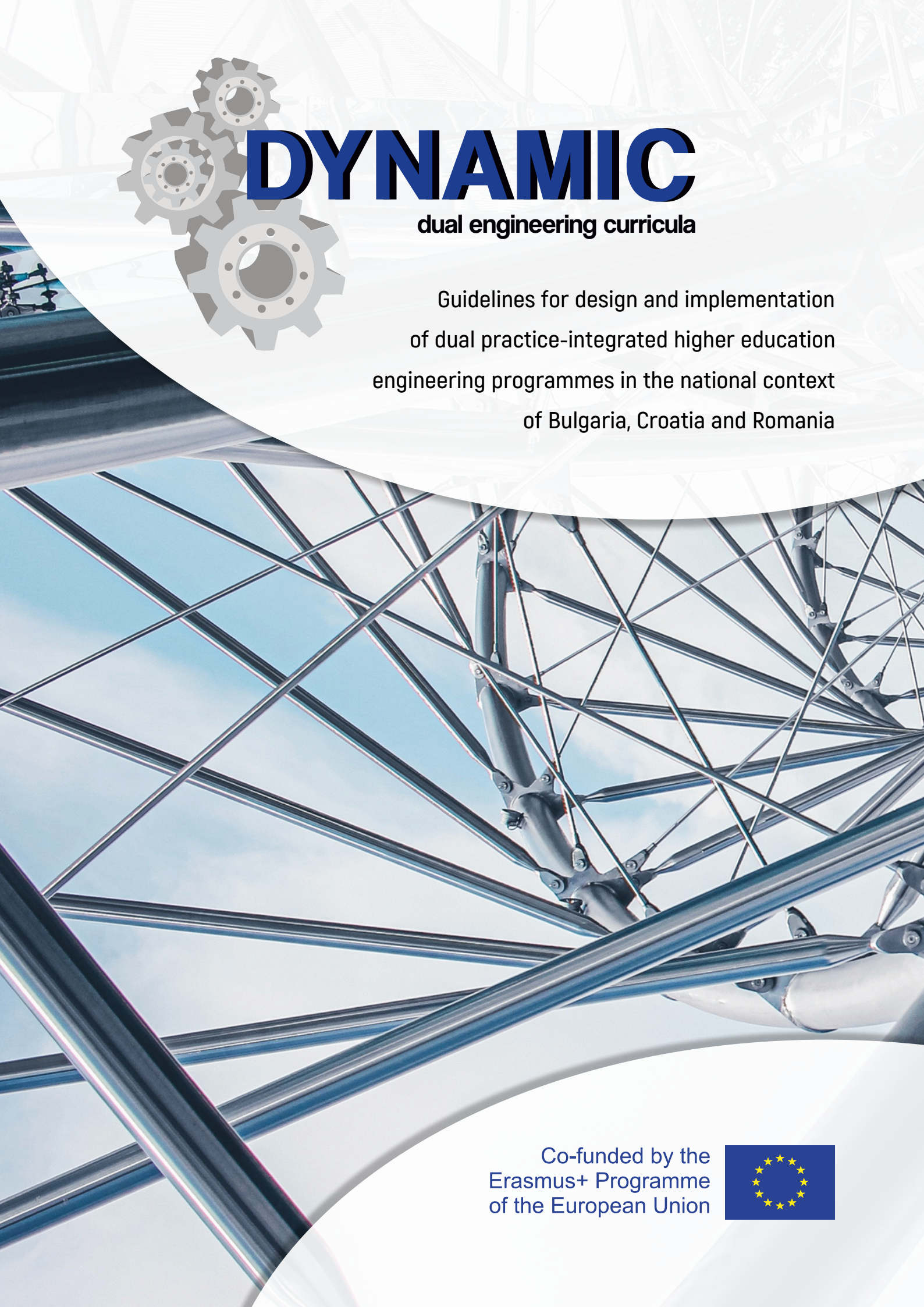
DYNAMIC

dual engineering curricula

Guidelines for design and implementation of dual practice-integrated higher education engineering programmes in the national context of Bulgaria, Croatia and Romania



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GUIDELINES

DYNAMIC

DUAL ENGINEERING CURRICULA

Towards responsive engineering curricula through europeanisation of dual higher education

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PREFACE

In the context of a rapidly evolving world, university graduates need the appropriate competences to manage the changes, complexities and uncertainty of the modern world of work. Requirements of employment and the workplace reflect advancements in knowledge and innovation being adopted by companies and the economy. Designing sustainable and practical solutions to equip students with employability and entrepreneurial skills requires a dialogue between academia and business. Finding space in the academic curricula to embed topics with relevance to the global labour market challenges can be addressed by mutually beneficial cooperation between these two stakeholder groups. The direct involvement of industry stakeholders in the curriculum design and delivery is seen as an opportunity to keep certain study programmes closely relevant to the needs of the labour market. This objective is best materialised by the dual system of education. The integration of regular practical in-company phases in study programmes makes curricula more flexible and responsive to the current industrial and technological developments. The advantages of the dual system of education are innumerable. They are not specific to engineering studies but are particularly relevant to this field. A few examples include:

For companies:

- training of specialists in accordance with the requirements of the company
- direct influence over the formation of the required skills
- better HR planning and securing permanent recruitment
- close relation with students at a very early stage and the opportunity to identify the best students
- faster integration of employees with reduced costs for adaptation of the recruited graduates to the requirements of their own business
- more formal/better transfer of knowledge and experience from leading employees to young colleagues
- involvement in the education process and approach to cooperate with universities in fostering employer branding
- build a sustainable and reliable relationship with the academic sector – improve cooperation with universities and facilitate access to research findings

For students:

- acquisition of practical training and industry-related skills at an early stage
- better understanding of underlying theoretical notions and higher potential to achieve better academic results
- possibility for early specialisation in a professional field
- access to knowledge shared directly from professionals
- source of first personal income
- increased motivation through an engaging learning experience
- award of a state-recognised job-related document (after passing exams)
- deeper confidence stemming from being able to say "I can do it" and not "I know it"

For academics:

- more flexible modernisation and curriculum updates of ongoing academic programmes
- ensure that taught content and teaching methods reflect the state-of-art in the concerned professional field
- improved understanding of theoretical notions for students by practical application
- increased relevance of engineering curricula through tight cooperation with the industry
- increased attractiveness of offered academic programmes and increased number of students
- improved employment rate of graduates and therefore reaching better national ranking rates
- build a sustainable and reliable relationship with the industrial sector

For the state and society:

- specific measure for addressing youth unemployment
- reduction of emigration among young people
- increased labour discipline (payment of taxes and social security) and motivation for professional development
- attracting investments and improving regional innovation power due to the availability of skilled and well-qualified young professionals

This methodological document aims to highlight the successful engagement experience between universities and industrial companies in three EU Member States: Bulgaria, Romania and Croatia. Within the project DYNAMIC, academic and industrial experts came together to jointly design and implement practice-integrated dual higher education models that are feasible for the country-specific conditions and regional needs. We would like to share with you the lessons we have learnt from the past 3 years of international cooperation (2017-2020), based on the evaluated data from the three country-specific implementations. This document serves the purpose to evidence the benefits of dual higher education for the flexibilization and modernisation of engineering curricula. It demonstrates a functional methodology for the modification of existing academic programmes and their realignment with current industry needs. Finally, the document aims to highlight the good practices with a high degree of transferability to other institutions, partnerships, thematic areas or curricular settings and promote the upscaling of dual higher education across Europe.

The project DYNAMIC team

CONTENT

Introduction

Advanced technologies are changing manufacturing industries and transforming traditional business models and supply chains into dynamic and interconnected systems. There is an urgent need to create a flexible, adaptable and active learning workforce. Education providers are challenged to regularly update engineering curricula in order to respond to the rapidly changing business and technological environment. However, the modernisation of an ongoing curriculum is often obstructed by a lengthy process of design, approval and accreditation phases within a laggard legal framework (university perspective). Furthermore, there is a lack of methodology on how to involve industry stakeholders in the design and delivery of curriculum content and practical in-company training (business perspective). To tackle these problems, the project DYNAMIC has established a knowledge alliance between academic organisations, industrial enterprises and chambers of commerce and industry to ensure a better flow of labour market intelligence and improve innovation capacities of the academic and industrial stakeholders. The alignment of both objectives – recurrent gathering of information on the skills needed by the industry and continuous reflection of these in the learning – can be realised through a practice-integrated dual study education programme that can strengthen the supply-demand feedback loop between business and academia.

The aim of the DYNAMIC project was to develop, implement and evaluate three practice-integrated dual undergraduate engineering programmes in Bulgaria, Romania and Croatia. The study programmes identified for the pilot project reflect the domains of strategic importance for the regions in which the academic and industrial partners are located. Therefore, the following programmes were selected for adaptation in dual form: Mechatronics and Robotics, Naval Architecture and Marine Technology and Mechanical Engineering and Production. Experience was shared from Germany and Austria, with knowledge drawn from two existing programmes: Mechanical Engineering and Production Technology and Organisation. The curriculum development process followed a participatory co-development approach involving the key stakeholders from academia, business, chambers of commerce and industry as well as through consultations with the students concerned. Regional working groups were formed comprising of one university working with two companies and a chamber of commerce and industry for each country of the pilot implementation.

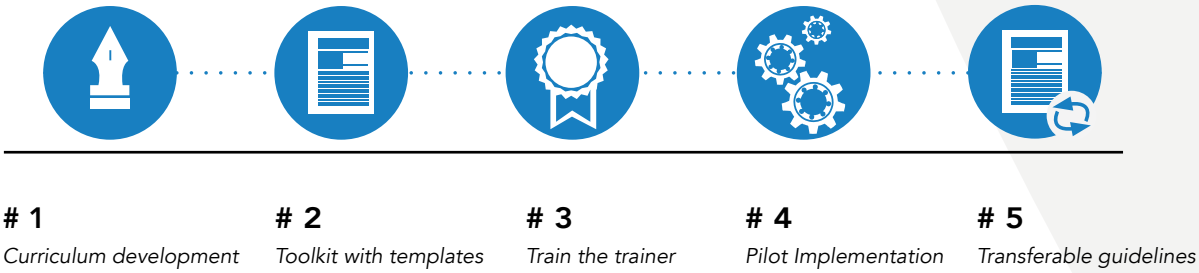
Pilot dual Programms

BULGARIA	ROMANIA
Naval Achitecture and Marine Technology	Mechatronics and Robotics
Marine Engineering	**CROATIA**
Design of Marine Power Plants and Systems	Mechanical Engineering and Production

The activities in the DYNAMIC project were organised around the development, preparation, implementation and evaluation of the dual pilot programmes in the field of engineering. National focus groups of key stakeholders worked on the adaptation of ongoing engineering curricula according to identified industry training needs, development of the syllabuses for

practical in-company training activities and elaboration of a coordinated implementation plan. To ensure the successful implementation of the pilot dual programmes, the project has developed a toolkit for documentation and assessment of the practical training for use by academic supervisors. To strengthen the training capacity and capabilities of the companies involved in dual education, the project also offered training for industrial mentors. The evaluation outcomes of the curriculum adaptation and implementation processes are reflected in the present document "Guidelines for design and implementation of dual practice-integrated higher education engineering programmes in the national context of Bulgaria, Croatia and Romania".

Fig. 1. Structure of project DYNAMIC



The methodological framework of the present document is based on empirical data collection through qualitative methods. During the evaluation process, a content analysis of project documentation and partners' reports has been applied in regular terms. For the data validation and extraction of lessons learnt interviews with individual partners as well as peer reviews with the participation of the main stakeholder groups have been conducted. The evaluation results provide the groundwork for the formulation of the present Guidelines and pay particular attention to elements with high transferability potential in similar institutional and country-specific settings. Therefore, the primary aim of these Guidelines is to support curriculum developers and faculty members in the partner and further higher education institutions involved in the development of practice-orientated education. In the medium term, the Guidelines intend to promote the scalability of the dual higher education model in Bulgaria, Romania and Croatia and contribute to the development of more practice-integrated dual higher education programmes. In addition, the Guidelines aim to support academic staff in supervising positions, HR managers and industrial mentors in companies interested in active talent development and, last but not least, researchers in the field of vocational education and training, professional education, and comparative education systems.

These Guidelines are structured in 11 chapters altogether. The first one presents the dual study model applied in higher education in Germany and Austria, where this model has been in practice for a long time now. Practical examples for dual higher education programmes in Germany and Austria are provided by the DYNAMIC partners – the University of Applied Sciences Wismar and University of Applied Sciences Joanneum. The second chapter investigates the transferability of the model identifying adaptive elements from the German and Austrian systems that are applicable to the national settings of Bulgaria, Romania and Croatia. Chapter 3 describes the context of curricula development by highlighting the common prerequisites resulting from the European cooperation in higher education; it also points out the limitations resulting from the specifics of the national higher education systems. Chapter 4 describes the approaches of curriculum development or curriculum adaptation for dual implementation followed by the partners in each country. Chapter 5 is devoted to the curriculum implementation. Consequently, chapters 6 and 7 are targeted at the academic and industry mentors by providing useful information on further qualification options and lessons shared by the mentors who have gained first experience with dual education within the DYNAMIC project. The next three chapters discuss on the lessons learnt from the implementation of the dual higher education pilot models, the impact expected in the long term as well as the implications for European cooperation in dual higher education. Finally, chapter 11 provides a brief outlook for further cooperation.

1. Dual study model in higher education

The approximation of both streams – on the one hand, the "academisation of the employment system" and on the other hand the "professionalisation of higher education", has led to "dualization" of a number of undergraduate and post-graduate study programmes. (Elsholz 2015; Kurtz 2015). "Dual study" is defined as a hybrid qualification model combining elements from both vocational and higher education systems. A dual study programme is composed of academic elements acquired at the university and professional elements practically acquired at a company. The company-based elements rest and construct on the theory basics from the academic part of education. The direct involvement of industry stakeholders in the curriculum design and delivery is seen as an opportunity to keep certain study programmes closely relevant to the needs of the labour market. The integration of regular practical in-company phases aims to make the curricula more flexible and responsive in order to keep pace with the rapid technological advancement and increasing innovation pressure.

The following chapter defines the dual higher education based on literature reflecting the perspective of the educational systems in Germany and Austria. The theoretical description of each of the described forms is accompanied by a practical example from the University of Applied Sciences Wismar (Germany), and University of Applied Sciences Joanneum (Austria).

1.1 Definition of dual studies

Due to the wide and confusing variety of formats, structures and terminology associated with the dual studies in the past, the Science Council in Germany has conducted a systematisation and in 2013 published the position paper "Recommendations for the Development of Dual Study Programmes". In this paper, the Science Council defines six dimensions of the dual approach. The recommendations of the Science Council distinguish the term "dual study" from the other practice-oriented study formats and formulate a qualitative classification of the existing dual study formats. To define a study programme as dual, at least the minimum requirements for the first three of the following six quality-relevant dimensions must be fulfilled (WR, 2013):

- **Relationship of the locations of learning:** measures in which the learning places are interlinked in content, time and institution
- **Scientific/academic aspect:** scope of academic training and academic requirements of study
- **Design of the practical phases:** duration of the practical phases, intensity of the learning process at the practice partner location, level of content delivered by the practice partner
- **Services of the practice partner:** involvement of the students in the company
- **Support from the university:** offers that go beyond the teaching of technical learning content
- **Costs and financing options**

The Science Council recommends that only study programmes that meet the minimum requirements for duality and academic degree shall be considered as dual. The criterion of duality presupposes a curricular interlinkage and relationship of the learning places. This feature of the dual study corresponds to the content, time and institutional interlinking of the learning venues, in the form of a closed curriculum that explicitly assigns certain learning processes to the respective learning venues and defines learning objectives and learning content (WDP 152, p.21). It is important to coordinate learning content and modules, to incorporate the

practical components into the curriculum and to include them in the ECTS system (WR, 2013). The academic criterion designates at least a science-related training format.

Several practice-oriented study formats that do not meet the recommended criteria for duality, for example, courses of study that only enable unrelated theoretical and practical phases are not referred to as dual by the Science Council. According to this definition, the accompanying study formats, such as studies with study-accompanying internships, should not be considered as dual. Nevertheless, such educational offers are recognized as valuable. Courses in which there are no organizational-institutional or content-related interlinking of the learning venues offer greater freedom and flexibility for the actors as well as a demanding academic study. They are easier to adapt to regional needs and are of great importance for the development of regional skilled workforce (WR, 2013, p.23).

