [7] addressed possibilities of utilisation of so-called Learning Factories to develop the competencies of engineers in Europe and give the necessary priority to the transfer of technology from science to production, but they did not address the initial phases of inventing innovations; i.e. the conceptual, research and analytical tasks necessary to be performed. Graduates should act proactively to face continuous change in knowledge and technology. Therefore, the challenges of teaching engineers need to address a two-fold problem, which can be described by questions of “what to teach?” and “how to teach?”

Additionally, Jack et al. [8] identify some key actions to be accomplished in order to improve the quality and effectiveness of engineering education in manufacturing, e.g., encourage students to pursue global travels and projects, incorporate topics and courses that support global manufacturing and, in particular, encourage teaching methods that engage students.

Another approach is called Experiential Learning resulting from works of John Dewey [9], Kurt Lewin [10], Jean Piaget [11], David Kolb [12, 13] and others. The essence of the approach can be explained by citation from Aristotelian Nicomachean ethics [14]:

“For the things we have to learn before we can do them, we learn by doing them, e.g. men become builders by building and lyre players by playing the lyre; so too we become just by doing just acts, temperate by doing temperate acts, brave by doing brave acts”.

Individuals, especially adults, could learn very effectively by reflection on what they do, in contrast to merely following instructions and procedures. Project-based Learning and Experimental Learning Laboratories are, among others, possible forms of implementing the concept of Experiential Learning [15].

The concept of experiential learning can be explained by *Fig. 1*, *Fig. 2*, and *Fig. 3*.

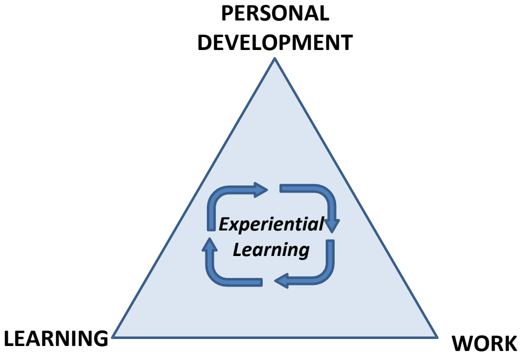


*Fig. 1.* Three aspects of experiential learning [12]

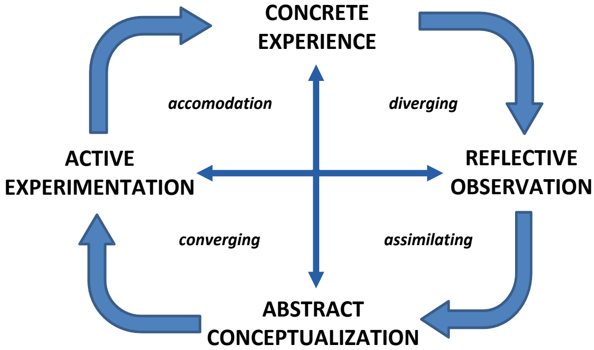


*Fig. 2.* Model of an experiential learning cycle [13]

