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Dual/Cooperative Education in Higher Education

Hagen Hochrinner[1*], Johannes Haas [1]
[1] University of Applied Sciences FH Joanneum GesmbH/engineering, Graz, Austria
[*] hagen.hochrinner@fh-joanneum.at

Abstract: *Learning cycles in experiential education show a striking similarity to the plan-do-check-act-cycle in corporate problem solving. These similarities from plan-do-check-act-cycle to learning were realized in the development of a dual/cooperative study program "Production Technology and Organization" at University of Applied Sciences FH Joanneum. From the beginning in 2002 the dual/cooperative study program "Production Technology and Organization" had a strong emphasis on integrating small and medium sized enterprises with little or no previous cooperation with higher education.*
Dual education is a good option to educate young engineers for future challenges within a company.
Several of the partner companies had not yet hired a college graduate but agreed to help educate students through dual/cooperative education.
The paper will present strategies and methods which were developed at study program of "Production Technology and Organization" and applied to meet growing requests from partner companies to extend this interaction to a wide range of issues, always concerning improvement and innovation in product development and production processes.
Meanwhile the dual/cooperative study program and the dual students play a central role in the Austrian industry – university relationship at FH JOANNEUM and for other regional universities.
Dual education has opened a completely new and innovative channel to small and medium sized enterprises regarding the promotion of innovation. The presentation shows the experiences in Austria, comparing them with activities at other universities and generating new ideas for further improvement of the role of dual programs as a partner to regional industry in coping with the present economic crisis in nations.

Keywords: *dual education, production technology and organization, university of applied sciences, networking, partnership to industry.*

1. INTRODUCTION

We live in the age of aquarious and have to accept that not only the industrial landscape has changed. It is also the field of education, in our special concern higher education, which has to be reconsidered. The following findings show the experience of 15 years dual studying at the program of "production technology and organization (PTO)" [1].

2. EXPOSITION

FH (=university of applied sciences) degree program "Production Technology and Organization (PTO)":

Study on the job - all in one

"Production Technology and Organization (PTO)" comprises the entire production process of a company. To mirror and represent this process successfully there are a few required criteria for dual degree program which shall be introduced in the following. The dual degree program provides job-focused training and teaches technology, business and social skills to future engineers. The program lasts three years (six semesters) and students finish with the degree of "Bachelor of Science in Engineering (BSc E)", the consecutive cooperative – dual master program "Engineering and Production Management" lasts two years (four semesters) The bachelor program provides the fundamental skill in engineering, logistics, quality assurance and economy and leadership whereas the Master program is more orientated to the needs in "Research and Development" (=R&D) and management.

The choice of the program PTO originates from a need of skilled technicians by the producing industry in the Austrian province of Styria. In this region, industrial production not only has a long history but still makes up for more than 30 % of the GNP. More than 60 % of the production is exported to countries all over the world with Germany being the traditionally most important partner. The emerging countries of the European Union in the east are a hopeful strategic advantage for the future development of the country.

This educational program of PTO started in 2002 and was the first and by now one of six dual educational programs at university level in Austria. The organizational concept for PTO was adapted from the successful model of the "Berufsakademie" (university of dual education) in Stuttgart, Germany [2] and fit into the Austrian landscape of industry and system of tertiary education. Since many of the required criteria for degree programs

are perfectly suited to be met by elements of dual education, PTO receives broad attention among decision makers in Austrian industry and public education authorities.

Students of the FH degree program PTO study alternately – for three months respectively - at the FH JOANNEUM Graz and in a work placement with a partner training company (see fig. 1), where they immediately apply in practice what they learned during the semesters of theory before.

In return for this effort of direct know-how transfer from university to their companies, students are paid an appropriate salary of about 700 € per month (14 times a year, equivalent to a 50 % employment, based on a model contract developed for this program).