1.2 Dual study models in Germany

Based on the recommendations of the Science Council described in the previous chapter, the following systematisation of the dual study formats in Germany can be presented as follows:

Fig. 2. Forms of dual higher education in Germany

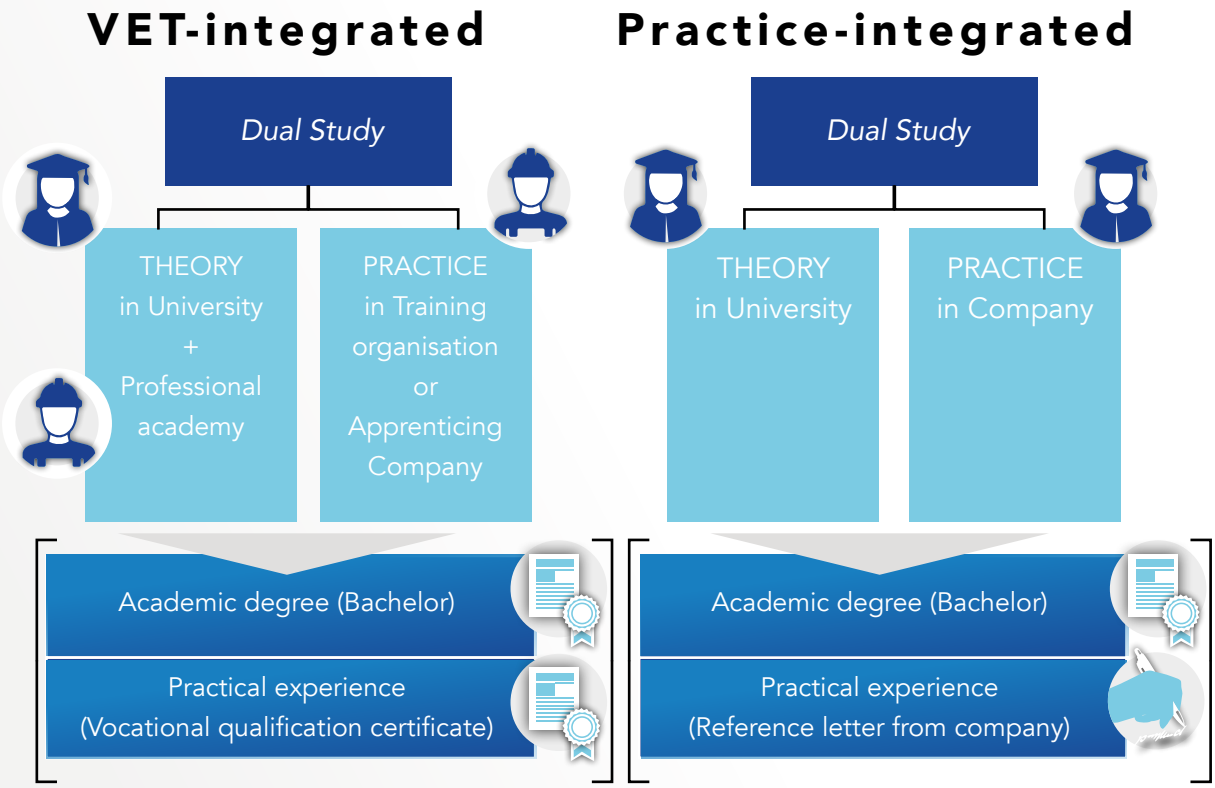
	INDIVIDUAL EDUCATION PATHWAY	STUDY MODELS
Initial education	with vocational training	BACHELOR vocational-training-integrated
	with practice components	BACHELOR practice-integrated
Continuing education	with professional occupation	MASTER/BACHELOR job-integrated
	with practice components	MASTER/BACHELOR practice-integrated

Source: Wissenschaftsrat, 2013 (Typologie der dualen Studienformate), translated from German into English

In general, study programmes at the universities of applied sciences are highly application-oriented and of great practical relevance. Against this background, particularly the universities of applied sciences offer the so-called dual study programmes (duale Studiengänge), which integrate vocational training and work through practical placements in an academic programme. For this purpose, higher education institutions conclude cooperation agreements with companies which provide training or traineeships. The study programmes, which integrate vocational training, link the study courses with in-company training in certain occupational fields. The periods of study and work experience are distributed according to various models and subject to the study regulations (Studienordnung) or module description. Study programmes at the universities of applied sciences, which integrate vocational training, lead to two qualifications for entry into a profession: graduates are awarded the Bachelor's degree, and at the same time, they obtain the vocational training leaving certificate for the occupation in which they have been trained. In study programmes, which integrate practical placements, the students complete more practical assignments, in addition to the practical semesters required in the

regular study programmes. The difference of a vocational-integrated dual study programme compared to a practice-integrated dual study programme is illustrated with the figure below:

Fig. 3. Comparison between VET-integrated and practice-integrated dual higher education



The following section describes, in brief, the vocational-training-integrated and practice-integrated models of dual study programme and presents a practical example for each of these forms provided by the University of Applied Sciences Wismar (Germany). To better highlight the similarities and the differences between the two dual study forms, the same engineering undergraduate programme has been selected as a demonstrating example for each of the two forms.

1.2.1 Dual vocational-training-integrated study

Definition:

For dual higher education programme, integrating vocational training, professional training is systematically applied within the study programme. This study form combines academic studies with vocational training, whereby the student acquires two officially recognised degrees. In addition to the first academic degree (Batchelor's), a state-recognised professional qualification is acquired.

Characteristics:

- Connects academic study with vocational training in a state-recognised professional occupation
- Leads to the acquisition of a university degree and a certificate for acquiring a professional occupation (two independent degrees – an academic and a professional one)

- A structural institutional integration of study and training (organisational, through contact of a university/professional academy and a practice partner)
- Transfer/recognition of parts of the vocational training as academic study achievements
- The required learning content is taught in many cases by the university
- Study content and training are usually interconnected in such a way that after completing the studies, a final examination in the field of the professional occupation at the respective chamber (usually industry and commerce or crafts) can be passed
- A training contract is an admission requirement

(Maschke 2015; Stifterverband für die Deutsche Wissenschaft)

Example from the University of Applied Sciences Wismar, based on the dual vocational-training-integrated Bachelor programme in Mechanical Engineering

The University of Applied Sciences Wismar, currently offers the possibility of completing a dual vocational-training-integrated Bachelor's degree programme in Civil Engineering, Mechanical Engineering, Mechatronics, Information Technology and Electrical Engineering as well as in Business Informatics. All dual vocational-training-integrated programmes are adapted to the quality standards of the Science Council and are independent degree programmes. The course of study is tailored to the premises of the University of Applied Sciences Wismar, and its curricular division in winter and summer semesters. This type of dual study model is exemplarily presented on the dual vocational-training-integrated Bachelor programme in Mechanical Engineering.

The standard period of studying in the dual programme in Mechanical Engineering is nine semesters (four and a half years) and it is completed with 240 ETCS points. The first and second semester (first academic year) are purely practical. The first year of study is focused on the professional and theoretical preparation for the external final examination in front of the respective chamber (Chamber of Industry and Commerce (IHK) or Chamber of Crafts (HWK)). The professional practice is obtained mainly in the partner companies. Learning venues are the Schwerin Training Centre (SAZ), the training company and the University of Applied Sciences Wismar, which cooperate closely with each other.

The curricular interlinkage is accomplished through the acquisition of extra-curricular credits acquired through professional practice in the company, in the first year of study. A recognition of the practice credits in the course of study is followed by a practice transfer report, whose preparation is based on the tasks from the company. The regular Bachelor's degree at the University of Applied Sciences Wismar, begins from the 3rd semester.

In the lecture-free periods, as well as in the practical semester, the vocational training in the company continues. After three years a proficiency exam is taken externally in front of the responsible chamber. After graduation of the VET part, the lecture-free periods are used for engineering internships. Furthermore, follows the preparation of the Bachelor thesis whose topic is provided by the company.

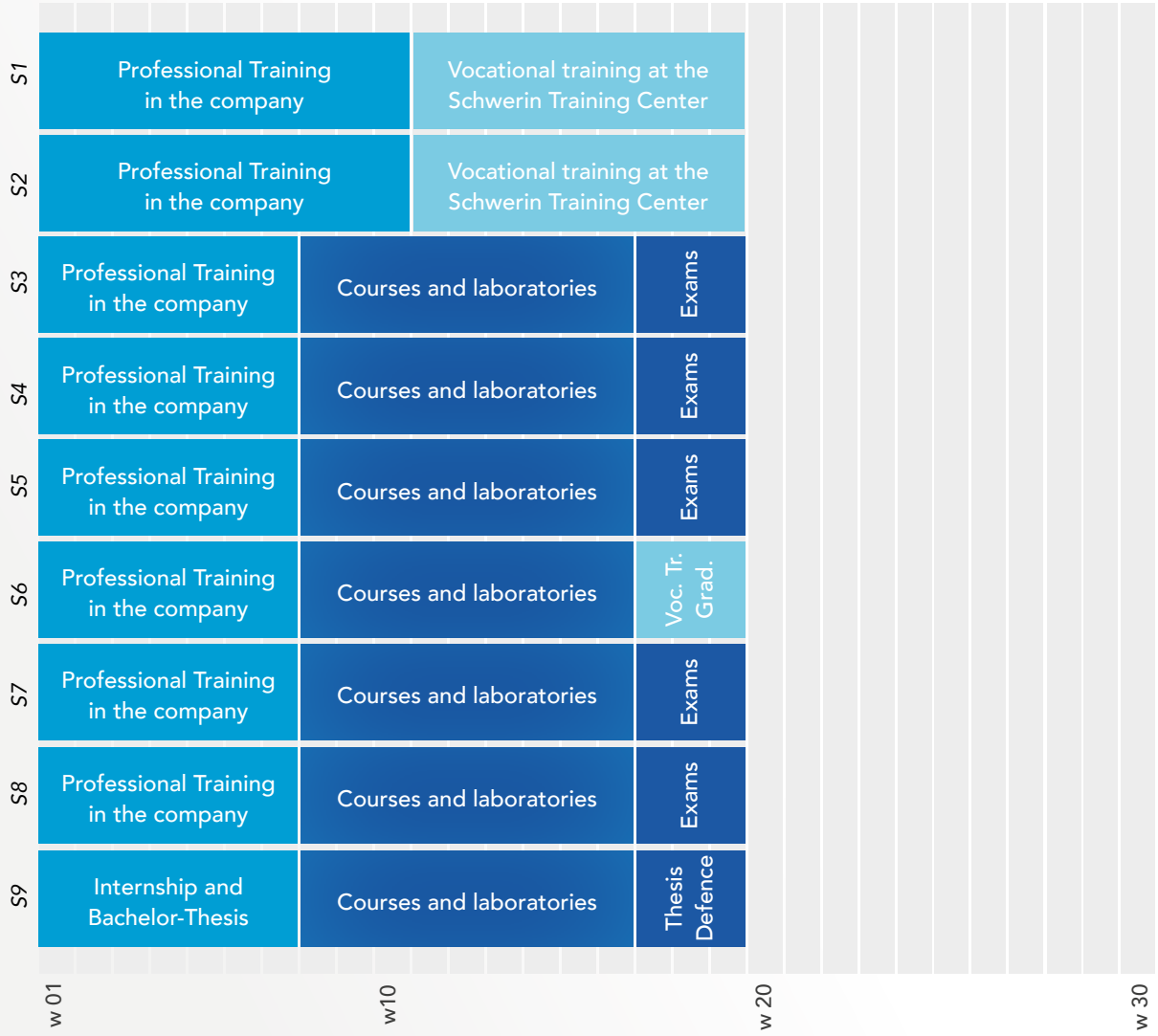
The dual vocational-training-integrated Bachelor's degree in Mechanical Engineering at a glance:

- **Admission requirements**: a university entrance qualification and a training contract over the entire standard period of study with a company entitled to a qualification
- **Standard period of study**: 9 semesters
- **Credits**: 240 credits
- **Degrees awarded:** professional occupation certificate as well as academic Bachelor's degree

Fig. 4. Dual VET-integrated Bachelor in Mechanical Engineering at the University of Applied Sciences Wismar

Case Germany

Dual Bachelor in Mechanical Engineering – VET-integrated



1.2.2 Dual practice-integrated study

Definition:

The practical components are systematically and to a greater extent integrated into the study as compared to the regular degree programmes with a mandatory internship. The practical components are at least structurally and institutionally interlinked with the study (organizational, through a contract between the university and the practice partner). Recognition of the practical components as learning achievements and specific competence acquisition follows (WR, 2013).

The dual practice-integrated degree programme includes studying at a university as well as practical work in a company. In contrast to the dual vocational-training-integrated programme, the students in the practice-integrated dual programme do not acquire a recognised vocational qualification in the respected professional field (Maschke, 2015).

Characteristics:

- Combines the study with longer practice phases in the company, which are supported by coordinated theoretical education phases at the university
- Leads to the acquisition of a university degree only
- Structurally and institutionally interlinked theoretical and practical phases
- Recognition of components of the training in the company as academic achievements
- A work or internship contract is an admission requirement

Example from the University of Applied Sciences Wismar, based on the dual practice-integrated Bachelor's degree in Mechanical Engineering

In order to enhance the career preparation and ensure higher chances on the job market for its students, the University of Applied Sciences Wismar offers dual practice-integrated programme as an alternative study mode option for several of its regular programmes. It combines a regular Bachelor's or Master's degree programme with a study-related practice in a company. In parallel with the academic studies, practical work during the lecture-free periods takes place in close consultation with the contracting company, taking into consideration the study objectives specified in the training agreement. During this time, the study-related and contractually agreed areas have to be undertaken in the contracting company. Elective modules, project work and a Bachelor thesis are components of the curriculum and should be prepared under the academic supervision of professors from the respective department. The students are supported by a mentor/supervisor, both in the company and at the University of Applied Sciences Wismar. A number of assessments are based on case studies from the training company to gain the credits assigned to the practical components.

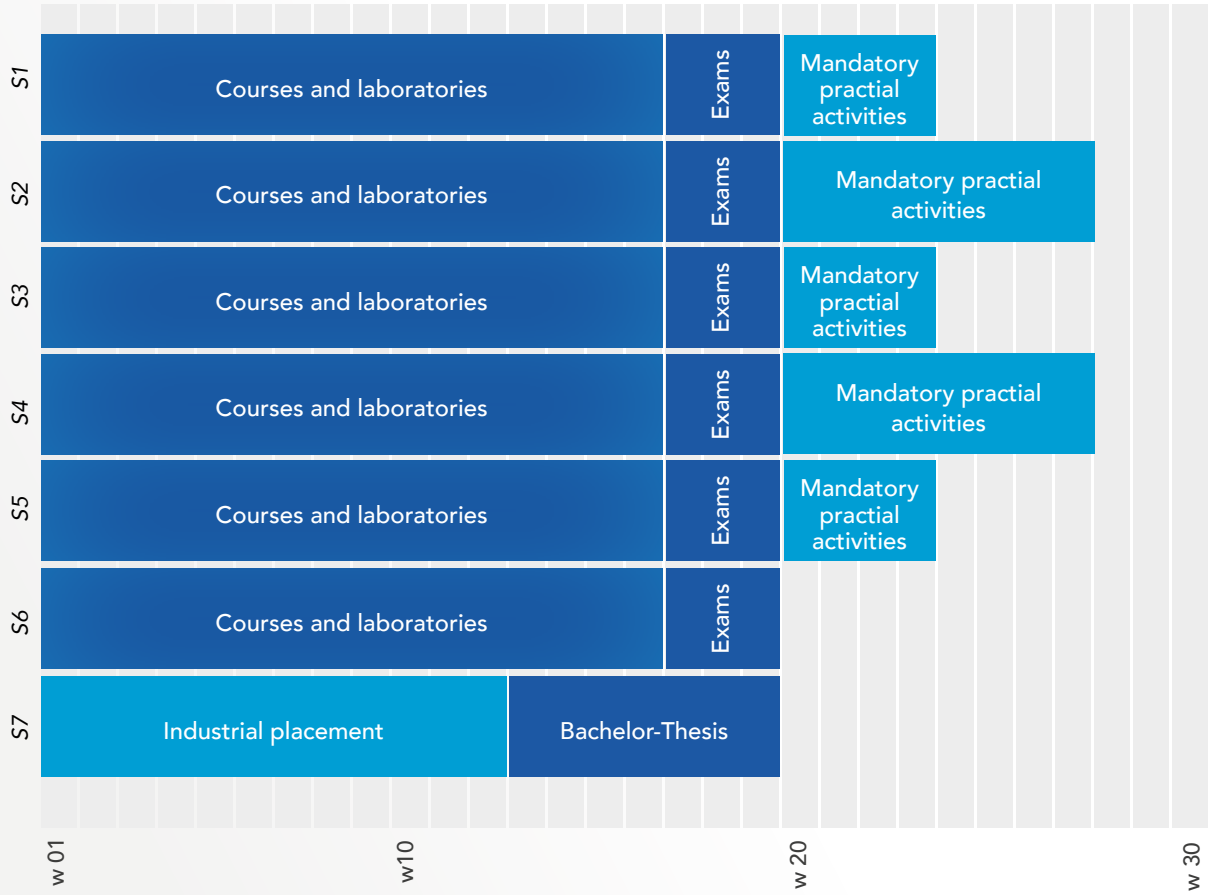
The provision of a dual practice-integrated programme is related to a significant increase in the practice hours. The duration of the practical phases in a dual practice-integrated programme should be at least 50 per cent higher than the practical part of the internships specified in the study-related and examination regulations for the regular programmes. The requirement for starting a dual practice-integrated study is, in addition to the study-related admission requirements, the submission of a contract between the University of Applied Sciences Wismar, the company and the student, considering the university's own quality criteria for the dual study. On this occasion, it shall be considered that the practical elements are included in the programme in such a way that they comply with the competences related to at least one quarter of the credits envisaged in the programme in at least four relevant modules confirmed by the competent examination board.

If the requirements are fulfilled, the dual practice-integrated study mode will be listed in the Diploma Supplement. The content and course of the dual practice-integrated study are governed by the applicable legal provisions of the examination and study regulations of the University of Applied Sciences Wismar for the chosen study programme. The University of Applied Sciences Wismar reserves the right to limit the number of study places. The application in the chosen study programme will be considered in the admission procedure according to the legal regulations. The number of study and training positions offered by the company depends on the particular company conditions.

Fig. 5. Dual practice-integrated Bachelor in Mechanical Engineering at University of Applied Sciences Wismar

Case Germany

Dual Bachelor in Mechanical Engineering – practice-integrated



1.3 Dual study forms in Austria

The dual study model in Austria is analogically established and comparable to the German model described in the previous chapter. In Austria, for example, "dual study" is understood as university studies with integrated practice periods in a company. At the end of the study, the academic degree Bachelor or Master is obtained.