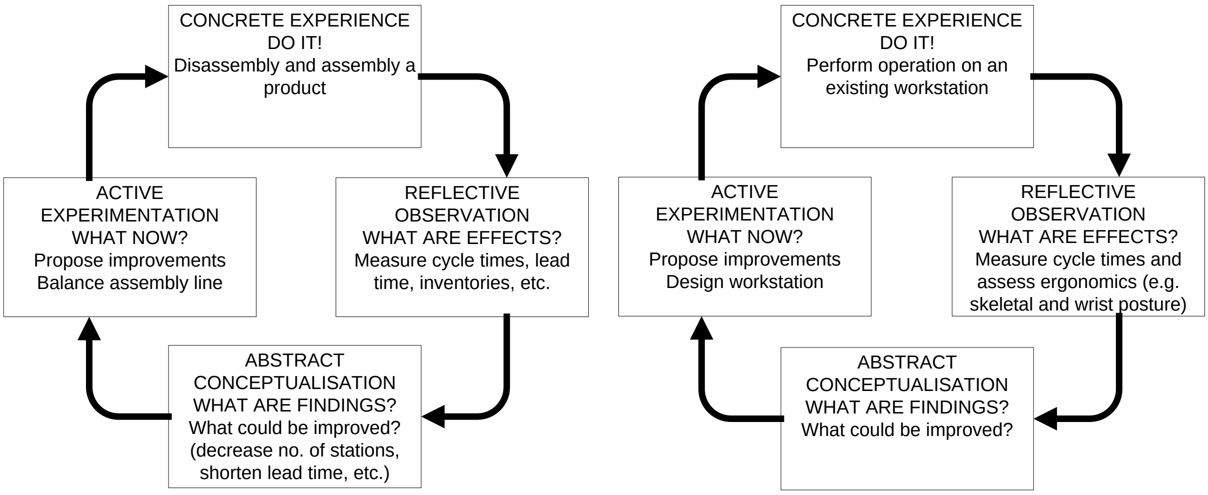


*Fig. 3.* Applications of Kolb’s cycle [15]

Examples of similar multi-university and education-oriented initiatives in the scope of the European Engineering Team are e.g.:

- “POLE – ON track” from FH Nordwestschweiz is an international and interdisciplinary project-oriented study platform that permits the development of projects in cooperation with industry partners [16].
- “Global Engineering Teams” managed by Global Education Team UG is an international and interdisciplinary project-oriented study course specifically for engineers [17]. Students from universities in different countries such as the USA, South Africa, and Brazil form one Global Engineering Team. The international and interdisciplinary group of students work throughout the course on a project provided by an industrial partner.

In conclusion, the EET is a unique transnational course based on experimental learning and teaching in Europe, which expands sustainable engineering to competitive technological innovations for empowering a global sustainable development.

## 2 CONCEPT AND INTEGRATION OF THE MASTER COURSE

This section outlines the main aspects of the concept as well as of the integration of the master course on the university-level.

The master course aims at increasing the teaching and learning productivity in higher education of engineers by establishing an interdisciplinary and intercultural team of students and supervisors from different European universities. Thereby, each university brings in three to four master students, one professor as a supervisor, and one PhD, Postdoc, or assistant professor as assistant supervisor to the course. The students of this European Engineering Team jointly work on a sustainable technology-based innovation. This innovation is put into practice by developing an entrepreneurial start-up within the last phase of the project work. The project work itself is supported by eLearning lectures addressing different topics on sustainable engineering. The course includes four physical presence phases of five days at each partner university for increasing the individual and mobility competencies of the students as well as virtual learning phases providing the required methodological and professional competencies relevant to sustainable engineering. In this sense, the concept of the course follows the idea of action- in combination with blended-learning. The training and teaching activities related to the master course combine theoretical knowledge, practical application and international as well as intercultural experience. Additionally, they aim to anchor sustainable thinking more deeply into the working method of the students since sustainability topics and aspects are the focus of the theoretical knowledge transfer as well as of the project work.

The integration of the master course on university-level contains five essential phases:

(1) The first phase aims to incorporate the master course “European Engineering Team” into the local curriculum of each partner university. This includes the design of an university-specific module description for the course, the definition of an individual credit point structure, as well as the determination of a grading system. The overall schedule of the master course is presented in *Fig. 4*.

(2) The second phase addresses the acquisition and selection of master students at each university. For acquiring appropriate master students, the local supervisors and their assistants give short talks about the concept of the EET in different engineering classes at their respective university. Consequently, the best students who have

already been working as student researchers for the involved university chairs or who have already performed outstandingly during their bachelor thesis are offered the opportunity to participate in the EET. Should the response exceed the capacity for available places, the students will be chosen according to their competencies. For this purpose, interviews are held to determine the most appropriate student candidates. Additionally, the target is to achieve an equitable gender distribution.