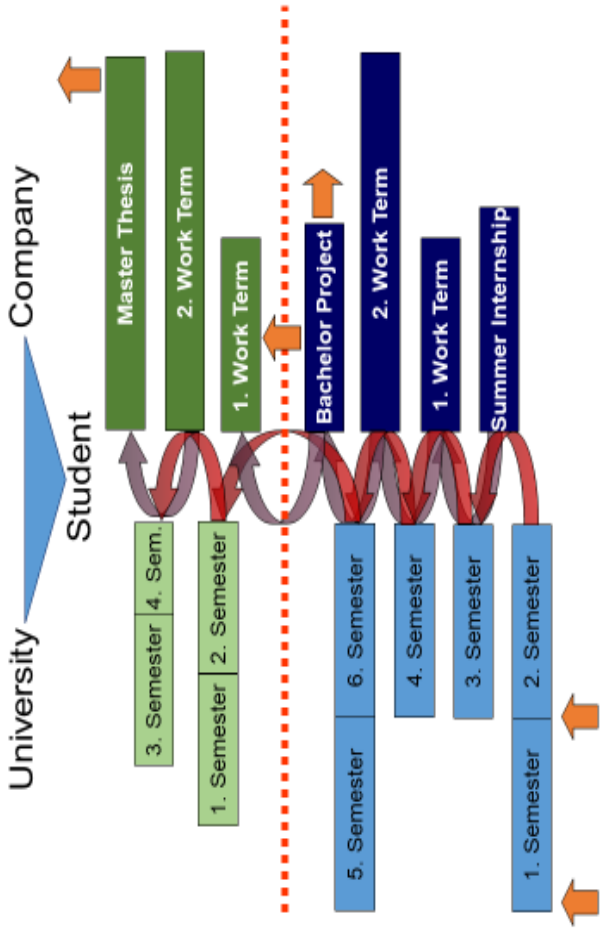

Figure 1. *Structure of the bachelor and master program at the University of Applied Sciences FH Joanneum*

Figure 1. depicts the structure of the dual bachelor and master program at the University of Applied Sciences FH Joanneum. There can be differentiated very well between practical terms in the university and theoretical parts in the company.

In Figure 2. the cycle of Work Integrated Education for the dual program shows the link between working and learning parts. The subjects, which the students learned at the program in the university, they can apply during their work term and after this they have to reflect on it. It is always a rotation between working and learning and the student's reflection. This cycle is according to the ideas of David Kolb [3].

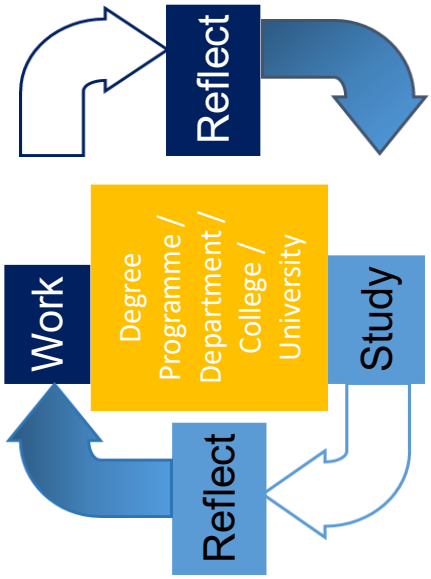

Figure 2. *Simplification of the cycle of Work Integrated Education in the dual program Production Technology and Organization*

New teaching opportunities within a company – platform

Besides theoretical inputs by experts with industrial background and the practical experience from projects with the training companies, much of the learning comes from exchange of experiences among the 35 students of each cohort, being placed in production companies in all branches and sizes, excursions to the participating companies and joint interdisciplinary projects. A big emphasis is given to the development of social and organizational skills by offering coaching, specific training modules and individual and group supervising during all work periods.

The cooperation between companies and university starts with the application process. Companies announce the need for a student for the next term. Interested graduates from high school (most of them with a specific technical focus) have to pass through the official application process of the university (written test, hearing) and after being formally admitted, the FH Joanneum provides the opportunity of a further hearing with at least three companies of their choice in terms of giving contact details about these companies to the students.

By agreeing to a joint effort in teaching future academics in PTO the participating companies enter a network with frequent opportunities to exchange experiences, receive support in designing practical projects or in mentoring the students, in organizing on the job training abroad or, at the end of the three years, in providing a suitable topic for the bachelor thesis.

Companies have learned to value this "extra" input from the university and make more and more use

of it. As there are first successful experiences with a Japanese chain manufacturer KITO one of the next steps in the development of the dual education at the FH Joanneum will be to design a "Corporate College" to further open the doors to other employees of participating companies.

Training companies for the first four courses

By engaging the companies for the practical aspects of the study program it is possible to include companies from a broad range of branches. By moving from university to company and back only every three months, companies can be located within a reasonable driving distance (about 400 km). Both factors play an important role in offering an exciting and multiple environment for dual education.