According to the Agency for Quality Assurance and Accreditation Austria based on the University Quality Assurance Act and the Federal Ministry of Education, Science and Research (BMBWF), a study programme has to fulfil the following criteria to be accredited as a "Dual study programme":

- Repeated succession of theoretical and practical phases and continuous reflection
- The practical phases go beyond the usual scope of a professional internship in one university of applied sciences, both in terms of time and specification of the content
- The acquisition of curricular defined competences takes place and is at both learning locations characterised by the combination of science and implementation orientation
- The company must undertake a training obligation and be able to convey the intended course content

- The organisation of the theoretical and practical phases provides the framework for a tolerable total time load for the students
- The admission procedures for universities and companies are responsibility of the respective partners and are coordinated with each other
- The relationship between the three parties – student, university and company, is subject to the binding regulations for quality assurance.
- There is a continuous training partnership with appropriate remuneration for the practical phases as part of an employment relationship, which is ideally continued consistently for at least two-thirds of the study period

The types of higher education programmes, including the dual forms, are described in the table below.

Table 1. Characterisation of study programmes in Austria (EQF 6–7)

	Dual or coop programmeme Work-integrated	Dual or coop programmeme Fulltime	Regular fulltime	Work-enabling part-time	Health Sciences fulltime
EQF Level Bachelor / Master	6/7	6/7	6/7	6/7	6/-
Type of programme HE or HVET	HE	HVET	HE	HVET	HVET
Duration (semesters) Bachelor / Master	6/4	6/4	6/4	6/4	6/4
Balance between education in university and industry	60-70% university, different modules 3 months ½ week	50% university 50% company (4x12 weeks a 40h)	1 internship between 4th and 6th semester	Working fulltime, studying at weekends	Short placements in the hospital
Curriculum-integrated Work-related Work-based Work-integrated	Work-integrated	Work-integrated	Curriculum-integrated	Work-based	Work-integrated
Formal contract	Employment contract (+educational part)	Employment contract (+educational part)	Internship contract	Employment contract	Placement without payment

Source: Hochrinner, 2020

Example from the University of Applied Science FH JOANNEUM based on the dual study programme Production, Technology and Organisation

The programme Production, Technology and Organisation (PTO) was the first dual higher education programme in Austria, established in 2002. It is hosted by the Department of Engineering at the University of Applied Sciences FH Joanneum Ltd., Graz. The programme is developed jointly by representatives of the higher education institution and industry partners. The university has the lead in the development and implementation of the programme, which is also reflected in the ratio between lecturers from the university (60%) and industrial partners (40%) being involved in the educational process.

The model of learning applied is a so-called curriculum-integrated learning which describes the development of integrated lessons helping students make connections across subjects and disciplines. Beside the process of curriculum development and revision, industrial partners are also involved in mentoring the final thesis (co-mentoring together with an academic mentor). The university has the overall responsibility for conducting student assessments. The involvement of the industry partners in student assessments is related to the practical part of education (work at companies) and is not unified. Industry mentors are usually supporting academic staff by issuing recommendations for student assessments, or drafting reports based on a standardised reporting form.

Industry partners have a direct working contract with all dual students in line with the Austrian Labour Law. Usually, students have part-time contracts (50% of the fulltime working contract). The first two semesters are usually carried out only by the universities. Starting from the 3rd semester, the educational process is divided between the university (theory at university) and industry partners (practical training) with a division of approximately 50:50 at Bachelor level. The teaching staff has to have at least 3 years of relevant industry experience and an academic degree amounting to a minimum of 300 ECTS.

The employment rate after graduation is very high, ranging from 90 to 100%, while drop-out rates are between 15 and 30%.

The education is focused on the following subjects:

- Basics of natural sciences
- Operational communication
- Project management
- Materials and strength theory
- Machine elements and construction
- Manufacturing engineering
- Process technology
- Production planning and organization
- Logistics
- Quality management

Fields of occupation

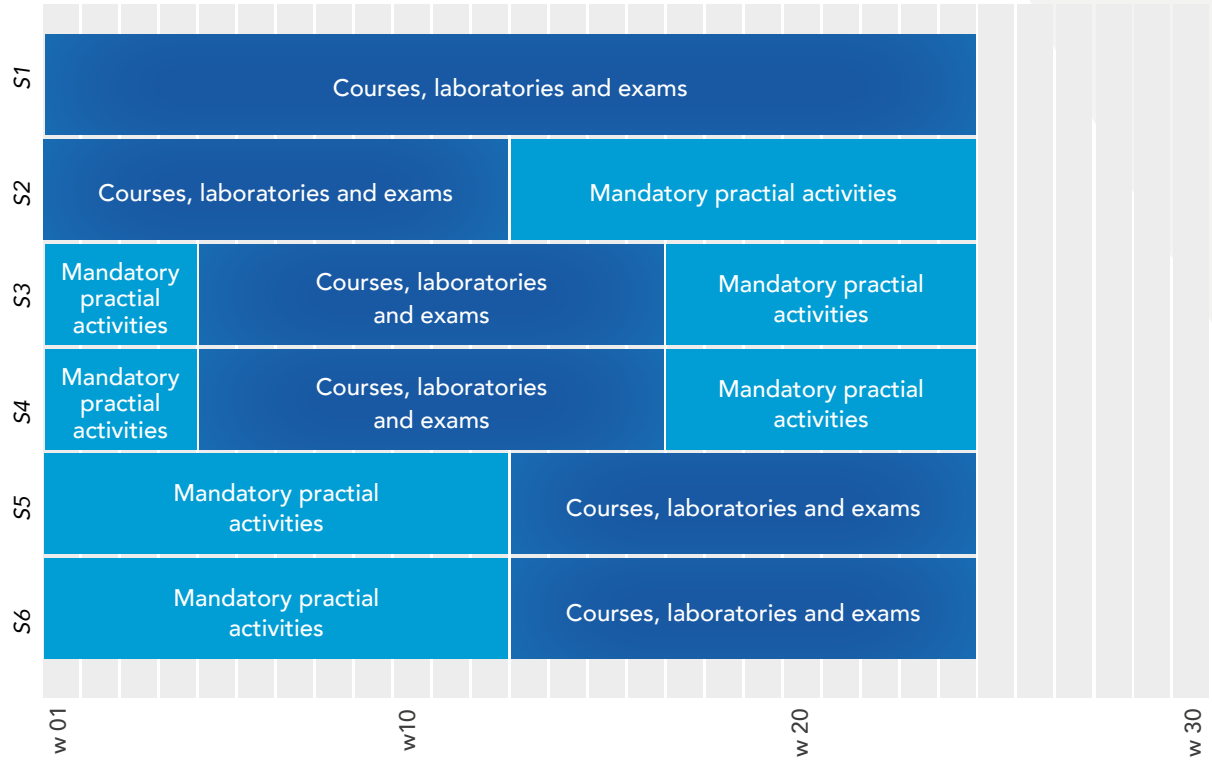
Occupational fields for the alumni (BScE) of the study programme of PTO BSC are:

- Project management
- Production Planning and Control

- Environment and quality management
- Materials management and logistics
- Work preparation
- Plant planning
- Fixture construction

The organisation of the PTO dual programme is illustrated with the figure below.

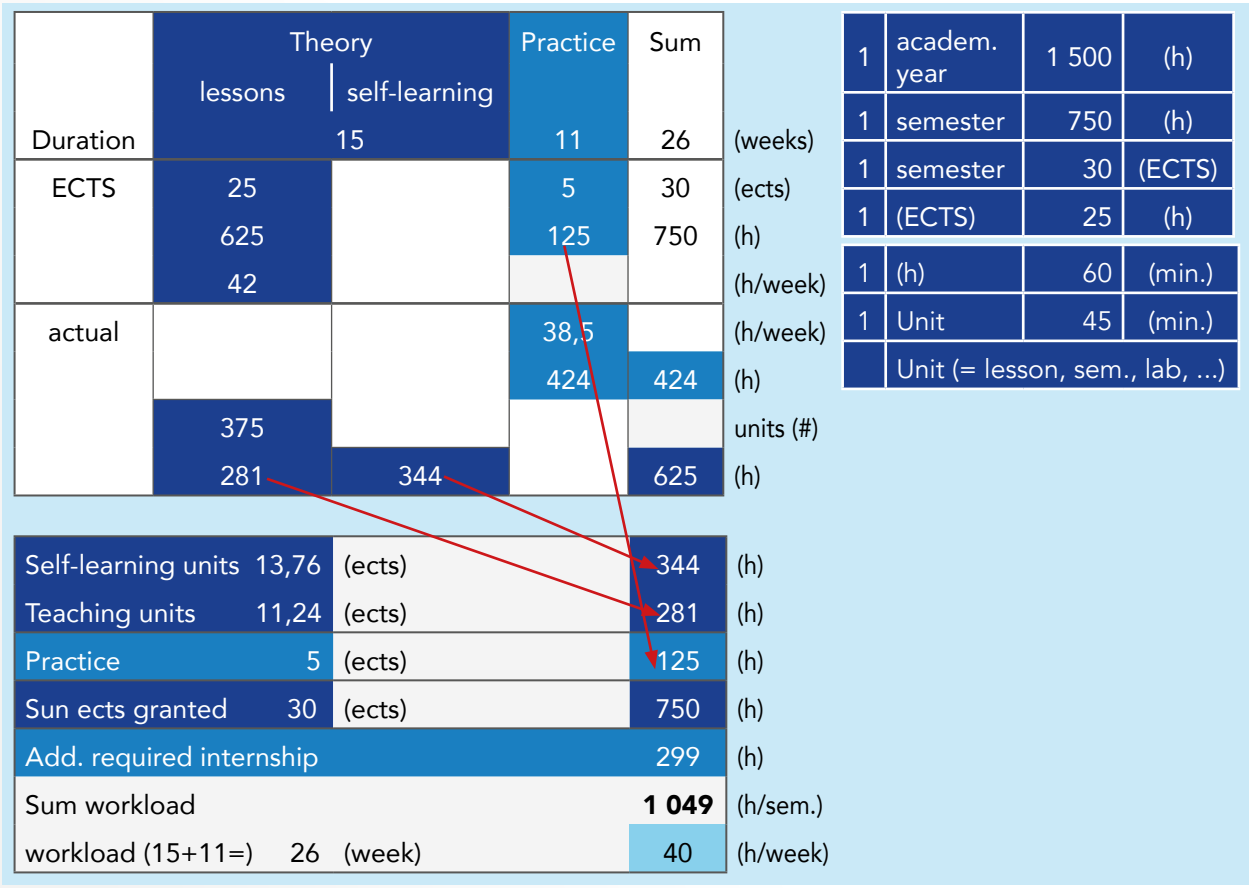
Fig. 6. Dual Bachelor in Production Technology and Organisation in FH Joanneum



Calculation of the workload for the students

The calculation of the student workload is based on an academic year embodied by 1,500 [h] with 60 [min/h]. The curriculum grants 30 ECTS per semester according to 750 [h] workload including 125 [h] (5 ECTS for the practical training in the company). In the PTO study programme, there is an additional requirement of 299 [h] of practical training in the company. So, the calculated weekly workload is on average about 40 [h]. The balance of the weekly workload in the theoretical and the practical term is calculated by means of the scheme given below:

Fig. 7. Scheme of weekly workload calculation



2. Transfer feasibility

The initial step in the development of dual higher education pilot programmes in Bulgaria, Romania and Croatia was to prove the context provided by the existing framework conditions in each country, including the current state of development of the VET sector, the economic prospects and needs, legal provisions for VET and higher education regulations. Also, the possibilities for cooperation with international partners has been explored by conducting a comparative analysis with the dual models applied in Germany and Austria for identifying adaptable elements and proving their transferability in the national settings in Bulgaria, Romania and Croatia. The current chapter describes the methodology and results of the feasibility study and the country analyses.

2.1 Objectives and methodology of the feasibility study

A feasibility study has been conducted within the scope of a preparatory project with the broad participation of partners from the DYNAMIC consortium.[1] The objective of the feasibility study was to identify the potential and experience of the partner countries and to find elements for transfer that can best be harmonized and adapted to the respective goals, structures and cultures. The EUDURE project examined the framework conditions and transfer options of the German dual study principle in Bulgaria, Romania and Croatia. Finally, a specific recommendation for action was issued.

[1] Project EUDURE (01DS15017), funded by the Germany Federal Ministry for Education and Research

The DAAD[2] study transfer factors, which have been identified for the institutionalisation of dual study elements in other countries, serve as a basis for measuring the adaptation potential: "Dual study programme in a global context: internationalisation in Germany and transfer to Brazil, France, Qatar, Mexico and the USA". Within the framework of the EUDURE study, the central questions based on the DAAD study have been asked on this basis:

- What type and quality of binational exchange already exists?
- Does the educational governance structure promote transfer initiatives?
- Is there already an understanding of dual education models in the target countries?
- Are the economic conditions in the target country conducive?
- What is the existing legal framework, country specifics and related university internal rules?
- Are there German companies in the target country that are interested in cooperation?

The study examined the transfer potential of the dual system of study, as known in Germany and Austria, in Bulgaria and Romania with a corresponding preference. A further important condition for the transfer of the dual study model is the fundamental interest of social, economic and political decision-makers in the target country, e.g. through reforms and initiatives to promote dual training models. The results of the feasibility study will be exposed in the paragraphs to follow.

2.2 Summarised results of the feasibility study

All three countries involved in the feasibility study offer undergraduate programmes at the level of the German Bachelor's degree programmes as part of the Bologna Process. Especially at universities, the focus is on practical and job-oriented university degrees. The three countries have comparable quality standards in teaching, a uniform higher education systems with ECTS and a similar semester schedule, divided into winter and summer semesters. Furthermore, the framework conditions (both political and economic) are set up so that a fundamental transfer potential exists. In all three countries, the efforts to upgrade vocational education and training are prominently located with the adaptation of the German dual vocational training system. Extensive networks and cooperation between national and international economic and institutional partners already exist. Many companies with German participation are located in Bulgaria, Croatia and Romania. Based on the evaluation of the factors suggested by the DAAD study on transfer potential, it can be concluded that favourable conditions for the initiation of pilot projects on dual study programmes exit and such pilot projects are necessary to foster the reform readiness and the paradigm change in the education sector.

In Croatia, Bulgaria and Romania, there is a significant shortage of skilled workers that may hinder the forecasted economic upswing. This increases the demand for more practical orientation in highly qualified occupations and higher education. Therefore, the dual degree programme is an attractive model for all three countries, where a strong initiative of the economy is currently restructuring and rebuilding the vocational training structures.

2.3 Current state of dual education in Bulgaria

Since 2014, dual VET has started to evolve in Bulgaria. It allows learners to acquire professional qualifications. The practical training in a company alternates with periods of theoretical training in a school or another VET provider. In-company trainers (mentors) are responsible for the practical training.

[2] DAAD stands for German Academic Exchange Services

The 2015 Law on Pre-school and School Education covers only the upper-secondary dual training and complements the VET Act. It defines work-based learning (dual training system) as a specific form of training in which the professional qualification is acquired through a) practical training in a real working environment and b) training in a vocational school. The work-based learning can be organised by the vocational school based on a partnership between one or more employers. Furthermore, work-based learning is organised for students that have reached 16 years and are in the second stage of upper secondary education. In the Vocational Education and Training Act, work-based learning is defined in the same way. Upon completion, the diploma for the training gives access to tertiary education.

The VET Act (1999) regulates the organisation, management and financing of VET in Bulgaria. A legislation modernisation was initiated in 2014 followed by important amendments in 2015 and 2016. In 2015, dual training, which is a combination of school- and work-based learning based on partnership between VET providers and employers, was introduced. Amendments from 2016 harmonised the VET Act with the Pre-school and School Education Act and introduced additional opportunities for acquiring a vocational qualification in the new secondary education structure (CEDEFOP, 2018).

The introduced legislation changes have attracted the interest of a number of actors from Germany, Austria and Switzerland, where VET is well established and has a long tradition. A non-exhaustive list of the pilot projects and cooperation initiatives in VET include:

- The German-Bulgarian Chamber of Industry and Commerce (AHK Bulgaria) promotes elements of a dual vocational training system. In January 1st 2015, AHK Bulgaria launched the dual vocational training cluster. One of the tasks of the cluster was to advise companies willing to commence dual vocational training and initiate basic pilot training courses until 2018.
- Project DOMINO "Swiss support for the introduction of dual training principles in Bulgarian education 2015-2019".
- Project VET of Advantage Austria in 5 regions of Bulgaria with 6 vocational schools.
- Different VET projects of private companies such as Liebherr-Hausgeräte Marica, Kaolin, Kittner Anlagen- and Maschinenbau etc.
- AHK Bulgaria started a dual educational project with Kaolin in 2016 and a pilot project in the field of VET in cooperation with ABB Bulgaria, branch Rakovski in 2018.

Assessment of the ongoing reform conducted by the Court of Auditors (2016) indicated major challenges such as underfinancing, poor cooperation with the business sector, increasing drop-out rates and lack of a coherent system to assess the quality of VET that need to be resolved. To address these challenges, in 2017, the Ministry of Education and Science approved the 2017-21 concept for the development of VET in Bulgaria. (CEDEFOP, 2019).

Another aspect to consider is the differentiation between general education and VET and the connection to the labour market. A country study of CEDEFOP from 2019 indicated that in some VET programmes (such as economics), up to 90% of learners continue studies in higher education directly after graduating from VET, instead of finding a job. While recent reforms are already dealing with profiling of the secondary general and VET education, higher education institutions consider the introduction of VET components as a means of increasing curriculum relevance and improving graduates' employability. In line with the growing demand for more professionally orientated education and industry-specific skills, the close cooperation between higher education institutions and industry stakeholders becomes inevitable.

In the course of the "DYNAMIC" project, the transferability of the dual education model with adaptable elements from the German higher education system was investigated. The current framework conditions (both political and economic) were investigated, concluding that a fundamental transfer potential exists. In Bulgaria, the efforts to upgrade vocational training are prominently located with the adaptation of the German dual vocational training system

in the implementation stage. Extensive networks and cooperation between national and international economic and institutional partners already exist. The recommendations were used for the development of pilot programmes, implemented in the Technical University of Varna.