(3) The third phase comprises the actual project work of the master students. The supervisors propose broad thematic topics in the area of Sustainable Engineering, such as waste reduction or sustainable factories of the future, to the students during the project kick-off-meeting. Based on these thematic topics, the students develop their own specific task by using Systems Engineering and Design Thinking methodologies. This task must address a technological innovation for coping with the overall sustainability challenge. Once a problem/solution is agreed, the students then split into several work packages with specific sub-tasks and related durations. Each work package is led by one supervisor or assistant supervisor. The students are assigned to the work packages according to their individual preferences and competencies. Since a work package should cover the partner universities' entire competencies as well as increase their intercultural exchange, a student from each university will form an interdisciplinary group within the EET and work together on a specific work package. A student can thereby contribute to more than one work package. The assignment procedure also ensures that the individual workload of all students of the EET will be similar. The students of each group then determine their group coordinator from within their own ranks. The project coordinator is the main contact person for the supervisors/ assistant supervisors and leads the work of the interdisciplinary group. The cooperation of the students is accomplished by virtual meetings as well as by physical presence phases at each partner university. Additionally, a web-based cooperation infrastructure (Section 3) is used for ensuring the effective and efficient cooperation of students and supervisors.

(4) The fourth phase is run in parallel to the previous three phases and covers the design and implementation of the eLearning contents. These contents provide the relevant competencies for the students' project work and cover eight thematic topics. Each partner university brings in their individual knowledge, experiences and use cases for the development of these topics. For each topic, two lectures are created covering 60 minutes each. Further, an additional-topic specific exercise is created in the form of a web-based training consisting of two blocks. The first block contains different tasks considering fundamental knowledge about the contents of the connected topic in order to develop a deeper understanding of the context and methods introduced within the lectures. The second block is based on tasks involving the application of specific knowledge mediated by the connected lectures to new and unknown circumstances by e.g. developing more complex solutions for specific practically-oriented use cases. After the lectures have been developed by the partner universities, they are provided to the student via a web-based platform (Section 3). The additional topic-specific exercises are run as a follow up to each lecture. The first two lectures are embedded into the web-based platform with the start of the project of the EET. The subsequent topics are uploaded to the platform in a four-week interval. The students thus have two week of lectures addressing each topic and two weeks as a follow up for solving the related exercise consisting of the two blocks.

(5) The fifth phase aims at performing a course assessment as well as at deriving improvement measurers for future repetitions of the master course. The supervisors and assistant supervisors create individual reviews of the course by taking into account quantitative indicators, e.g. quantity of students' applications or dropout rate,

and qualitative indicators, e.g. cooperation and communication between the stakeholders or efficiency and effectiveness of the course. Moreover, each participating student can anonymously give “bottom-up” feedback using the questionnaire provided via the web-based platform about her/his experiences during the project work and s/he can also propose improvement measures for the next EET. After completing the project work, all supervisors and assistant supervisors carry out an assessment and performance workshop. This workshop covers the formulation of an improvement concept for the next EET. In order to develop this concept, the Delphi Method is applied to the workshop. In this context, the workshop moderator provides an anonymous summary of the student and supervisor reviews as starting point for the Delphi Method. The outcomes of the workshop are concrete improvement measures agreed on by the supervisors, which are subsequently applied to the next run of the EET.