Industrial sectors include:

- Wood and paper products: e.g. HAAS Fertigbau, the affiliation of a German Manufacturer of prefabricated houses, Mondi Packaging – one of the world's largest producer of pulp and paper, Wall (member of the American MeadWestvaco Group)
- Food processing: e.g. Agrana Fruit – one of Europe's biggest fruit processing companies (a fast growing branch with production facilities mainly in eastern Europe)
- Electronics: e.g. AT&S (electronical parts for mobile phones), TDK (a world leading producer of ceramic sensors)
- Automotive: e.g. BMW Motoren Steyr, AVL List, MAGNA (Steyr, Fueltech, Powertrain and Heavy Stamping – a multinational supplier with headquarters in Aurora, Ontario and Austrian roots), KTM (off-road motorcycles), Robert Bosch (one of the founders of the "Berufsakademie" in Germany)
- Machine building and steel construction: several companies that are worldwide players in niche markets - EVG (mesh welding machines), Siemens VATech (transformers and generators), VAB Sandvik (machinery for hard and soft rock mining)
- Metal working: e.g. Böhler Edelstahl (steel producing and forging), SMEs as suppliers for the large companies
- Logistics: e.g. Knapp Logistics, Schäfer PEEM
- A selection of other companies: ROCHE DIAGNOSTICS (headquarters of near Patient Testing in Graz, main production facility in Indianapolis), Atomic (most successful producer of skis and snowboards), Heineken Group as one of the biggest brewery concerns in Europe.

Existing dual programs in Germany

1974 the first model of dual education in higher education was invented in Germany and therefore two universities of dual education were built in Stuttgart and Mannheim [4]. This invention had big success in the German industry and society. This can also be seen in the amount of participants. At the moment there are around 1,600 dual programs in Germany. About 48,000 companies and 100,000 students are participating this dual system. Moreover, it can be expected that the number of participants in all three departments, university, student and company will increase in future. Germany with its accomplished knowledge is a pioneer in the section of dual programs. Other countries are recognizing this hype about dual education and try to develop dual programs. The need of those programs is getting higher and higher because of the need of well-trained employees in the companies. A dual program is a win-win-win situation. The students get an intense education and are trained on the job, which the company wants to have. Furthermore, the companies can get and stay competitive in the economy. The universities stay in touch with the needs of the industry and get more students and well-trained alumni with an outstanding image.

For a student the enriched experience leads to enhanced engagement in learning. Moreover, professional attitudes, behavioral skills like communication and relationship building can be intensified in a work term. Earning work experience helps students to get a greater understanding of the demands of the workplace and a better understanding of the functional units in an enterprise. The employment outcomes can be improved and the bridge between academia and world of work can be strengthened.

At the university the curricula can permanently adapted and held relevant according the aim to improve the employability of graduates. Furthermore, the contribution to social and economic development are supported.

The companies respectively the employers get fresh ideas and develop a higher level of critical thinking applied to real life problems. Dual programs offer new recruitment opportunities, because of the access to university resources. A corporate social responsibility can be improved.

Dual programs in East-Europe

As a result of moving to foreign countries in the eastern parts of Europe, German companies recognized a need of well-trained employees especially engineers. To supply those needs universities started to cooperate with the companies and other Austrian and German universities with the existing knowledge in this issue. Study program of PTO is in partnership with several universities in the east of Europe like the agricultural and economical university KINEU in Kostanay/Kazakhstan, the Politechnica Pula/ Croatia, the TU Gabrovo as well as the TU Varna in Bulgaria. The TU Gdansk/Poland and the TU Lucian Blaga in Sibiu/Romania are in cooperation through projects with the program of PTO at FH Joanneum to earn the knowledge, how a dual program could be developed and how it could work. The excessive demand of dual programs is existent in Europe and to face those needs especially the countries of east Europe form alliances with Austrian and German pioneers to learn from them.