2.4 Current state of dual education in Romania

Since 2017/18, a dual form of 'professional' VET has also been available in Romania. Based on the Government Emergency Ordinance No 81/2016 the municipality (local authority) engages in the partnership agreement alongside the standard contract concluded in regular school-based VET programme between school, employer and learner (or legal representative). The students involved in dual VET must be lower secondary programme graduates (usually, 14-15 years old) and under 26 years old. VET is offered at upper secondary education (ISCED 3) and comprises of the following programmes (CEDEFOP, 2019):

- four-year general and VET (vocational and technological) programme (grades 9 to 12) (34) providing access to higher education
- three-year school-based VET programme (nationally referred to as 'professional' programme and may be offered as dual VET)
- short VET programme (720 hours of practical training)

VET programmes exist also at post-secondary level (ISCED 4, postliceu). The CEDEFOP country report on Vocational Education and Training in Romania provided a detailed description of the VET programmes at initial and continuous VET level.

The dual education in Romania is officially stated at EQF 3 level in professional schools (școală profesională în sistem dual). The pupils can choose after the eighth grade to learn an occupation in this type of schools. The dual education at EQF 3 level takes 3 years, with a theoretical part in the school and a practical part in the company. At the end of this period, the graduates get a professional certificate. They can take a job in a company or they can study two more years to finish high school and get their baccalaureate, which allows them to study at a university.

The dual education is regulated in Romania by the Ministry of Education through the National Centre for Vocational Education (Centrul Național de Dezvoltare a Învățământului Profesional și Tehnic). The legal framework is regulated through different emergency decrees added to the National Education Law.

There is another type of in-company learning in Romania, which is called apprenticeship (ucenicie). The participants learn only at work, they are not obliged to follow theoretical courses. At the end of the apprenticeship, they get a certificate. This form of training is regulated by the Ministry of Labour.

VET programmes are based on training standards that describe learning units consisting of learning outcomes and are based on occupational standards. Training standards play a key role in designing VET curricula, assessing learning outcomes and awarding qualification certificates. The practical stages in dual VET are organised entirely in partner companies and all the costs are supported by them.

There are no dual studies at university level. In the university curricula, a minimum of 2-3 weeks of practical phases during the university year can be introduced, beginning with the second year. For the practical phases, the university has to establish a learning and practical plan for the students. The companies to accept students have to be active in the field of studies of the faculty and to have sufficient expertise, equipment and knowledge. The companies should also provide mentors for the students and after the practical phases, they have to write an evaluation for them. There is no legislative indication that the mentors should have a

pedagogical background or studies. Usually, in Romania, there are a lot of students working during their studies, so they already have practical experience in the companies.

The dual VET has been introduced as a response to the growing and diversified labour market requirements and in order to improve the education and training system's response to the economic and social dynamics in Romania.

2.5 Current state of dual education in Croatia

Vocational education and training (VET) is offered at upper secondary level and its provision is regulated by the following acts (CEDEFOP, 2020):

1) Primary and Secondary School Education Act (2008, last amended in 2019)
2) Vocational Education and Training Act (2009, last amended in 2018) defines the acquisition of IVET qualifications, quality assurance, stakeholder cooperation and in-service training for VET teachers
3) Crafts and Trades Act (2013) regulates trade and craft qualifications and responsibilities of stakeholders involved in apprenticeships
4) Adult Education Act (2007, last amended in 2010) regulates adult education including VET

The initial VET programmes comprise of:

- two-year programmes
- three-year programmes for professions in craft and industry
- four-year programmes providing access to higher education
- five-year programme for general care nurses, providing access to higher education

To complete an IVET programme and receive a formal qualification, all learners have to develop and present a final practical assignment (izradba i obrana završnog rada). Assessment is organised and conducted by VET schools. Upon passing it, a learner acquires a secondary school qualification and receives a certificate of completion (svjedodžba o završnome radu) from the VET school.

In 2018/19, the Ministry of Science and Education launched the experimental dual education programme based on the concept described in the model of Croatian dual education (MZO, 2018). The implementation was in cooperation with economic and crafts chambers, associations of employers and with support from partner institutions from Austria, Germany and Switzerland. The piloting was also supported by the Modernisation of VET programme project, realised through Swiss-Croatian cooperation. In 2019/20, dual education was offered experimentally in three-year and four-year programmes leading to EQF level 4 qualifications (three-year programmes for salesman, glazier, chimney sweep and painter-decorator at CROQF level 4.1 and four-year programmes for beautician and hairdresser at CROQF 4.2). In total, 19 VET schools and 469 learners were involved. In the first year of the dual programme, learning takes place in the VET school. In the following years, most work-based learning is undertaken in companies: 161 companies employing 522 people have been involved so far. Companies are required to employ and provide training and continuous professional development to mentors, as well as to ensure quality assurance of work-based learning. Learners sign a contract for work-based learning with companies during the first year and are entitled to monthly remuneration; a bonus might be paid as well. Remunerations are unified per qualification and per year of education and training.

Within the scope of the DYNAMIC project, the legal framework has been analysed. As a result, no legal regulations or provisions for dual higher education could be identified in

Croatia. Thus, the only possibility for introducing dual forms at higher education level is in the current legal framework through:

- The law on Quality Assurance in Science and Higher Education (article 20)
- The rules on the content of the permit and the conditions for issuance of a permit for performing higher education activities, the conduct of a study programme and the reinstatement of higher education institutions
- Conclusion of the National Council for Higher Education (Class: 003-08 / 11-09 / 0006; no. 355-02-01-11-9) from 16th January 2012

As for the time of implementation of the DYNAMIC project, there is no legal framework regulating dual higher education, the Croatian partner institutions explored the realisation of a pilot of the selected study programme. Conclusion of the National Council for Higher Education (Class: 003-08 / 11-09 / 0006; no. 355-02-01-11-9) from 16th January 2012 says: *"Changes up to 20% of the content of the study programme are made by the Academic Council of HEI`s"*. In the adaptation of the selected undergraduate programme for dual implementation, there will be no changes made in the content of the study programme, but only part of the teaching process of selected courses will be held in companies from industrial partners. In a medium to a long term, however, there will be a need for legal adoption and regulations of dual education in higher education institutions.

2.6 Transfer potential for dual higher education models

Dual vocational-training-integrated higher education model

As mentioned in Chapter 1, vocational education and training (VET) is systematically designed within the curriculum and study organisation for dual vocational-training-integrated study programmes. This study form combines academic studies with vocational training, whereby the student acquires two officially recognised degrees. In addition to the first academic degree (Bachelor), a state-recognised vocational qualification in the respected occupation is acquired too. This requires intensive structural and institutional integration of study and training between the three parties involved – university, chamber (or another social partner with similar functions) and practice partner. An additional prerequisite is an already well-established vocational education and training system. The restructuring of vocational education and training is still ongoing in Romania, Croatia and Bulgaria. Due to the still immature vocational education and training systems, a transfer of the dual vocational-training-integrated higher education is considered as not recommendable at the time the feasibility study has been conducted. In addition, an orientation towards the dual vocational-training-integrated higher education programme can be seen as problematic since the universities would then be dependent on still unclear political and economic conditions. Nevertheless, after successful implementation and establishment of the dual vocational education and training system as well as reformed legal and political framework conditions, modified forms could be considered feasible in the future.

Transfer potential for dual practice-integrated higher education model

As described in Chapter 1, in practice-integrated dual programmes, the practical parts are systematically and to a greater extent compared to the regular programmes with compulsory work placements. However, directly compared to the regular programmes, in the practice-integrated dual forms the practical parts are structurally and institutionally interlinked with the studies (organizational, through contact between university and practice partner). There is a crediting of the practice phases, which are recognised as study achievements (WR, 2013). The dual practice-integrated degree programme also includes studies at a university as

well as practical work in a company. In contrast to the dual vocational-training-integrated programmes, the students do not acquire a recognised vocational qualification in this type of dual study (Maschke, 2015). The practice-integrated dual study format presented in Chapter 1 offers the opportunity to enhance practical training while integrating it into an academic system without aggravating curricular interventions required for embedding vocational education training structures. Another advantage is the relative independence of universities, as the nature of the offer is within their autonomous decision. Thus, they are less dependent on political and legal framework conditions in their decision.

A successful transfer of the dual practice-integrated study model in a modified form will promote the development of the university landscape and the region. This can lead to political reform or support it significantly, preparing the groundwork for the introduction of dual vocational-training-integrated programmes as a second step. An introduction of the dual practice-integrated form based on the German model is recommended in a modified form under the current dynamic process of change, both politically and legally. The development of education policy as well as the strengthening of the working and economic structure should be in the foreground of the transfer. In conclusion, the practice-integrated dual higher education model is considered transferable provided that the specifics of the country and those of the respective educational system are respected during the course development and implementation.

3. Context of curricula development/adaptation

This chapter describes the context in which the main project activities related to curricula development, respectively curricula adaptation, and pilot implementation are performed. With this regard, a summarised overview of the Bologna Process structures and tools applied is provided. First, the common degree structure (in particular the three cycles), promoted by the Bologna Process is shortly described. The remaining part of this chapter is concentrated on two main Bologna tools: the European Credit Transfer System and the Diploma Supplement. Consequently, the specifics of the national higher education systems in the project pilot countries are highlighted in brief.

The aim of this chapter is to explain the origin of similarities in the operational environment of the partner higher education institutions, which justify the transferability of the dual higher education model across Europe. At the same time, the different approaches followed by the academic partner institutions during the curricula adaptation process are explained by the country specifics of the single national higher education systems.

3.1 Convergence of the higher education systems across Europe

Higher education across Europe is strongly characterised by the Bologna Process, whose reforms aim at more coherence to higher education systems across Europe. The Bologna Declaration started a coordinated activity to establish a common European Higher Education Area (EHEA) by meanwhile 48 signatory countries in order to increase transparency, mobility and mutual recognition and to enhance quality and competitiveness. By identifying 10 different action lines and measures, the Bologna Process aimed to achieve this target and to implement a common and flexible three-cycle structure of higher education including a common European Credit Transfer System (ECTS) and shared approaches to quality assurance by 2010. (Heitmann, Kretzschmar 2017, p. 13)

According to the Bologna Process Implementation Report from 2018, the dominant European model is now a clearly structured three-cycle degree system, with most countries having made the necessary reforms in line with Bologna guidelines. The main Bologna tools – ECTS, Diploma Supplement and national qualifications frameworks, are also well implemented in most countries. (European Commission/EACEA/Eurydice 2018, p. 13)

The three-cycle structure, promoted by the Bologna Process, consists of undergraduate (first-cycle), graduate (second-cycle) and doctoral (third-cycle) programme, with the possibility of intermediate (short-cycle) qualifications linked to the first cycle. The Bologna first cycle degree after three to four years of study and the achievement of 180 to 240 ECTS credits should prepare graduates for the labour market and guarantee their employability. The DYNAMIC project deals with higher education curricula at the first-cycle level.

ECTS, the European Credit Transfer System, was developed by the Commission of the European Communities in order to provide common procedures to guarantee academic recognition of studies abroad. ECTS is a learner-centred system for credit accumulation and transfer based on the principle of transparency of the learning, teaching and assessment processes. It provides a way of measuring and comparing learning achievements and transferring them from one institution to another (European Commission 2015, p. 69).

ECTS credits express the volume of learning based on the defined learning outcomes and their associated workload. The workload is an estimation of the time learners typically need to complete all learning activities such as lectures, seminars, projects, practical work, work placements and individual study required to achieve the defined learning outcomes in formal learning environments. 60 ECTS credits are allocated to the learning outcomes and associated workload of a full-time academic year or its equivalent, which normally comprises a number of educational components to which credits (on the basis of the learning outcomes and workload) are allocated. Formalised by national legal provisions, in most cases, student workload ranges from 1 500 to 1 800 hours for an academic year, which means that one credit corresponds to 25 to 30 hours of work. (European Commission 2015, p. 68 and p. 77)

ECTS provides the foundations for the common understanding of European higher education programmes. ECTS helps in the design, description and delivery of programmes. ECTS can be applied to all programmes, whatever the mode of delivery (classroom-based, work-based, distance learning) or the status of students (full-time, part-time), and to all kinds of learning contexts (formal, non-formal and informal). ECTS makes it possible to blend different learning styles, such as university and work-based learning, within the same programme. (ECTS User's Guide 2015, p. 6)

In all countries participating in the DYNAMIC project, ECTS has been integrated as both a credit accumulation and transfer system, with learning outcomes and student workload increasingly used as the basis for credit allocation. (European Commission/EACEA/Eurydice 2018, p. 15)

The implementation of the Diploma Supplement as a tool promoting the transparency of higher education qualifications is also widely successful. Most EHEA countries now comply with all the commonly agreed principles. (European Commission/EACEA/Eurydice 2018, p. 13)

The Diploma Supplement is a document attached to a higher education diploma. It gives a detailed description of its holder's learning outcomes, and the nature, level, context, content and status of individual study components. It includes several pieces of information: the name of the holder of the Supplement, the qualification and its level and function, the contents and achieved results, certification of the Supplement, information on the national higher education system under which the Supplement was issued, and other relevant information. The Diploma Supplement helps higher education institutions, employers, recognition authorities and other stakeholders more easily understand graduates' skills and competences. The Diploma Supplement is based on the following founding principles that respect national and international academic autonomy. The Diploma Supplement is (Diploma Supplement Revision Final Report Work Plan 2015-2018, p. 25):

- a flexible, non-prescriptive tool, capable of adaptation to local needs
- a device that has national and international applications
- a system to aid recognition for academic and professional purposes

- an approach that specifically excludes any claims and value-judgements concerning recognition by providing sufficient objective information
- a tool to focus on the outcomes of the learning that has taken place
- an addition to the original credential, not a substitute of it

The implementation of education reforms based on Bologna objectives in Bulgaria, Romania and Croatia, in particular the use of ECTS and Diploma Supplement tools, are fundamental for the introduction of dual studies at a higher education level. The tools of EHEA establish comparability between programmes at the same graduation level throughout Europe. These were used to identify common parts in the degree structures between Germany and Austria, where dual studies at under-graduate level are well established, with those in the pilot countries Bulgaria, Romania and Croatia. At the same time, national regulations and specifics of the higher education systems, academic autonomy and factors from the country-specific or even regional framework conditions determine the transfer of the dual higher education model. The following sections provide an overview of the higher education systems of Bulgaria, Romania and Croatia, which is necessary for the explanation of the supportive and limitation factors that influenced the curricula adaptation approach of the involved institutions.

3.2 Specifics of the national higher education system in Bulgaria

One of the main responsibilities of the Bulgarian Ministry of Education and Science has been to develop the higher education legislation in compliance with the European tendencies and the Bologna Process. The modernisation of the Bulgarian higher education is related to the integration of Bulgaria in the EHEA (the Bologna process) as well as in the European Research Area. The introduced reforms reflect the Bologna Process in Bulgaria in view of the financing of the higher education, the management of the higher education institutions, the introduction of clear accreditation criteria and a system for quality and control. (Efficient Education Management Network for LLL in the Black Sea Basin 2014, p. 4-5)

The adoption of the new Act on Higher Education and all its amendments as well as the inclusion of the country in the European system of higher education through the signing of the Bologna declaration, caused certain changes in the national system of higher education, mainly related to: (Technical University of Varna, ECTS Guide 2016-2017, p. 8):

- Creation of real academic autonomy
- Introduction of the 3-cycle system of education
- Transformation of the two- and three-year education institutions into colleges
- Introduction of a system for accreditation and evaluation of the higher education

The Higher Education Act (HEA) (1995) has introduced a degree structure based on three cycles – Bachelor, Master and Doctor – which has been fully implemented in the higher education system.

As to the developments in the higher education curricula, not less than 180 credits obtained within not less than 3 years of study are required for the acquisition of a Professional Bachelor. The goal of this educational degree is to provide fundamental theoretical knowledge, practical knowledge, ICT skills and competencies and access to a minimum 2-year Master's course in a major from the same professional field. For the acquisition of a Bachelor's degree, not less than 240 credits are required within a study period of at least 4 years. Basic multi-profiled knowledge is acquired, access to a Master's course of at least 1 or 2 years with minimum 60 credits is ensured and opportunities for direct employability are provided. There are some specialties like Structural Engineering and Medicine where in order to obtain a Master's degree, one should acquire a minimum of 300 credits during at least 5 (or 6) years of study. Profiled training and profiled knowledge with research orientation characterise the Master's

degree, which is referred to as the second Bologna cycle with the first being the Bachelor's degree and the third – the doctoral studies. (Efficient Education Management Network for LLL in the Black Sea Basin 2014, p. 5)

In Bulgaria, all higher education programmes are linked with ECTS credits. The compliance of higher education with the Credit Accumulation and Transfer System (CATS) came into force in the academic year of 2004/2005.

Since 01 January 2005, the European Diploma Supplement has been issued for free to Bachelor's and Master's degrees graduates. (Ibid, p. 7)

There are 51 higher education institutions in Bulgaria providing academic and professionally oriented education, of which 37 are public institutions and 14 are private.

Rules for curriculum development, example of Technical University Varna (D2.4 Project Dynamic)

The development of new training documents (new qualifications, curricula for existing and new specialties and a doctoral programme and amendments to existing curricula and programmes) shall be carried out in compliance with the following requirements:

- Law on Higher Education
- Classifier of higher education areas and professional fields
- Ordinance on the State Requirements for Higher Education for the Bachelor's Degree, Master's Degree and Professional Bachelor
- Ordinance No. 21 on the implementation of a system for accumulation and transfer of credits in higher education institutions
- Regulations for the structure and activity of the Technical University of Varna
- Standard of Technical University Varna in relation to the training of PhD students

The development of new training documents is coordinated with:

- Users of staff regarding the need for new specialists; the requirements of the employers and the extent of their interest towards the competences obtained through the doctoral programme
- Tutorial Committee / Committee for Accreditation and Post-accreditation monitoring
- Majors providing training in regulated professions; training plans and programme are approved by the Maritime Administration and agreed with the relevant branch organisations

3.3 Specifics of the national higher education system in Romania

Since 2005, the higher education system in Romania has been organised in three cycles: Bachelor the first-degree programme, Master programme and Doctorate programme compatible with the European qualification framework and laid out in Law 288 of 2004. Students who have graduated from an upper secondary institution are eligible to apply for admission to a first-degree programme according to the admission methodology of each university and study programme. Admission generally depends on student performance at the national examination at the end of upper secondary education (called Bacalaureat), performance in upper secondary school and performance at the university entrance examination.