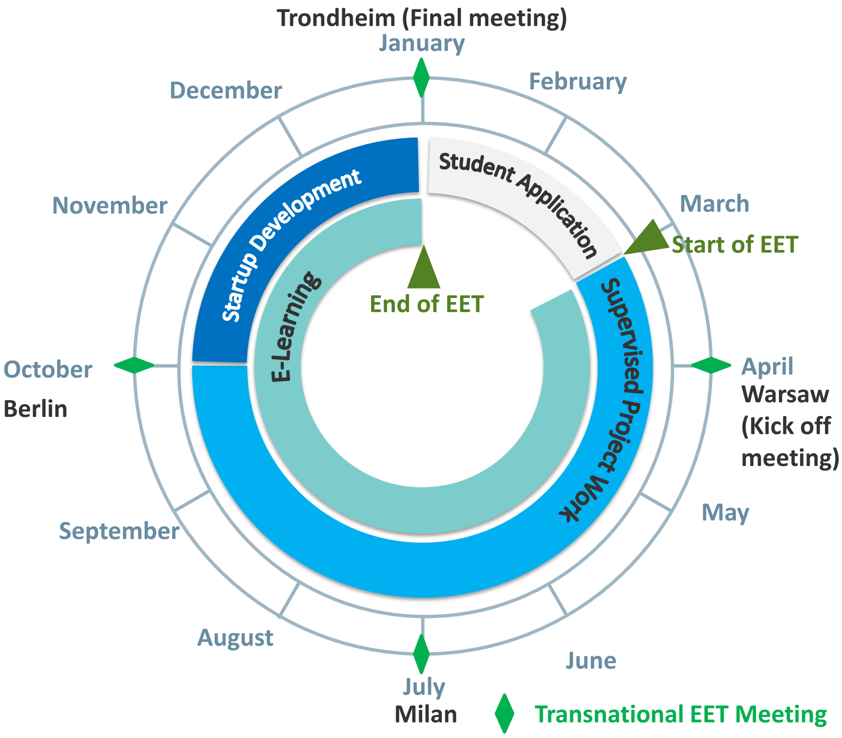


*Fig. 4.* Schedule of the European Engineering Team

## 3 WEB-BASED COOPERATION INFRASTRUCTURE

This section gives an overview of the web-based cooperation infrastructure. It is a tool for supporting the transnational project work of the students and their supervisors by providing an online cooperation infrastructure. The cooperation infrastructure can be divided into (1) an infrastructure related to strategic planning tasks on a higher aggregation level as well as (2) an infrastructure related to operative planning tasks on a lower aggregation level.

(1) The infrastructure related to strategic planning tasks is designed as a web-based platform. It is the central cooperation tool for managing the master course with its overall project work and eLearning contents. It must be used by all students and supervisors. The web-based platform has been built using the free and open-source content management system WordPress [18] as well as using three main open-source WordPress plugins: BuddyPress [19], LearnPress [20], and BuddyDrive [21]. BuddyPress is used for building a simple social network. LearnPress provides the possibilities to provide eLearning contents such as screen casts or exercises.

BuddyDrive is being applied to the platform for realizing a cloud storage for documents and other digital files. In conclusion, the platform offers the functionality of a social network specifically adjusted for joint project work and offers the possibility for providing eLearning contents as well as for sharing project files and documents. *Table 1* provides an overview of the main functionalities of the web-based platform.

*Table 1.* Overview of the main functionalities of the web-based platform

| **Functionality** | **Description** |
|---|---|
| Activity Stream | The activity stream is part of the start page after logging into the platform. It continuously displays the most recent user activities on the platform, comparable to the timeline on Facebook. Users can also post their own information, visible to the whole project team, using this stream. |
| News | The news section contains the most important news for the students, e.g. travel information for the next meetings. News can only be posted by the platform administrators, who in this case are the supervisors. |
| Groups with discussion forums | Groups are related to specific project activities such as meetings or work packages of the project. For these project activities, the exchange of information as well as the distribution of tasks or certain progress can be shared and discussed in these groups by the students and supervisors. |
| eLearning | The eLearning section offers access to the eLearning contents. This includes the lectures as well as the related exercises and supplementary materials such as literature. The supervisors manage access by opening and closing subscription periods. |
| User Profiles | Each student and supervisor can create their own user profile. Using profiles, each activity on the platform can be clearly referred to a person. Moreover, users can post information on other user profiles. |
| Cloud Storage | Documents and files can be uploaded to the platform and shared on their own user profile and within groups. This functionality is realized by the cloud storage on the platform. |

*Fig. 5* exemplarily shows a screenshot of the frontend of the web-based platform with explanations of the relevant functionalities.