Expectations of participating companies of dual program alumni and the higher educational institution

The Erasmus+ project aCIRET (=Apprenticeship Cluster for Industry-Ready Engineers of Tomorrow) [4] deals with the development of a dual program in the field of mechatronics in Bulgaria at the TU Gabrovo and in Poland at the TU Gdansk. Below, the focus groups like students, companies and university specified their perspective and wishes about a dual program. Regarding this project, it can be said that the discrepancies between university education and business demands can be traced back to inconsistent ratio between theory and practice. This mostly is caused by a poor communication between industry and university. They dual education is able to bridge this gap. While teaching theory, there were no references to practice provided and the learning content was often not well visualized. University teachers pointed out that university labs were not equipped with state-of-the-art machinery, which prevented students from keeping up with the advanced technologies and equipment used in companies. Overqualified specialists in theoretical subjects are not needed, since there is a problem of skill-experience mismatch in industry. In both countries, in Bulgaria as well as in Poland they need a better balance between theory and practice to achieve a higher skill match and better market tailored graduates.

Companies expect fundamental knowledge of engineering subjects, equipment and machinery components, as well as computer modelling (CAx technologies) from the graduates. They want them to earn programming skills, recognition and proper selection of measuring instruments, assembling and disassembling equipment components. Moreover, soft skills like self-performance, rhetorical, organizational and presentation skills and leadership qualifications form the perfect graduate according to the participants in the survey.

The key areas can be improved by dual programs, e.g. in mechatronics in different ways. The students point of view is working on communication, teamwork, maintenance and repairs, as well as assembling and disassembling equipment components, as well as a clear defined career path, experience in industry and own earned money. The TU Gabrovo in future wants to produce industry-ready engineers, closer cooperation between University and industry and a better image. Direct contact with industry, attractive courses and an outstanding image are the wishes of TU Gdansk. The industries needs are the availability of upskilled engineers to stay competitive and a higher education tailored to their needs.

Distinct features of cooperative and work integrated education

First, it can be said that education is the key priority of the dual program. Curricular tools like faculty qualification, competency orientation, workload calculation, modularization and assessment should be applied. Moreover, companies should redefine theirselves as a learning and teaching environment for student and university. Next step should be to introduce formal entrance requirements and a final degree or rather a possible job description.

For a good cooperation it is important that the partnership between an educational institution and company happens "at eye level". The well-defined tasks and duties for the participating partners promise a good cooperation. Both, company and university, represent a special environment and within this learning environment is created. Furthermore, open information policy and clear allocation of cost elements permit a functional cooperation between different partners.

At least the integration of work terms in a study program is to create a distinctive education "third culture" with both elements of working and studying. There should prevail a constant reflection in action and on doing (not only for the student!) for a growing and functional partnership and also for a constant development. A good integration is made when all experience of students transcended with the quality of work and study.

Current situation R&D in Austria

Referring to the current situation of R&D in Austria three important things can be said. First, it can be said that the contribution from companies is declining continuously for several years. This also seems to be for programs of the EU. Furthermore, research organizations and universities fail to connect to small and medium-sized enterprises (=SMEs). The Research & Development is more and more concentrated to international corporations. The SME structure, as well as innovative products and processes are vital to sustaining production in Austria. Therefore, a well-balanced partnership between industry and university is very important to strengthen the connection between those partners.

3. CONCLUSION

The dual system in higher education has opened a completely new and innovative channel to SMEs regarding the promotion of innovation.
The survey shows the experiences in Austria, comparing them with upcoming activities at other universities and countries. They are generating new ideas for further improvement of the role of dual programs as a partner to regional industry and a missing link between universities and industries in coping with the present economic crisis in nations. Other universities from Europe learned to know the advantages of dual programs and try to get in touch to industry. Even companies meanwhile understand the benefits of dual education for their business. Different EU projects open new doors for other countries in the eastern Europe like Bulgaria, Poland, Croatia and others. The dual education was undervalued a long period of time, but now everyone is recognizing its benefits and it is starting to get a hype in higher education.

4. REFERENCES

[1] K. David, *Experiential Learning,NJ.*: Prentice Hall: Englewood Cliffs, 1984.

[2] "FH Joanneum"©1995-2018. FHJOANNEUM, GmbH, Available: https://www.fh-joanneum.at/produktionstechnik/bachelor/imstudium/studienabschluss/, [Accessed 03 04 2018].

[3] D.H.B.-W.Stuttgart. "Duale Hochschule Baden-Württemberg/Stuttgart,"[Online]. Available: https://www.dhbw-stuttgart.de/home/, [Accessed 03 04 2018].

[4] Technical University of Gabrovo, BG, "aCIRET,"2017. [Online]. Available: http://www.aciret.eu/index.php/en/partners/full-partners, [Accessed 03 04 2018].