Most Bachelor's programmes take 3 years (6 semesters) to complete – sciences, humanities, economic and social sciences, political science. However, some programmes take longer to

complete, for example, those in some technical fields take 4 years (8 semesters), medicine and architecture take 6 years (12 semesters). Master's programmes take 2 years beyond the Bachelor's degree. A Master's degree is a prerequisite for admission to PhD programmes. PhD programmes usually take 3 years to complete. Under special circumstances, the duration of study may be extended by 1 or 2 years.

According to a Ministry of Education report of 2007 (http://www.edu.ro/index.php/resurse/7942), in Romania higher education is provided by universities (universități), institutes (institute), study academies (academii de studii), schools of higher education, and other similar establishments, collectively referred to as higher education institutions or universities. Higher education institutions can be state-owned or private; they are non-profit, apolitical in nature and focused on the public interest. Starting with the summer of 2011 and the implementation of the new Education Act, universities were divided into three tiers (http://chestionar.uefiscdi.ro/):

- Universities focusing on education (which offer only Bachelor's degrees)
- Universities focusing on education and scientific research and universities focusing on education and art (offering Bachelor's and Master's degrees)
- Universities with an advanced research and education focus (which offer Bachelor's, Master's, as well as PhD degrees)

Curricula are established autonomously by the higher education institutions, according to the national strategies for higher education development and the national academic standards. According to the provisions of the law regarding higher education institutions accreditation and diploma recognition, the higher education curricula have to include compulsory, optional and facultative subjects. Compulsory and optional subjects belong to any of the following categories: fundamental, profile/specialisation and complementary subjects.

For each reference domain and specialisation of study recognised by the law, the higher education institutions establish an educational plan. The educational plan is a complex document, comprising of duration of studies, subjects by type and year of study, types of activities, number of allocated periods by subject and activity, examinations and number of credits allocated, etc. The structure and content of the educational plan regarding subjects, activities and number of periods have to comply with the national academic standards. The specific standards provide the indicative list of fundamental, profile/specialisation and complementary subjects and the ranges of the weights of the subjects on each specialisation curriculum. Depending on the specialisation of studies, the weights of the different types of subjects in the total number of periods may range between 15% and 30% for fundamental subjects, between 50% and as high as 80% for profile and/or specialisation subjects, and between 5% and 10% for complementary subjects. Most of the education and training programme is compulsory (at least 60% of the time, but can be as high as 90% for certain specialisations); optional subjects can also contribute to the study credits, but facultative subjects usually do not. Regarding the activities, the national standards establish for each reference domain/specialisation the ration of theoretical activities (courses) and practical ones (seminars, laboratories, practical training, project work, etc.). For most specialisation this ratio is 1:1 with a maximum of 20% deviation in either sense; however, for certain specialisations, the time allocated to the practical activities has to be significantly larger than for the theoretical ones (e.g. for medicine 1:2). The final curricula for each subject are elaborated by the higher education institutions departments according to these specific standards, analysed by the department councils, and approved by university senates. The teaching-learning activities have to comply in terms of fundamental types and ratios with the national academic standards for each reference domain and specialisation. The teaching-learning activities for most academic subjects include lectures (theoretical courses), seminars, laboratory classes, practical activities and projects preparation and presentation. For certain specialisations, practical activities – in

the form of field work, scientific research, teaching practice, etc. – are required. (European Education Directory)

At national level, the curriculum design for higher education is regulated by the Romanian Agency for Quality Assurance in Higher Education (ARACIS), established with the Emergency Ordinance no. 75/2005, as approved by Law no. 87/2006. Every study programme has to pass two assessment stages: the provisional authorisation (when the programme starts) and the accreditation (every five years). The lists of fundamental, domain and specialty subjects are also imposed by ARACIS. Moreover, after two accreditations (every five years), the university is allowed to change the curriculum, without the need of passing a new accreditation only in a percentage of 20%.

The ARACIS Agency is one of the main national institutions that has been created for monitoring and control in terms of compliance with the Bologna requirements. ARACIS is a public institution of national interest responsible for the development of standards and methods necessary for the admission of undergraduate or graduate academic degree programmes. The Diploma Supplement was introduced on the basis of the Ministerial Order adopted in April 2000. At present, it is issued automatically, free of charge, by all institutions and for all Bachelor's and Master's programmes.

3.4 Specifics of the national higher education system in Croatia

Higher education in the Republic of Croatia is performed within university and professional courses. University study programmes qualify students to work in science and higher education, private and public sector and society in general as well as to develop and apply scientific and professional knowledge. Professional study programmes provide students with an appropriate level of knowledge and skills required to work in applied professions as well as a direct integration in the working process.

The university study programmes have three levels: undergraduate, graduate and postgraduate. Undergraduate programmes normally last three (180 ECTS) to four (240 ECTS) years. Upon completion, students are awarded an academic title of Bachelor (prvostupnik) with reference to a specialisation. Graduate programmes normally last one (60 ECTS) to two (120 ECTS) years. The total number of credits earned after completing both undergraduate and graduate studies is at least 300 ECTS. Upon completion of both undergraduate and graduate studies, students are awarded an academic title of Master (magistar struke) with reference to a specialisation. Postgraduate university studies are divided into specialist and doctoral studies. Specialist studies last for one to two years. Upon completion, the student is awarded the title of University Specialist with reference to a specialisation (univ. spec.). Doctoral studies last three years (180 ECTS). Upon completion of doctoral study, the academic title of Doctor of Science or Doctor of Arts is awarded (dr. sc. or dr. art.).

Professional study programmes are split into: short professional studies, undergraduate professional studies, and specialist graduate professional studies. Short professional studies last two (120 ECTS) to two and a half (150 ECTS) years. Upon completion, students are awarded the professional title of stručni pristupnik/pristupnica with reference to a specialisation. Undergraduate professional studies last three (exceptionally four) years and students earn 180-240 ECTS credits. Upon completion of professional studies, students are awarded the professional title of stručni pristupnik/pristupnica with a reference to a specialisation. Specialist professional graduate studies last one to two years and students can earn 60-120 ECTS credits. Upon completion, students are awarded the title of a specialist of the respective profession. The total number of credits earned after completing both undergraduate and graduate professional studies is at least 300 ECTS. There are currently 1358 accredited study programme in the Republic of Croatia.

During the feasibility and transferability study, the situation in Croatia for support of dual education has been analysed in respect to the current legal frameworks and responsible institutions. The analysis has pointed out that there are no existing legal regulations for dual

higher education in Croatia. Therefore, the introduction of dual higher education models can be currently explored only within the current legal framework:

- Law on Quality Assurance in Science and Higher Education, Article 20 (Official Gazette, No. 45/09)
- Law on Scientific Activities and Higher Education (Official Gazette 123/03, 198/03, 105/04, 174/04, 46/07)
- Law on Recognition of Foreign Educational Qualifications (Official Gazette 158/03, 198/03, 138/06)
- Law on ratification of conventions on recognition of higher education qualifications in Europe (Official Gazette 9/02, 15/02)
- Act on Academic and Professional Names and Academic Degrees (Official Gazette 107/07)
- Ordinance on the conditions for selection in scientific sound (Official Gazette 84/05, 138/06, 42/07, USRH Decision 120/07)
- Rulebook on Conditions and Procedure for Issuing Licenses for Performing Scientific Activities ("Official Gazette", No. 97/07)
- Rulebook on Evaluation of Scientific Organizations (Official Gazette, No. 39/05, 104/08)
- Ordinance on Scientific and Artistic Areas, Fields and Branches (Official Gazette 118/09)
- Ordinance on the organization and manner of work of regional councils and parent committees (Official Gazette, No. 76/05, 113/05, USRH Decision, 118/05, 55/09)

After a closer investigation of the existing legal framework, the Croatian partners have identified an opportunity for introducing a dual education pilot through:

- The law on Quality Assurance in Science and Higher Education article 20
- The rules on the content of the permit and the conditions for issuance of a permit for performing higher education activities, the conduct of a study programme and the reinstatement of higher education institutions
- Conclusion of the National Council for Higher Education (Class: 003-08 / 11-09 / 0006; no. 355-02-01-11-9) from 16th January 2012 *(Changes up to 20% of the content of the study programme are made by the Academic Council of HEI`s.)*

Respecting the above-listed rules, a pilot of dual higher education is only possible through curriculum adaptation within the 20% flexibility rule, which allows certain changes in the teaching process of selected courses. In the medium term, there will be a need for legal adoption and regulations of dual higher education in Croatia in order to scale up the model.

4. Approaches for curriculum adaptation for dual implementation in national context

The implementation of reforms based on the Bologna objectives in Bulgaria, Romania and Croatia, in particular the use of tools such as ECTS and Diploma Supplement, are fundamental for the introduction of dual studies at higher education level. The tools of EHEA establish comparability between programmes at the same graduation level throughout Europe. These were used to identify common parts in the degree structures between the pilot countries and compared to German and Austria, where dual higher education has been practised for a long time now. All partner countries represented in the DYNAMIC project participate in the European Higher Education Area (EHEA). Despite the different scale of implementation of the Bologna reform in the project partner countries, they all have a common degree structure. Nevertheless, variable structures defined by the implementation of the EHEA principles in the various national contexts and different academic traditions still exist across different national higher education systems. Having in mind the national context for curriculum adaptation described in the previous chapter, additional factors from the operational environment of the universities also have an explanatory value for the feasibility of the approach followed in each pilot country. Such determinant factors mainly result from the political and economic external environment:

1) Political factors – regulatory system and specifics of the higher education systems; recognition and accreditation of dual studies by the Ministry of Education and related authorities; additional regulation bodies for specific programmes (e.g. Marine Administration); labour market structures and employment regulations
2) Economic factors – size and type of companies available in the region; prior experience in working with students; current state of university-business cooperation at regional and institutional level (from well-established in Sibiu to starting from the scratch in Pula)

For the stated reasons, standard definitions and best practices applied in one or another country may not be applicable in other European countries, despite the common assumptions and prerequisites framing the curriculum development process.

4.1 Guiding principles of the curriculum evaluation and adaptation process

The pilot introduction of dual higher education models in Bulgaria, Romania and Croatia required an evaluation of the ongoing curricula of selected undergraduate programmes in the partner universities in order to identify a solution for the integration of practical training phases. The adaptation of the curricula for dual implementation was guided by internationally recognised standards for design of engineering curricula.

In the context of the Bologna Process, the development and implementation of Qualifications Framework was accompanied by negotiations to agree on European Standards and Guidelines for internal and external quality assurance in higher education (ESG). The first ESG were adopted in 2005. Since 2005, considerable progress has been made in quality assurance as well as in other Bologna action lines such as qualifications frameworks, recognition and promotion of the use of learning outcomes, all these contributing to a paradigm shift towards student-centred learning and teaching. In 2015, a revised version of the ESG has been adopted. In the revised ESG of 2015, a stronger emphasis was put on student-centred learning and appropriate assessment, teaching staff development and on-going monitoring and review of programmes. (Heitmann & Kretzschmar 2017, p. 32-36)

For the design and approval of programmes (Guidelines 1.2) it is stated (ESG, 2015; p.11-12):

"Study programmes are at the core of the higher education institutions' teaching mission. They provide students with both academic knowledge and skills including those that are

transferable, which may influence their personal development and may be applied in their future careers. Programmes

– are designed with overall programme objectives that are in line with the institutional strategy and have explicit intended learning outcomes;

– are designed by involving students and other stakeholders in the work;

– benefit from external expertise and reference points;

– reflect the four purposes of higher education of the Council of Europe such as

– preparation of the labour market

– preparation for life as active citizens in democratic societies

– personal development

– the development and maintenance of a broad, advanced knowledge base

– are designed so that they enable smooth student progression;

– define the expected student workload, e.g. in ECTS;

– include well-structured placement opportunities where appropriate;

– are subject to a formal institutional approval process. "

The implementation of student-centred learning and teaching (Guidelines 1.3):

– "respects and attends to the diversity of students and their needs, enabling flexible learning paths;

– considers and uses different modes of delivery, where appropriate;

– flexibly uses a variety of pedagogical methods;

– regularly evaluates and adjusts the modes of delivery and pedagogical methods;

– encourages a sense of autonomy in the learner, while ensuring adequate guidance and support from the teacher;

– promotes mutual respect within the learner-teacher relationship;

– has appropriate procedures for dealing with students' complaints."

Curriculum development in higher education is often focused on actions limited in scope like up-dating syllabi, introducing new courses or modules or implementing new teaching/ learning approaches like collaborative learning or problem-based learning. In the past, curriculum development or revision used to represent a negotiation process between faculty members and university management on the basis of existing experiences and the availability of resources than an educational research based systematic approach. These negotiation processes were mainly focused on reaching agreements for a particular programme about a range of subjects, syllabus and content, the number of teaching hours per course or module and examination requirements. More recent approaches to curriculum development have shifted explicitly to learning outcome-based approach relying on sound theoretical ground. (Boev, et.al., 2013; p. 21-22)

The curriculum design process in the project DYNAMIC followed the principles of a competence-based and learner-centred higher education. The development and curricula integration of the practical phases was guided by a learning outcomes-based approach applying proper ECTS allocation. The learning outcomes of the practical phases match the

overall learning objectives and outcomes set for the regular of the selected pilot programme. External stakeholders have been involved in all phases of the curriculum revision, curriculum design and pilot implementation processes.

4.2 Practical steps and working procedures for developing dual study programmes

The dual form of study organisation is an educational model at university level which is typically realised in close cooperation with partner companies and corresponds to a particularly consistent occupational field orientation and practice integration. The entire curriculum is organised in modules with a certain number of ECTS each. The organisational form of the dual study is typically a "full time" study which contains practical training integrated in the curriculum. Some key characteristics of the dual study include:

- The entry into the training company generally starts in the summer after the second semester, so the accuracy of the training contracts (including terms of a probationary period, legally required holidays, payment, insurance, etc.) could be cleared. Students without technical training and experience can acquire the necessary basic knowledge, students from the dual education can get used to the requirements and can be prepared to enter the training companies.
- The practice phases become operational through direct assignment activities on individual modules more involved in the acquisition of skills-integrated scientific and technical training. This affects an agreed workload of total of supervised and documented practical work in the companies.

The main differences to a non-dual full-time study are in the selection of partner training companies and mentors, organisation and evaluation of the practical training, integration of practical projects in the education, assessment of practice phases.

Based on the experience of the partners – the University of Applied Sciences Wismar (Germany) and the University of Applied Sciences Joanneum (Austria), a process description with practical steps for the design and implementation of dual higher education programmes has been developed within the scope of the DYNAMIC project. Considering the country-specific conditions, identified during the feasibility study, the process flow applied in the context of Bulgaria, Romania and Croatia could be illustrated with the following transferable practical steps:

Resolution

The starting point for developing a dual higher education programme is the university resolution declaring the decision of the university management and the commitment from the respective faculty, which will offer the dual study programme. The resolution shall name the programme that will be developed for dual implementation. It describes the rules that have to be respected in the curriculum design process and defines the criteria for selection and cooperation with training companies.

Programme coordinator and development team

Once the development of a dual study programme has been decided by the university management and the responsible internal bodies, it is necessary to appoint a person in charge of the development process. Generally, this will be the programme coordinator. The programme coordinator is the main contact person for the initial partners and manages the

development team of relevant staff members who will be working on the development of the study programme.

Needs and acceptance analysis

A preceding general market analysis followed by a detailed demand analysis, including current and projected training needs, build the foundation of a well-accepted and relevant dual study programme. The basis for of the demand and acceptance analysis is surveys of the framework conditions and the operational environment as well as interviews with the selected partners among the potential training companies. The analysis should also prove the availability of sufficient number of training places.

Partner portfolio and building training partnerships

At the beginning of the process chain, specific training and development concerns of different companies have to be examined for their suitability as a basis for a training partnership. Strategically interesting situations for the production site development as well as for the regional economic development should be investigated and should be more closely involved in the future acquisition of new companies. These training situations shall complement specific areas of a study programme which must focus on specific industries and companies for the internship. The practical parts are then carried out in a well-structured partnership between the partner training company and the lecturers of the study programme. The basis for this partnership is regulated in the Training Agreement.

Joint curriculum evaluation and identification of training gaps

The practical training foreseen in the dual study model is organised as a training partnership, settled by a training contract and follows in its content the acquisition of skills in the study to deepen the theoretical notions of the specialised subjects in a particular professional field. "Education partnership" means that the entire study, from the development, application, the admission procedure, the content and timing coordination, reflection and assessment, is designed together – university and company. In addition to the general conditions ensuring certain academic standards laid down in the training agreement, for each training situation an individual approach and focus shall be defined to align the training outcomes with the curricular embedded skills and competences resulting from the professional work field. The stakeholder dialogue is a continuous process along the entire chain of curriculum design and delivery.

The table below presents an example for stakeholder dialogue for the design and implementation of the pilot dual higher programmes in the scope of the project DYNAMIC. The evaluation of the ongoing engineering curricula of the pilot programmes in Bulgaria, Romania and Croatia was jointly performed by representatives of the higher education, business and social partners. The methodology used was focus group meetings conducted in 3 cycles taking place in each country.