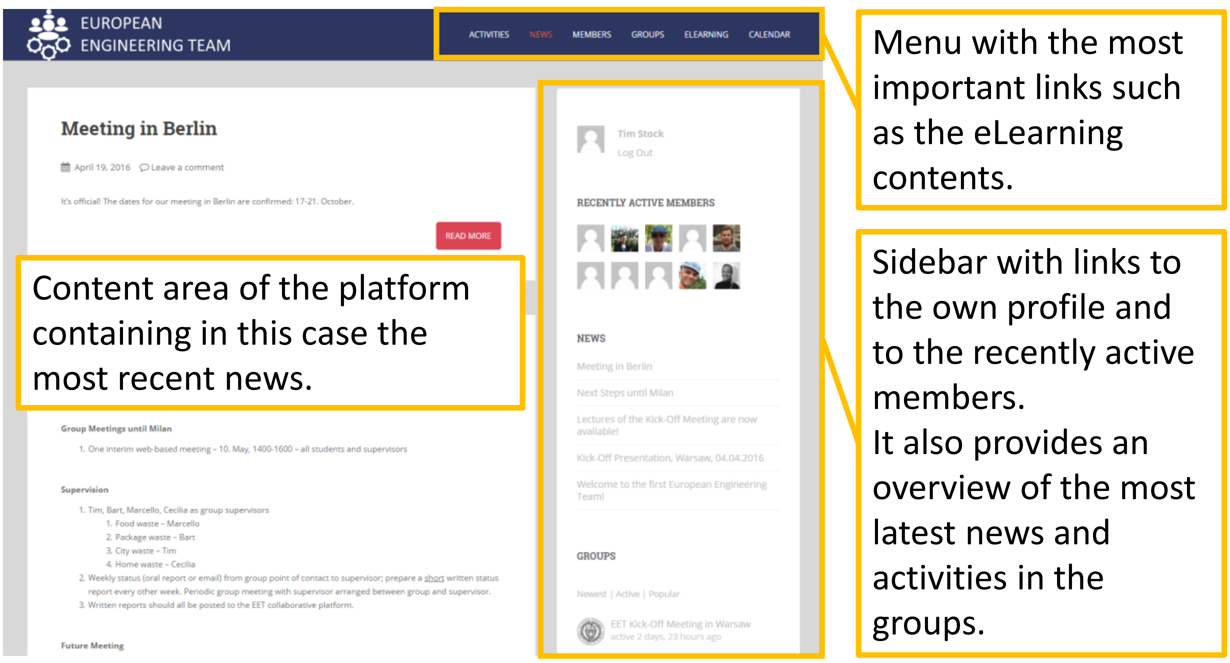


*Fig. 5.* Screenshot of the web-based platform

(2) The infrastructure related to operative planning tasks is organized in a decentralized manner. This means that the students themselves chose within their group, the relevant web-based tools for organizing their work. Three different types of tools have been considered as relevant in this connection. The first one is a tool that enables virtual team meetings such as Skype [22] or Google Hangouts [23]. The second toolset is used for continuously exchanging work-relevant messages and files between the virtual meetings. Therefore, messenger tools such as Slack [24] have been utilized by the students. Thirdly, a tool for continuously planning the operative work, e.g. Trello [25], is applied and managed by the group coordinator. The operative planning tools are, in contrast to the web-based platform, of a proprietary nature.

## 4 FIRST RESULTS OF THE IMPLEMENTATION PROCESS

One of the auxiliary objectives of the course is to develop engineers capable of higher-level decision-making capabilities. As practicing engineers, they will need to deal with problems that are not well-defined, may have multiple solutions and are complex in nature [26]. The student activities began with understanding the problem, evaluating alternatives, then building, testing, documenting the solution for eventual sale in a to-be defined market. During the introductory section of the first physical transnational EET meeting (*Fig. 4*), students received a brief overview in systems engineering [27] and startup development [28]. These methods each provide frameworks within which the students could structure their collaboration. Systems thinking is generally acknowledged as essential for tackling the type of wicked problems normally associated with sustainability by helping to cope with the 'uncertainty, complexity, and value conflicts' associated with such problems [29]. Others make a strong case for including entrepreneurial considerations as early as possible in design decisions [30].