Table 2. Main topics during the 3 cycles of national focus group meetings

First cycle
• Current peculiarities related to the practical training of students • Educational programmes for the selected specialties and syllabus • Specifics of the practical training in these programmes • Possibilities and opportunities for setting the foundations of the dual education practices and training • Ideas and requirements for partners' cooperation within the project • How to deal with the challenge to set-up "dual education" without existing related legislation
Second cycle
• Screening of existing models for dual education training in EU • Discussion about the DYNAMIC guidelines for pilot introduction of practice-integrated dual curricula • Evaluation of ongoing curricula of the selected specialities – presentation and discussion of all specific features, in agreement with the corresponding legislation • Ideas and possibilities for implementation of dual education and training aligned with the requirements of the industrial partners • Elaborating an efficient schedule for practical training for the students from the selected programmes during the summer and winter semester and the summer vacation • Alignment of the schedule for practice-integrated training with the study plan
Third cycle
• Specification of the next steps regarding the implementation of the dual education and training • Preparing information for students involved in dual education training and its pilot implementation • Discussions of the proposed diary template and contract template • Questions and uncertainties to be clarified prior to the pilot implementation

The stakeholder dialogue is a continuous process which involves the periodical re-evaluation of the ongoing curricula in order to identify training gaps and needs for curricula updates responding to the changing operational environment and trends in the professional field. The reflection from the implementation process and the experience made by all parties shall flow into the programme update.

Programme objectives and learning outcomes

Based on the requirements from the professional work field and the training needs and gaps identified in the course of the stakeholder dialogue, the learning objectives of the selected programme need to be adjusted accordingly. Then the learning objectives of the practical training and the competences that the students are expected to acquire through the practical assignments need to be defined and plugged in the overall programme curriculum. Setting the competence profile and main focus of the curriculum requires as well a clear definition of the responsibilities in the implementation of the dual organisational form:

- The university accepts responsibility for communicating the scientific, operational and organisational principles and methods to the students as well as to facilitate the peer learning among the students
- The training companies provide knowledge and experience to ensure the understanding of all the processes of production and enable the implementation of the theory learned into operational practice

The operational curriculum for the practical training includes a jointly developed catalogue of learning objectives for the practical training throughout the study and a rough "road map" of skills development planned together by the company and the student for the duration of training.

Integration of the practical activities in the curriculum

Generally, the entire curriculum is modularly constructed in a grid with the smallest unit of a certain number of ECTS. In some cases, with strong project and practical orientation two or more units are combined into modules with a higher number of ECTS. An overall score is assigned for each module, which can result from all the learned content according to the module description in different ways. If no module examination or marks are foreseen on a module project, the grades result from partial examinations in the offered module courses, which are made in proportion to the ECTS. The practical phases can be integrated through direct assignment to the detected operational activities for individual modules. A certain number of ECTS are awarded for in-company activities and projects that are tailored to the specific courses. The selection of the activities is carried out by the company in coordination with the respective lecturer of the course. The relevant activities are included in the practice report and evaluated.

A block model with a cyclic change of theoretical and practical phases adapted to the respective existing semester schedule is widely favoured in higher education. This model is favoured – compared to the weekly model – because the universities here are also independent and flexible from the company's location area and do not restrict the ability of students to attend courses in the university. Furthermore, the practical phases can be easily integrated into the respective semester break and into the respective planned practical semester without restructuring the existing curricular course of study. Thus, the universities are politically and legally autonomous in the design and implementation of dual practice-integrated higher education programmes. Another advantage is that the project partner universities do not have to commit additional teaching capacities.

Organisation of the practical phases

The entire training is carried out for each student in cooperation with a partner company with which the student signs a training contract for the duration of study. All practical phases are completed in the chosen partner company. The total duration of the practical training divided into practical phases depends on the provisions in the curricula. In general, the working week in these "practical phases" corresponds to a full-time job. Over the entire duration of the training contract in Bachelor study, there is an average employment of 50% (in Germany and Austria). However, the percentage may vary depending on the national employment regulations. The practical training follows a fixed schedule that is set out in a grid pattern and is specified for each year to an individual schedule.

Basis for the organisation of the practical phases are:

- The schedule
- The yearly specific schedule that is created before the start of the programme
- The curriculum (including the prescribed practical projects)
- The content framework for the practical phases of the curriculum
- The catalogue of learning objectives for the practical training throughout the study
- A rough "road map" of skills development planned together by the company and the student for the duration of study set up at the beginning
- Content and organisational arrangements between the training company and a faculty representative that take place twice a year (usually recorded in written form)

Each company determines at the beginning of the study a mentor who is responsible for the general supervision of the students in the company and who is taking over the later assessment. Usually, this mentor is an appointed person from the HR department. Moreover, a company determines additional industry mentors from the various departments as direct supervisors of the individual assignments. For each student and for each practical phase, a lecturer is designated to supervise the practice and to support the in-company trainer. The first practice is usually based on getting to know the company and learning of basic skills and gaining knowledge. Students without technical training and experience can earn the necessary basic knowledge.

Embedding in study and examination regulations

As a next step, the dual higher education model has to be anchored in the applicable examination and study regulations. Here, the universities are limited in their autonomy and depend on the political and economic framework conditions. For the time of implementation of the DYNAMIC project, the available option for the institutionalisation of the dual practice-integrated study is to make a corresponding identification in the Diploma Supplement.

Create internal university guidelines

The creation of internal university guidelines and framework conditions for quality assurance and implementation reliability are an important step in the process flow of design and implementation of dual higher education programmes. Such guidelines are based on the general study and examination regulations applied in the university and settle the rules dealing with evaluation and quality assurance, admission, assessment and examination procedures.

Admission must be in accordance with the admission requirements in each country, the requirements of the university and the specific requirements of the study programme, if such exist in the university. The admission notice for the students in the training companies must be preferably before the start of the study, but not later than the end of the second semester. The practical training can begin with an initial internship during the holidays after the second term, in which the legally required probation time is integrated.

The following elements provide examples of tools for ongoing **evaluation of the practical phases** and try to quantify the learning success:

- During all the phases, students have to keep a diary that is submitted and assessed for the modules involved in the delivery of dual education and training.
- Students must submit a final standardised report which is assessed at the end of the practical training.

- Students set for every practical phase their personal educational goals, which are either taken directly from the programme educational goals or formulated individually. The level of achieving these goals is to be commented in the practical report.
- After each practical phase, there is a documented evaluation interview between student and industry supervisor using the educational goal catalogue.

A work diary, a written report and a presentation are common elements used in the assessment of the practical phases. While a work diary is usually delivered for each practical phase, a final report and a presentation may be required after the last practical phase. The documentation of the practical phases is designed with special reference to the specified professional contents in the curriculum. The feedback of the industry mentors and the assessment of the overall student performance in the company are also considered during the assessment process and are often integrated into the overall rating of the practical training.

Contractual arrangements with the training companies

Creation of a contract template for cooperation with companies is the final step before the implementation of the developed programme can start. The basis of the successful cooperation between the university and the company is – especially in the case of dual programme of initial training – a cooperation agreement, either an oral or a written one. However, a written contract is the rule. The cooperation agreement defines the following aspects for a certain period:

- Name of the programme
- Type and number of study places
- Objectives and basic features of the cooperation
- Admission and selection process for the students
- Contractual obligations of the educational institution
- Contractual obligations of the company
- Information on the academic degree
- Contract period and the termination modalities
- Financial modalities (where applicable)

It is also important that all parties contractually name a contact person who will look after the student during the training. A precise definition of the training and study content is also a fundamental component. The university is responsible for carrying out the courses, while the company undertakes to properly run the practical phases and deliver the content that must correspond to the theoretical training at the university. Furthermore, the cooperation agreement contains information on the examination regulations, whereby the examination authority for the academic training lies with the university. The admission procedure includes the formal admission requirements of the university and regulates the requirements specific for the dual study programme. It is also recommended to define minimum requirements for the companies involved in dual higher education.

Start a pilot with a limited number of students

It is strongly recommended to start the pilot programme with a limited number of participants. Only then corrective measures can be taken, if necessary. Once the framework conditions

have been successfully established and adjusted, an independent dual study programme can be considered in order to meet the emerging needs on the side of the economy.

The application of the described set of practical steps for design and implementation of dual higher education programmes is demonstrated in the section to follow, which provides practical examples of undergraduate dual models from the engineering domain in national context.

4.3 Practical examples of practice-integrated dual education models in country-specific context

While the previous chapter section describes the practical steps usually involved in the design of practice-integrated dual higher education programmes, this section presents the results of the curriculum development, respectively curriculum adaptation process, under the influence of the national and institutional context. Since all three countries, Bulgaria, Romania and Croatia, are presently lacking of specific normative in the higher education law that recognises and specifies the rules for dual higher education, different approaches for integration of practical phases in the ongoing curricula have been identified and followed in each country. The following approaches will be described in details as an example for the design of practice-integrated dual higher education forms in Bulgaria, Romania and Croatia:

1) Holistic approach for dual curriculum development
2) Stepwise dualization of ongoing curriculum
3) Module dualization of selected subjects in the ongoing curriculum

The holistic approach in Romania presents a description of the entire process of curriculum development paying special attention to the revision of the regular curriculum and the content design of the practical phases using competence-based principles and formulation of dedicated learning outcomes for the practical training components. As a result of this process, a new form of the existing regular programme in "Mechatronics" can be offered to students in the University Lucian Blaga, Sibiu. The dual form is offered in parallel with the regular form providing the students with a choice between the two forms at the beginning of their study.

The second model presents a step-by-step approach for curricula dualization moving from initial curriculum update of the ongoing programme towards stepwise dualization. This strategy was imposed by a national regulation in the Higher Education Law in Bulgaria according to which each student must complete her/his degree with the curriculum from the beginning of the study. Therefore, the dualization in the programme "Naval Architecture and Marine Technology" in the Technical University Varna can be achieved through curriculum modification between the student cohorts.

The third model presents a module dualization of an on-going curriculum. In this case, only selected subjects are delivered in cooperation with an industry partner while the curriculum itself remains unchanged. Such an approach is suitable when the operational environment of the university is affected by strong legislative restrictions. The model is also recommended in new university-business partnerships, in which the cooperation between university and company is still in the process of establishment.

All three models are transferable in the respective national context. The higher degree of transferability is achieved through the implementation schedule of the practical phases. In most of the cases, the practical activities take place during the lecture-free time, so that the semester plan is not compromised. In this way the dual forms of the selected programmes can fulfil all formal requirements for obtaining a Bachelor's degree under the current regulatory framework. Besides, the labour legislation mostly allows part-time jobs for students outside the programme scope, which also provides a certain flexibility for the student in-company placements.

4.3.1 A holistic approach – Dual Bachelor in Mechatronics in Romania

Institution	University Lucian Blaga Sibiu (LBUS)
Department	Faculty of Engineering
Domain	Mechatronics and Robotics
Specialization	Mechatronics – dual education
Degree	Bachelor
Duration	8 semesters
Total workload	258 ECTS
Workload practical activities	1050 hours; 18 ECTS
Language of instruction	Romanian
Industrial partners	Continental Automotive Systems Sibiu (CASS) Marquardt Schaltsysteme S.C.S. Sibiu (MSS)

"Mechatronics" started as a study programme at Lucian Blaga University, Sibiu (LBUS) in the academic year 2008/2009. Since then, it has become one of the most successful specialisations of the Engineering Faculty at LBUS in respect to graduates' employability. Graduates of the specialisation "Mechatronics" are highly required on the labour market with the degree of employability being close to 100%. At LBUS, the "Mechatronics" programme is organised both in Romanian (MECH-RO) and in English (MECH-EN) languages. These facts corroborated with the rapid industrial development of the Sibiu area led to the need of organising "Mechatronics" as dual-study specialisation.

The mission of the study programme "Mechatronics" at Lucian Blaga University of Sibiu consists in training of specialists who are capable of integrating the principles of mechatronics in the conception and realisation of machines and industrial products requested by the market, in conditions of high precision and quality, reduced conception and production time and minimal manufacturing costs. The future graduate of the study programme "Mechatronics" will be a system engineer, with abilities both in the mechanical domain and in the domain of electronics and computers. Beneath systemic thinking, students have to acquire team working skills, specific for the new approaches, both in exploitation and design. A great attention is granted to the practical instruction, to work on mechatronic equipment.

Aims of the dual programme in Mechatronics:

- To develop students' practical skills and to reinforce the theoretical notions acquired in the specialised courses. This ensures training in the design, manufacturing and operation of mechatronic systems, measuring and control equipment, sensors and transducers, specific electronic systems, biomedical, "intelligent" surveillance and control equipment, home appliances, robots and micro robots, peripherals, control and service, management of mechatronic systems, etc.
- Familiarising students with the notions and knowledge regarding the primary procedures of elaboration and processing of materials, plastics processing, machines and processing systems, knowledge of how to interpret technical documents and knowledge of means and procedures for measuring accuracy and inspection quality
- Address problems regarding the knowledge of the main technologies and technological flows specific to the field of mechatronics and of the partner commercial companies, of the computerisation systems and management of the mechatronic systems
- Impart knowledge about construction, operation, regulation and maintenance of machines, equipment and production lines in the economic unit where the technological practice takes place, current trends, design elements in this field, research methods, preparation of technical documentation, organisation of technical services, etc.

For the practical activities of the dual programme learning outcomes and specific competences have been elaborated as well. The list of competences categorised in general, professional and transversal skills is presented in the table below.

Table 3. Learning outcomes for the practical activities in dual Bachelor in Mechatronics

Specific competencies acquired through the practical activities	
General skills	
1.	Identifying the stages and technological processes for obtaining products specific to mechatronics
2.	Designing and organising phases of specific technological processes in mechatronics and microsystems
3.	Recording and transmitting information specific to production flows for the proper functioning of equipment, devices, machines and installations used
4.	Verification of quality parameters on manufacturing phases of specific products
5.	Identification of construction, kinematics, regulation and programming of equipment, machines and machinery, of drive and automation systems
Professional skills	
6.	Applying the basic knowledge of general and specialised technical culture to solve technical problems specific to the field of Mechatronics
7.	Elaboration and use of diagrams, structural and operating diagrams, graphic representations and technical documents specific to the field of Mechatronics
8.	Realisation of local automation applications in mechatronics and robotics using standardised and non-typed partial components and assemblies as well as CAD resources
9.	Design, construction and maintenance of subsystems and components of mechatronic systems
10.	Design, implementation and maintenance of electronic control subsystems of mechatronic systems
11.	Assisted design, implementation and maintenance of mechatronic systems by integrating component subsystems (mechanical, electronic, optical, computer, etc.)
Transversal skills	
12.	Fulfilling the professional tasks with exact identification of the objectives to be achieved, of the available resources, the conditions for their completion, the work stages, the working time and related deadlines
13.	Responsible execution of work tasks in a multidisciplinary team with the assumption of roles on different hierarchical levels
14.	Identifying the need for continuous training and the efficient use of information and communication resources and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian and in an international language

"Mechatronics" at LBUS, as a regular study programme is unfolded in 8 semesters, with a compulsory amount of practical activities of 240 hours. Students do not pursue practical activities in the first study year (1st and 2nd semesters). For the dual "Mechatronics" programme, supplementary hours of practical activities have been added. A supplementary number of 810 hours of practical activities have been added to the existing 240, which leads to a total number of 1050 hours for the dual study option. Nine weeks of supplementary hours have been added at the end of the 2nd, 4th and 6th semesters (a period which now

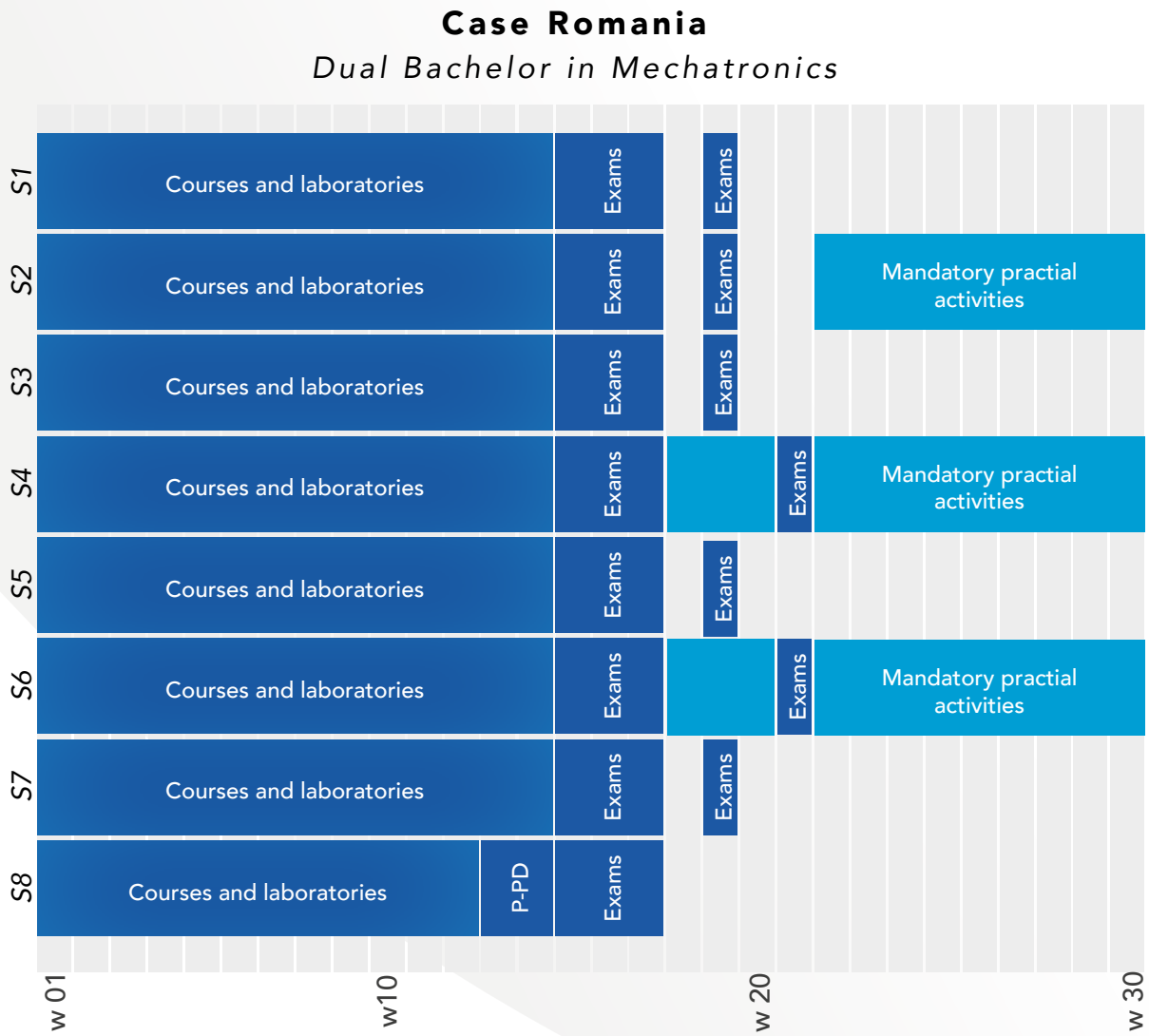
is allocated to the summer holidays). Consequently, the total number of hours for practical activities reaches 1050 h for the dual-study specialisation.

Duration of the practice according to the Dual Curriculum:

- sem 2/ 9 week × 30 hours / week = 270 hours
- sem 4/ 12 weeks × 30 hours / week = 360 hours
- sem 6/ 12 week × 30 hours / week = 360 hours
- sem 9/ 2 week × 30 hours / week = 60 hours (separate programme – elaboration guide)
- Total practice hours: 1050 hours

In summary: at the end of the first year (sem. 2) there are 9 weeks practice (270 hours), at the end of year II and III (sem. 4 and 6) there are 12 weeks of practice (360 hours each) and at the end of year IV (sem. 8) there are 2 weeks practice (60 hours) for the elaboration of the diploma project, in total of 1050 hours on the undergraduate cycle of "Mechatronics" dual education.

Fig. 8. Structure for practical activities for the dual-study programme in Mechatronics



At national level, the curriculum design for higher education programmes is regulated by the Romanian Agency for Quality Assurance in Higher Education (ARACIS). Every study programme has to pass two assessment stages: the provisional authorisation (when the programme starts) and the accreditation (every five years). As an example, the curriculum fur "Mechatronics" specialisation must fulfil the following percentages:

- Fundamental subjects ≥ 17%
- Domain subject ≥ 38%
- Specialty subjects ≥ 25%
- Complementary subjects ≤ 8%

The lists of fundamental, domain and specialty subjects are imposed by ARACIS. Moreover, after two accreditations, the university is allowed to change the curriculum, without the need for passing a new accreditation only in a percentage of 20%. Such changes can dramatically affect other rules/percentages, so making them is quite a cumbersome process. Thus, adapting "Mechatronics" as a dual-study programme, according to the requirements of the industrial partners has to cope also with the regulation enforced by ARACIS, so changing the curriculum has to adhere to these regulations. The best way to integrate the requirements of the industrial partners into the educational process was to adapt the syllabuses of specialty subjects. An example of how this approach is working is represented by the syllabus of "Microcontrollers programming" – specialty subject, taught in the 5th semester. It was analysed by LBUS staff and engineers from the industry partners. Now the course and practical work are focused upon two main architectures, Microchip PIC16F690 and AVR ATMega328P on Arduino and both assembler and C are taught as main programming languages. After the analysis and the feedback received from partner companies the following changes at the level of curricula were decided: the course will remain focused upon both architectures (Microchip PIC16F690 and AVR ATMega328P on Arduino), the practical work will be focused only on AVR ATMega328P and C will be studied as a programming language (only basic assembler knowledge will be taught). Other specialty subjects selected for adaptation were Computer programming, Digital Electronics, Power Electronics, Hydraulic and Pneumatic Driving Systems and Programmable Logic Controllers.

A new syllabus for practical activities was designed for the dual study programme in "Mechatronics", taking into consideration the following:

- the content was tailored according to the content of the curriculum and the requirements of the partner companies
- during internships students should become familiar with all sections and activities of the partner companies (CASS and MSS)
- the training items were designed to match the content of "Mechatronics" as a multi-disciplinary study programme, the main field of activity of the partner companies, the automotive industry and the new paradigm of "Industry 4.0"

The thematic areas of the practical activities are presented in the table below.

Table 4. Competence catalogue for the practical activities in dual Bachelor in Mechatronics

Framework theme for the practice activity / Semester 2		
Practical applications thematic content		Hours
1.	Organisation of production departments and sections, technical compartments, design-development, and technological documentation circuit in the enterprise	30
2.	Technical standardisation: organisation of the standardisation service, evidence of material and energy consumption, accounting system in the productive sections; quality assurance and quality management	24
3.	Technological flow and technological documentation in commercial companies, assimilation of new products (financing, technological documentation, cost price, supply and sales)	24
4.	Constructive elements of mechatronics, hardware structure of mechatronic systems; interpretation of subsystem integration (mechanical, electronic, computer) to form complex mechatronic systems	24
5.	Constructive elements of machines and robots, hardware structure of mechatronic systems	24
6.	Application and interpretation of basic principles on the optimal choice of mechatronic subsystems and components	24
7.	Application and interpretation of technical drawing standards and conventional engineering graphics in the elaboration of execution drawings, technological sheets, product manuals and maintenance and testing manuals	24
8.	Assessing the quality of mechatronic systems according to the characteristics of the materials and components used	27
9.	Computer programming and programming languages; use of computers	30
10.	Product quality control, geometric precision inspection; measuring apparatus and systems	30
Total		**270**
Framework theme for the practice activity / Semester 4		
Practical applications thematic content		Hours
1.	Explanation, interpretation and use of operating principles of subsystems (mechanical, pneumatic, hydraulic, electrical, optical, etc.) in the design and implementation of block and operating schemes for local automation systems used in mechatronics	24
2.	Efficient use of modern methods for evaluation, diagnosis, measurement and testing of mechatronic subsystems by an integrated approach	24
3.	Measurement techniques, measurement methods and principles for determining the different quality characteristics	24

4.	Applications to measurement and control methods used in manufacturing processes and technologies; execution drawing; execution precision, tolerances and limit deviations, roughness, general technical conditions; Intermediate dimensional control methods; final dimensional control methods / by assisted measurement, on-line and off-line programming of coordinate measuring machines Measurement technologies using optical and laser control-digitisation measurement equipment; Quality control of components and partial assemblies of products; tests, trials and final tests of products, industrial machines / equipment, etc. Specific QC / QA procedures, reports and documentation	24
5.	Electric and hydro-pneumatic actuators, equipment and installations in production systems, digital electronic and hydro-pneumatic automation systems, precision drives	24
6.	Applications of the notions and concepts in the field of power electronics, digital electronics, the basics of automatic regulation, sensors, signal theory and circuits in the field of mechatronics	24
7.	Applications for the use of measuring and testing equipment (multimeter, oscilloscope, signal type, parallel / series connection of voltage sources; measurement and testing of passive and active components; reading of electrical diagrams and realisation of practical PCBs; control circuits for DC motor, signal PWM, practical realisation, interconnection and circuit testing; Practical understanding of the difference between the linear source (with its limitations) and the switching source; current / voltage limitation	30
8.	Processes, machines and technological equipment for obtaining and processing metallic and non-metallic materials	24
9.	Manufacturing and assembly technologies in industry: Applications for the manufacture of mechatronic products for general use and specific to the companies in which the practice takes place: specific technological processes; elaboration of technological files	30
10.	Flexible production systems, robots, intelligent computer- aided manufacturing systems	24
11.	Computer aided 2D design applications; user interface specific to the 2D work environment (AutoCAD 2D, SolidEdge 2D, etc.); Elaboration of technical product documentation (execution drawings for parts and 2D overview drawings) using software applications for 2D assisted graphics	24
12.	Computerisation and management systems of mechatronic systems, software specific to the programming of mechatronic systems, assisted design and simulation of mechatronic systems	24
13.	Basic applications in C ++, Arduino programming; Data management, Applications related to: SAP, DOORS, PDM LINK, MKS, etc.	30
14.	Numbering systems, organising information in binary system. Fundamentals of programming languages. ASM and C languages, basics. Data types in the C language.	30
Total		**360**

Framework theme for the practice activity / Semester 6		
	Practical applications thematic content	Hours
1.	Sensors and transducers; automatic control and serving. Applications to know the categories of sensors, transducers, identification and diagnostic systems with which the mechatronic / RI / MUCN systems equipped by companies are equipped; constructive – functional characteristics; measured sizes / parameters; measuring range; accuracy, resolution, measurement sensitivity	24
2.	Microcontroller architectures (AVR, ARM, S08, PIC). Semiconductor manufacturing techniques. CPU, ALU, general-purpose registers, registers with special functions. Peripherals (timers, PWM, Analog / Digital conversions, IO Ports, SPI communication buses, I2C, UART). CPU-peripherals: control, interrupts, system clock, power management & consumption, watchdog	24
3.	Applications to the analysis, modelling, identification and synthesis of automatic control subsystems through the acquisition, processing and interpretation of data simulated or obtained from real equipment by appropriate instrumentation	24
4.	Applications for programming microcontrollers and programmable controllers for controlling mechatronic systems; programming of industrial equipment using programmable controllers; Comparisons between major microcontroller architectures (e.g. ATMega328 vs. NXP S08RN vs. KEAZN64)	24
5.	Monitoring and interfacing of manufacturing systems; Information display / visualisation / acquisition systems provided by sensors, transducers, identification and diagnostic systems; Understanding dif. analogue signal – digital signal; Understanding the frequency spectrum concept	24
6.	Reliability and maintenance of equipment, machines and machinery: installation, operation and current maintenance / preventive maintenance of drive and automation systems, supply – transport – automatic transfer systems, industrial robot manipulators as well as other technological installations / equipment used in current manufacturing processes; current maintenance – service for industrial robots, machine tools / processing centres, technological equipment, etc.	24
7.	Applications to computer-aided 3D design (solid modelling); user interface specific to the 3D working environment in which you work (Catia V5 / V6, SolidEdge 3D, NX, SolidWorks, etc.); 3D modelling of solids. "Part design" and "assembly design", constraints, representation of complex spatial surfaces; elaboration of virtual prototypes for specific components and assemblies	30

8.	Applications in advanced computer-aided 3D engineering: MEF modelling, programming and off-line simulation of robotic manufacturing systems and processes (Ansys, Nastran, RobCAD, Simulate process, etc.). CAD-CAE for optimising product design and assisted engineering; structural optimisation / modelling of static, dynamic, thermal behaviour / performance analysis of components / partial assemblies / general assemblies of mechanical / electronic, electro-mechanical / pneumatic / hydraulic products and systems for industrial and general use; CAD-CAM for the assisted manufacture of mechanical / electronic components of industrial and general use products (Catia V5 / V6 CAM, NX-CAM, MasterCAM, SolidCAM, etc.)	30
9.	Use of computer-aided design for system modelling, virtual and real prototyping, simulation and performance evaluation, subsystem and system optimisation	24
10.	Applications to artificial intelligence: practical applications, current trends; operation with virtual instrumentation programmes	24
11.	Applications for programming and operation of machine tools, robots, technological equipment / technological equipment and specific production lines for partner companies: CNC programming and assisted programming – off-line simulation of the operation of industrial robots / machines – tools / CNC machining centres (programming in ISO / One Touch IGF code, etc.), robotic / flexible cells / production lines for specific technological processes of handling, arc and spot welding, painting, assembly-assembly, cutting and unconventional processing, palletizing, storage – shipping	30
12.	Modern manufacturing technologies in mechatronics: implementation of new technologies and alternative equipment for processing current mechatronic products	24
13.	Software techniques in the field of embedded systems	24
14.	Elaboration and execution of technical projects for mechatronic components and subsystems; Realisation of virtual and real prototypes for partial command and control assemblies of mechatronic systems	30
Total		**360**

Note: *No.* of hours allocated to each topic may vary depending on the concrete conditions of each partner company and the purpose pursued in training students.

Another difference between the regular and the dual study forms is that students from the dual study programme must attend extracurricular courses organised by the companies (mandatory requirement), while for the students from the regular study programme the attendance is optional. All diploma works/graduation papers for the graduates of the dual study programme must be unfolded in the partner companies (mandatory requirement).

Assessment system

New rules for assessing the student performance during the practical activities have been established by LBUS and agreed on with the industry partners. The main element of the assessment procedures is the individual practice notebook, in which students note the main knowledge acquired during the practice in the form of technical sketches (of equipment, machines and machinery, tools, devices, apparatus), kinematic diagrams, diagrams, graphs

and explanatory texts for technological procedures and equipment operation. The internship activity ends with a colloquium that takes place at the end of the semester in front of a commission established by the department director composed of teachers and representatives of the partner companies. The colloquium consists of questions and discussions based on the topics and the practice book and will be specified in a note (for obtaining credits). The grade awarded is conditioned by the student completing the number of hours provided by the internship activity per semester and is awarded according to the relevance of the activities carried out in the professional training, the notes from the internship notebook, skills and knowledge acquired.

Table 5. Assessment system for dual students in LBUS

<table>
<tr><th colspan="4">Student assessment system</th></tr>
<tr><td>Type of activity</td><td>Evaluation criteria</td><td>Evaluation methods</td><td>Share of final grade</td></tr>
<tr><td rowspan="4">Practice</td><td>Volume and correctness of knowledge</td><td rowspan="3">Relevance to the topic and objectives of the paper for the specialised field; Solving practical problems with immediate applicability; Critical thinking, application of concepts and methodologies – case study; Correctness of the proposed solutions</td><td rowspan="3">40%</td></tr>
<tr><td>Scientific rigour of language</td></tr>
<tr><td>Content organisation</td></tr>
<tr><td>Drawing up and defending a paper</td><td>Treatment of the subject; Organisation of the work; Originality, personal contributions; Exposure quality; framing in the time interval; presentation structure; tools used</td><td>40%</td></tr>
<tr><td></td><td>Active participation in applications</td><td>Evaluation sheet</td><td>20%</td></tr>
<tr><td colspan="2">Minimum performance standards</td><td colspan="2">The practice report components</td></tr>
<tr><td colspan="2">• Attendance of all scheduled practical activities
• Correct and complete preparation of the report, case studies, practice book
• Correct answers to all questions</td><td colspan="2">• Presentation of the company where the practice takes place
• Daily diary of work in the company
• Description of the work performed according to the topics provided by the discipline sheet</td></tr>
</table>

The implementation of the practical phases for the dual study specialisation has been formalised by the following contracts/agreements:

- LBUS – industry partner – student will sign the contract of practical work
- Industry partner – student will sign the contract of internship

The differences between the regular and the dual study form have been formalised by designing a modified curriculum for the dual study option of the "Mechatronics" programme, which has been approved by the Council of the Faculty of Engineering and by the University Senate of Lucian Blaga University of Sibiu.

4.3.2 Stepwise dualization approach – Bachelor in Naval Architecture and Marine Technology in Bulgaria

Institution	Technical University Varna
Department	Faculty of Engineering
Domain	Transport, Navigation and Aviation
Specialization	Naval Architecture and Marine Technology
Degree	Bachelor
Duration	8 semesters
Total workload	236 ECTS
Workload practical activities	640 hours
Language of instruction	Bulgarian
Industrial partners	MTG Dolphin, Keppel Fels Baltech Bulgaria

At the end of 2018, the Innovation Strategy for Smart Specialisation of Bulgaria was updated including a new priority direction "Blue economy – development technologies". Currently, there is an urgent need for personnel in the shipbuilding and ship repair industry in Bulgaria. For this reason, the Technical University of Varna has selected the programmes "Naval Architecture and Marine Technology", "Marine Engineering" and "Design of Marine Power Plants and Systems" for update of the ongoing curricula and alignment with the industry needs. The national regulations and institutional rules at the time of programme selection allowed a different degree of adaptation for each of the three listed programmes. The most flexible one is the programme "Naval Architecture and Marine Technology" that allows the highest degree of dualization. Nevertheless, due to the specific rule in the Higher Education Law (students must graduate their education in a strong agreement with the curriculum they started their study with) dualization of the existing programme is only allowed through a stepwise approach.

Together with the development of the new curriculum for the dual study programme, the existing curriculum of the regular programme has been updated in parallel. The updated curriculum aims to:

- propose an amended structure of the curriculum that better responds to the needs of the marine industry
- integrate the current peculiarities of the interests of the students
- comply with the pre-school plan for upper secondary students
- respond to the engagement in the learning process and the available capacity of the teaching staff
- reflect on the comments and recommendations made by BULNAS (Bulgarian National Association of Shipbuilding and Ship repair)

During the curriculum update process the following principles and the stipulations have been respected:

1) The plan should be in line with the requirements of the "Methodological standard for the development of study documentation in TU-Varna", approved by the Academic Council of the Technical University of Varna (October 2018)
2) Make an appropriate shifting of the disciplines between the semesters so as to allow the introduction of another course project on "Production Technology for Ships and Marine Structures"
3) The practical exercises and the ability of students to work independently in performing various tasks have been leading in selecting new disciplines and developing a corresponding syllabus

4) Wider involvement in the training in the subject of modern software products and systems for the design and construction of ships and marine technology to partially address the enthusiasm of young people related to information technology

5) Drop out or combine disciplines on the curriculum that do not meet the specific needs of the business, the changing market circumstances and the interest of the students

6) Reintroduce the State Examination in English and increase, if possible, the number of lessons to 30 hours per semester

Summary of the main characteristics is shown in Table 6.