Students share a common attribute in that they all were recruited from programs in mechanical engineering. However, the similarities stop there as each university offers different curriculum and options for specialization. For example, within the group there were varying levels of appreciation for the concept of sustainable development and the importance of considering each of the three pillars equally: environment, economy and society. The students also varied in the amount of prior project teamwork they had, and their familiarity with the theory and practices of working in teams. Tuckman [31] describes the developmental stages of small groups, which he summarized as illustrated in *Fig. 6*.

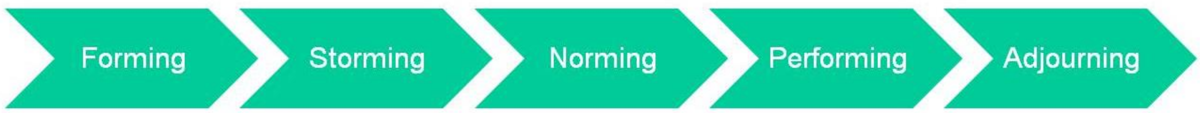


*Fig. 6.*Tuckman 5-stages of teamwork maturity [31]

Warsaw (WUT) accommodated the first transnational EET physical meeting in an ideal setting for brainstorming and team formation activities with a room that contained whiteboards, flipcharts, adequate seating around a large table and floor seating made comfortable by extra-large pillows. In the course of the week, the students availed themselves of all these features. The room also allowed the student advisors to sit out of the way but in a position to observe the group dynamics and progress. The observations throughout the week were captured and are summarized in *Table 2*.

*Table 2.* Observations of student activities and maturity phases

| Tuckman | Day | Nr. | Observation |
|---|---|---|---|
| Forming | 1 | 1 | Opening presentations from coordinator and supervisors |
| Storming | | 2 | After lunch, discussion of the alternative 'solutions' which did not satisfy the sustainability criterion; changed the conversation to "what is the problem?" which resulted in a decision to settle on waste management after establishing a context based on the UNSDG [32] |
| | 2 | 1 | Presentation on the innovation diamond |
| Norming | | 2 | Agreed to continue analysis of waste management using the EU waste hierarchy [33]); create a matrix of solution ideas mapped to the hierarchy |
| | | 3 | Do research to better understand the matrix |
| | | 4 | After lunch, reviewed the matrix and voted for 'preferred' problem domain |
| | | 5 | Performed a competency inventory of the group members; agreed on criteria for evaluation of alternative solutions; weighted the criteria |
| | | 6 | Lorenzo proposed that some of the solution candidates could be merged |
| | | 7 | Vote for preferred solution domain – agreed on the top 3 |
| | | 8 | Created research groups based on the top 3 – i.e., smart cities, expiry dates on food, packaging – and look for synergies between the groups |
| | 3 | 1 | Groups shuffled to bring new eyes to the topic areas |
| | | 2 | Groups were encouraged not to converge too early; to use the 3 areas to maintain a multi-dimensional perspective on the Product/Problem. |
| | | 3 | Student presentations by each of the 3 groups; Lorenzo, Marta, Kjersti, Joanne – municipal solid waste; Teo, Paulina, Kata, + - handling food waste; Even, Henry, Matt, Jo – packaging. |
| | | 4 | Feedback from supervisors – look for business drivers and other driving factors that create waste; solve a problem, not a symptom. |
| Norming | 4 | 1 | Effectively worked without any supervisor presence |
| Performing | 5 | 1 | Students had identified one student to serve as a project manager; they then used a democratic process to volunteer/assign group participants |
| | | 2 | These newly defined groups then worked in the morning to prepare their task lists and make detail plans leading to next face-to-face in Milan |
| | | 3 | Before breaking for lunch, created an overall plan leading to end in January |
| | | 4 | Started right after lunch with group presentations; Henry started with a quick review of their process thus far |
| | | | Group 1 – Marta, Felix, Giovanna – Food waste; supervisor Marcello |
| | | | Group 2 – Joanna, Even, Lorenzo – Package waste; supervisor Bart |
| | | | Group 3 – Teo, Alice, Maciek – City waste; supervisor Tim |
| | | | Group 4 – Paulina, Katarzyna, Kjersti – Home waste; supervisor Cecilia |
| | | 5 | Dialogue between supervisors and the whole group |
| | | 6 | Individual meeting of group members and their supervisors |
| | | 7 | Adjourn |

Later review of the overall progress confirmed that the Tuckman framework (*Fig. 6*) provides a good indication of the evolving maturity of the group and forecast a positive outcome as they formed smaller teams for their information gathering before the next face-to-face meeting in Milan. Students followed techniques for nominal consensus building to ensure that they could identify an appropriate set of activities by the end of the first week [34]. These practices will be continued as they move to agree upon which solution(s) are worthy of prototyping and begin to use the innovation diamond to identify potential markets for the solution.

## 5 SUMMARY

In conclusion, the results of this project will provide a novel concept for a project-oriented and inter-university engineering master course supported by eLearning as well as by a specifically developed web-based platform for virtual cooperation. Subsequently, the implementation procedure and first results of the implementation will serve as an initial template for the EET course. This master course aims to prepare students to thrive in and contribute to an increasingly demanding work-life in Europe by promoting key skills required in the EU labour market. Future work will focus on the improvement of the web-based platform, moving towards a freely available open-source solution. In addition, a full validation of the 12 months EET will be conducted for providing a final implementation guideline for the master course for the partners and other interested universities.

## 6 ACKNOWLEDGMENTS

This research was supported by the ERASMUS+ Strategic Partnerships Project “New Culture in Higher Education: Project-Oriented Learning Beyond Borders” funded by the European Union.

## REFERENCES

[1] Reich, R. (1990), Redefining Good Education: Preparing students for tomorrow. In: Bacharach (Ed.), Education Reform: Making sense of it all, Allyn and Bacon, Boston (MA).

[2] European Commission (2010), Communication from the Commission - Europe 2020 - A strategy for smart, sustainable and inclusive growth, Brussels.

[3] Vernon, J. (2000), Engineering education: ending the centre or back to the future, European Journal of Engineering Education, Vol. 25, No. 3, pp. 215-225.

[4] Manufacturing Institute, Deloitte Consulting LLP (2016), Skills Gap in Manufacturing, www.themanufacturinginstitute.org/Research/Skills-Gap -in-Manufacturing/ Skills-Gap-in-Manufacturing.aspx, Viewed May 26 2016.

[5] Deloitte Consulting LLP, Manufacturing Institute (2015), Boiling point? The skills gap in U.S. manufacturing, www.themanufacturinginstitute.org/ ~/media/827DBC76533942679A15EF7067A704CD/2015 _Skills_Gap_Report.pdf, Viewed May 26 2016.

[6] Paci, A.M., Lalle, C., & Chiacchio, M.S. (2013), Education for innovation: trends, collaborations and views, Journal of Intelligent Manufacturing, Vol. 24, No. 3, pp. 487-493.

[7] Ziemian, C.W. & Sharma, M.M. (2007), Adapting Learning Factory Concepts Towards Integrated Manufacturing Education, International Journal of Engineering Education, Vol. 24, No. 1, pp. 199-210.

[8] Jack, H., Mott., R, Raju, V., Conkol, G., Stratton, M., Waldrop, P., Wosczyna-Birch, K., Bates, S. (2011), Curricula 2015; A Four Year Strategic Plan Manufacturing Education, SME Education And Research Community.

[9] Dewey, J, (2009), Education and experience, Simon and Schuster, New York.

[10] Schein, E.H. (1996), Kurt Lewin's change theory in the field and in the classroom: Notes toward a model of managed learning, Systems practice, Vol. 1996, No. 1, pp. 27-47.

[11] Piaget, J. (1964), Development and learning. In: Ripple, R.E. & Rockcastle, V.N. (Eds.), Piaget Rediscovered: A Report on the Conference of Cognitive Studies and Curriculum Development, Cornell University, Ithaca (NY), pp. 7-20

[12] Kolb, D.A. (1984), Experiential learning: experience as the source of learning and development, Prentice Hall, Englewood Cliffs (NJ).

[13] Kolb, A.Y. & Kolb, D.A. (2005), Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education, Academy of Management Learning & Education, Vol. 4, No. 2, pp. 193-212.

[14] Ross, W.D. (Transl.) (2014), Aristotle. Nicomachean ethics: Ancient Greek Classics, Createspace Independent Pub.

[15] Gladysz, B. and Santarek, K. (2014), Experiential learning for production and engineering management studies – a case study, Selected Conf. Proc. IV International Scientific-Technical Conference MANUFACTURING 2014: contemporary problems of manufacturing and production management, Poznan (Poland), pp. 87-95.

[16] Fachhochschule Nordwestschweiz (2016), POLE - ON TRACK (A-WELLE), web.fhnw.ch/technik/projekte/i/ip512/pole/index.html, Viewed May 26 2016.

[17] Global Education Team UG (2016), Global Engineering Teams, www.global-engineering-teams.org/, Viewed May 26 2016.

[18] WordPress Foundation (2016), WordPress, wordpress.com, Viewed May 26 2016.

[19] BuddyPress, BuddyPress (2016), Buddypress.org, Viewed May 26 2016.

[20] LearnPress (2016), LearnPress - WordPress LMS Plugin, wordpress.org/ support/plugin/learnpress, Viewed May 26 2016.

[21] BuddyDrive (2016), BuddyDrive, wordpress.org/support/plugin/ buddydrive, Viewed May 26 2016.

[22] Microsoft Corporation (2016), Skype, skype.com, Viewed May 26 2016.

[23] Google Inc. (2016), Google Hangouts, hangouts.google.com, Viewed May 26 2016.

[24] Slack Technologies (2016), Slack, slack.com, Viewed May 26 2016.

[25] Trello Inc. (2016), Trello, trello.com, Viewed May 26 2016.

[26] Claesson, A. N., & Svanström, M. (2015), Developing systems thinking for sustainable development in engineering education. Proceedings of EESD'15.

[27] International Council on Systems Engineering (2011), Systems engineering handbook: A guide for system life cycle processes and activities. C. Haskins (Ed.), International Council of Systems Engineering.

[28] Stock, T.; Seliger, G. (2016), Methodology for the Development of Hardware Startups. WGP Congress 2016, Paper accepted for publication.

[29] Lönngren, J., & Svanström, M. (2015), Systems thinking for dealing with wicked sustainability problems: beyond functionalist approaches, Proceedings of EESD'15.

[30] Young, A. (2015), Engineering sustainability markets: why T-shaped engineers need communication design, Proceedings of EESD'15.

[31] Tuckman, B. W. (1965), Developmental sequence in small groups, Psychological bulletin, 63(6), p. 384.

[32] UNSDG (2015), The UN Sustainable Development Goals (SDG), www.un.org/sustainabledevelopment/sustainable-development-goals/, Viewed May 26 2016.

[33] Gharfalkar, M., Court, R., Campbell, C., Ali, Z., & Hillier, G. (2015), Analysis of waste hierarchy in the European waste directive 2008/98/EC. Waste Management, 39, pp. 305-313.

[34] Hutchings, H. A., Rapport, F. L., Wright, S., & Doel, M. A. (2013), Obtaining consensus from mixed groups: an adapted nominal group technique. British Journal of Medicine and Medical Research, 3(3), p. 491.