Table 6. Main characteristics of actual and updated curriculum

Main characteristics of actual and updated curriculum		
Item	Actual	Updated
Total number of disciplines	57	57
Exams	27	28
Current evaluation	14	12
Course project	3	4
Lectures (h)	1050	990
Seminar classes (h)	225	300
Course project (h)	90	120
Course work (h)	60	90
Laboratory classes (h)	825	750
Total hours	**2250**	**2250**
Extracurricular activities (h)	4340	4360
Student total workload (h)	6590	6610
Credits	237	233

The updated curriculum is valid as from 2019/2020 academic year. At the same time, in the Qualification Characteristics Statements, the following text was added *"The 'Specialised practice' discipline enables the application of the principles of practice-integrated (dual training) higher education. The practical training is held in the summer months after the 6th semester in BULNAS (Bulgarian National Association of Shipbuilding and Ship repair) companies with which TU-Varna has concluded partnership agreements."*.

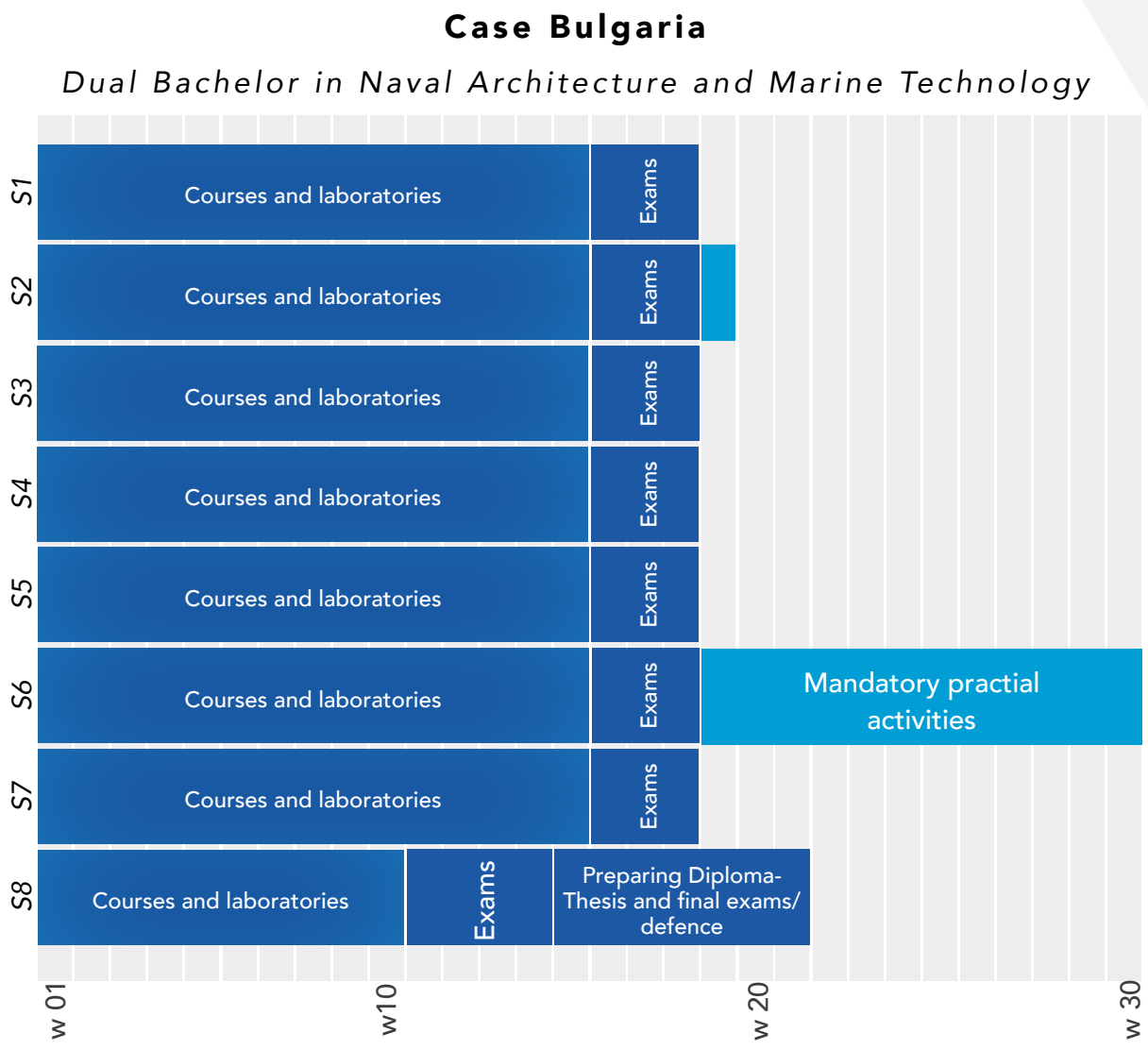
Beside the national and internal institutional rules that determined the structure of the pilot dual education and training, additional principles mutually agreed on with business partners have been taken into consideration. The following rules have been respected:

- Any adaptation made to the curricula and in the content of the syllabus, for various subjects, under consideration for dual education, must be approved by the responsible institutions. The procedure starts with a proposal of the Department Council, acceptance by the Faculty Council and finally approval by the Academic Council.
- According to the Higher Education Law, the student has to complete his/her training on the curriculum on which he/she started. This means that the dual programme developed within the project can be piloted just after the project. So far, only practical activities embedded in the approved ongoing programme can be implemented at the partner companies.

- It was agreed that the diploma work in the last year of study could be related to the activity of the corresponding company. At the same time, there is a rule that in order to develop a Diploma thesis, students need a certain minimum grade. Therefore, if the final thesis can be completed at the partner company, it needs to be considered case by case depending on the grades of the participating students.
- All documents and corresponding agreements between the Technical University of Varna, the Business partner and the Student will be agreed on between the parties and will take into account all local rules and regulations.

Current state of dualization of the NAMT programme: According to the actual curriculum, there are two practical activities. After the second semester, there is the so-called "Introduction Practice" (30 hours) and after the 6-th semester the "Specialised practice" (60 academic hours – 2 ECTS). There are other subjects like Marine Piping Systems, Electrical Equipment of Ships and Marine Structures, Technical Safety, Structural Mechanics of Ships and Marine Structures, Welding of Marine Structures, Strength and Structure of Ships that include more than 500 extracurricular activities. Based on this, the structure of the dual study is organised in two phases: 1) during semesters in TUV and 2) in partner company in the summer vacation after the 6th semester. The developed structure is presented in Fig. 9.

Fig. 9. Updated Bachelor in NAMT and proposed structure for practical activities



The practice starts with the student application followed by an approval by the company. In the summer vacation after the 6th semester, there is a total of 640 academic hours (480 astronomical hours). This is equal to 60 working days (eight-hour working day). The practice is paid according to the company conditions. This and all other conditions are described in the corresponding training agreement. Special training logbooks are elaborated for the needs of the pilot implementation. All the necessary documentation – contracts, logbooks, reports, etc. are developed considering the local conditions, based on good practices shared by the partner countries involved in the DYNAMIC project. The pilot implementation of the dual study is based on a voluntary choice by the students of the 3-year study course.

As it is related to the intentions for extension of the dual education, the envisaged steps and activities can be summarised as follows:

- include new specialties
- select and contact new industrial companies to cover the training for the new specialties included in the dual education offered by the university
- organise meetings and workshops with industrial partners to discuss and retrofit curricula with the needs of the industry for more qualified and educated people with improved industry-related skills
- workshops with students for identification of their needs for education and qualified training
- development of new curricula for newly included specialties which are in agreement with state legislation and rules
- co-development of appropriate dual models with the partner companies
- fine tuning of the developed toolkit of documents (logbooks, training, questionnaires, etc.)
- model implementation, self-evaluation and improvement

4.3.3 Module dualization – Cases from Croatia and Bulgaria

Institution Department	Juraj Dobrila University of Pula Faculty of Technology and Institute for Science and Technology VISIO
Domain	Production Mechanical Engineering
Specialization	Mechanical Engineering
Degree	Bachelor
Duration	6 semesters
Total workload	180 ECTS
Workload practical activities	915 hours of which 105 industrial practice
Language of instruction	Croatian
Industrial partners	Holcim Hrvatska Ltd, RED FORK

The Faculty of Technology was established in 2016 at University of Juraj Dobrila in Pula. The aim of the department is to educate engineers at the level of today's technical knowledge in the areas of production and computer engineering by combining new technologies and industrial practices. In addition to the basic technical, conventional and mechanical disciplines, the focus is shifting on the study of new STEM technologies with emphasising the use of 3D printers, mechatronics and robotics. Additive technologies are globally represented and are becoming one of the main tools for the development of functional prototypes in a wide-area of products, from the automotive industry, shipbuilding industry, buildings to the development of medical models. In addition to the great benefits of using, there are

also disadvantages such as the size limit of printed models, production time and the high cost of the material used. The undergraduate programme in "Mechanical Engineering" from the Faculty of Technology has been selected for dualization and integration of industrial requirements into the ongoing engineering curricula.

The programme Mechanical Engineering is organised in 6 semesters with a total workload of 180 ECTS. The classes include lectures and exercises for the acquisition of theoretical knowledge and laboratory exercises in modern equipped laboratories. This study programme provides not only conventional mechanical and computer disciplines, but also a few modern technologies like automation, electronics, additive technology, robotics and mechatronics. The Croatian higher education system permits a certain amount of industrial practice. For the purpose of industrial practice activities, a total of 9 ECTS is planned, 4 ECTS in the 2nd semester and 5 ECTS in the 6th semester in which the activities of industrial practice one and two take place. The current framework and law do not allow students to be employed and study as full-time students. Therefore, it's necessary to look in which direction the new regulations and new legislative framework should be proposed. Considering that the higher education system does not foresee a significant amount of industrial practice, the possibility for students of practical and professional fields to enrol in industrial practice on their own should be analysed and permitted. In that end, students would get closer to the goals of dual curricula. Furthermore, it's clear that curricula for a speciality must be specified strictly based on the national laws. All the changes in the syllabus and in the curricula necessary for the dual study programme, must be approved by the Department and Faculty councils as well as by the Ministry of Education. All changes must follow the national legislation. For these reasons, no changes can be currently made in the content of the study programme, but only part of the teaching process of selected courses will be held in cooperation with the industry partners. A few courses from the undergraduate study programme Mechanical Engineering will be offered as a dual course. Courses involved in the dual study programme will be from the 5th and the 6th semester, selected in agreement with the industry partners in accordance with the learning outcomes and required competencies. The exception was using knowledge and skills from 4th semester lectures in 3D modelling. The following courses have been selected:

- From 4thsemester: 3D modelling (3 ECTS) – students have already acquired some of the required knowledge in this course before the start of the project
- From 5th semester: Technology 2 (6 ECTS) and Technological preparation of production (5 ECTS)
- From 6th semester: Industrial Practicum (5 ECTS) and Bachelor Thesis (15 ECTS)

The total number of ECTS involved in dual education is 34 ECTS.

Table 7. Excerpt from the curriculum Bachelor in Mechanical Engineering at UNIPU

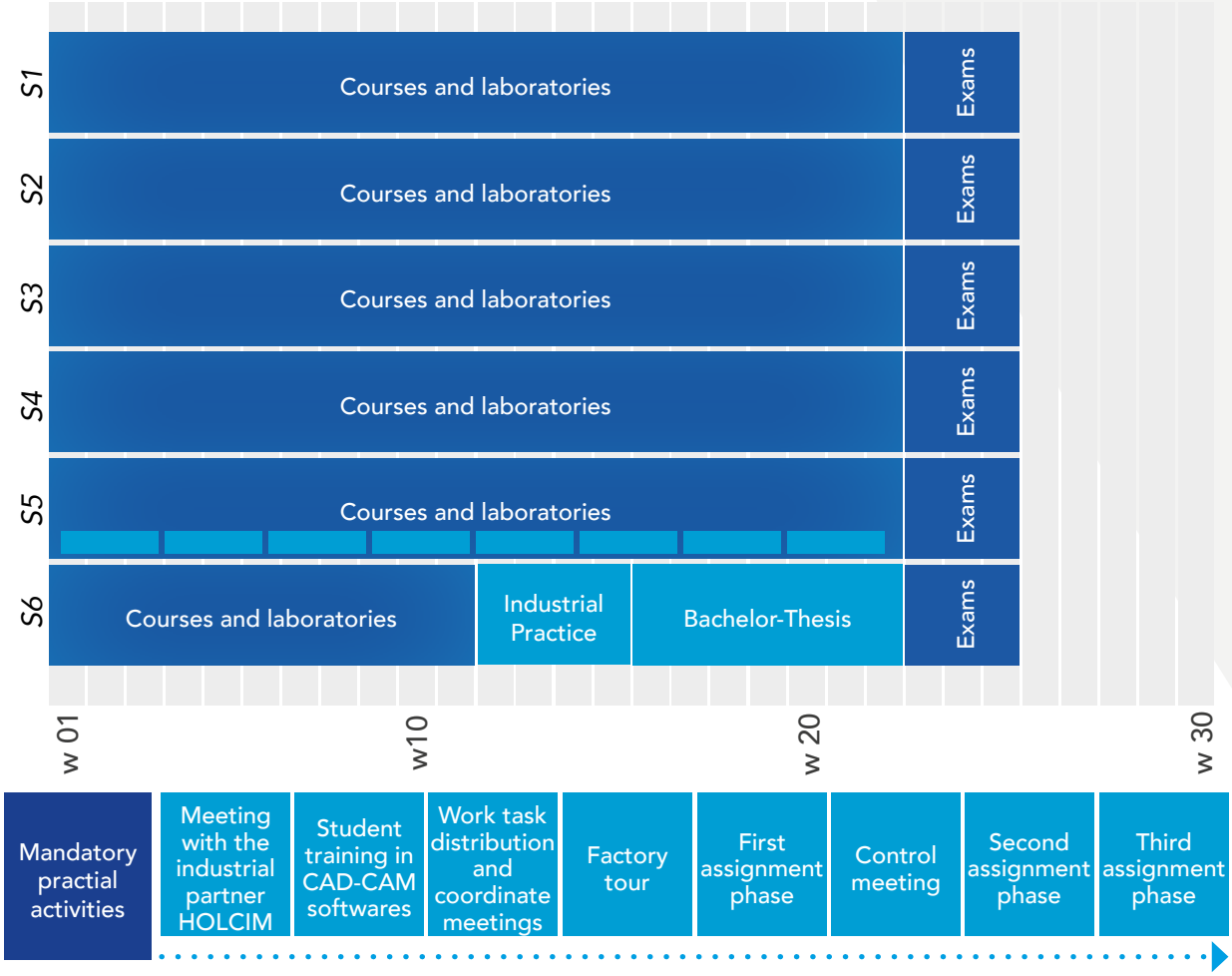
5. semester						
ETC	Name of the course	Course Code	Lectures workload	Practical workload	Seminar workload	Total workload
5.0	CNC Machining Systems	187193	30	30	0	30
4.0	Measurement in Production	187194	30	30	0	30
5.0	Maintenance of Industrial Plants	209278	30	30	0	30
6.0	Technology 2	187196	30	30	0	30
5.0	Technological Preparations for Production	187197	30	30	0	30
Elective course						
3.0	The Basics of Ecology	187204	15	30	0	45
3.0	Hydraulic Pneumatic	187207	15	30	0	45
3.0	Surface Treatment of Materials	187214	15	30	0	45
3.0	Heating, Air Conditioning and Cooling Technology	187211	15	30	0	45
3.0	Safety at Work	187199	15	30	0	45
Total in 5. semester						
28	/	/	165	180	0	345

The practical training is in several topics from general engineering to specialised fields of CAD/CAM, maintenance, processing activities, 3D modelling for virtual reality, all according to the curricula for the current semester. The training is implemented in cooperation with the VISIO Scientific Technology Institute of University of Juraj Dobrila Pula, which specialises in CAD modelling, 3D printing, FEM analysis, rapid prototyping, robotics and autonomous systems, IoT (internet of things), simulation and virtual reality. For the purpose of the DYNAMIC project, VISIO ensured laboratory infrastructure for the students in order to assure an adequate level of skills needed for training purposes in HOLCIM Hrvatska. The VISIO Scientific Technology Institute has a laboratory equipped with eleven Prusa i3 3D printers, which are used daily for both educational and productive purposes. Professors and industry mentors have worked together to develop a syllabus for each course offered in a dual form. In the winter semester (for students – full-time education, 3rd year of study) for the first 13 weeks students must pass all their lectures and exercises. In the first 4 weeks students will have introductory activities at VISIO institute in order to assure an adequate level of skills to enter the activities in the partner companies HOLCIM Croatia and Red Fork. During the next 10 weeks, students will have to work on specially designed tasks and will be included in practical training. In next semester, students will pass practical training in other subjects, in accordance with the curricula.

Fig. 10. Integrated practical activities in Bachelor Mechanical Engineering at UNIPU

Case Croatia

Dual Bachelor in Mechanical Engineering and Production



The organisation of the practical activities has been organised in the following stages taking place during the 5th semester of study:

Step 1: Meeting with the industrial partner HOLCIM

Meetings with industrial for setting up mutual goals and tasks.

Step 2: Student training in CAD-CAM software

Training a team of students in CAD-CAM softwares. To that end we have used several educational CAD-CAM programs to teach them how to make virtual 3D objects on computer, and how to make different types of technical drawing.

Step 3: Task distribution & coordinated meetings

Dividing into groups, and giving assignments to the students.

Step 4: Factory tour

Guided tour of the factory by professionals in the field of cement industry.

Step 5: **First assignment phase**

In the first phase, students had replicated and created virtual 3D models of some of the factory machines that are being used in the process of making cement.

Step 6: **Control meeting**

Control meeting with students and industrail partners to check out the first phase of the assignment, and to check out on the deadlines.

Step 7: **Second assignment phase**

After the first phase was approved by the industrial partners, students had proceeded in creating detailed assembly and technical drawings of the previously created models.

Step 8: **Third assignment phase**

Using the models to create an automated VR/AR tour of the factory.

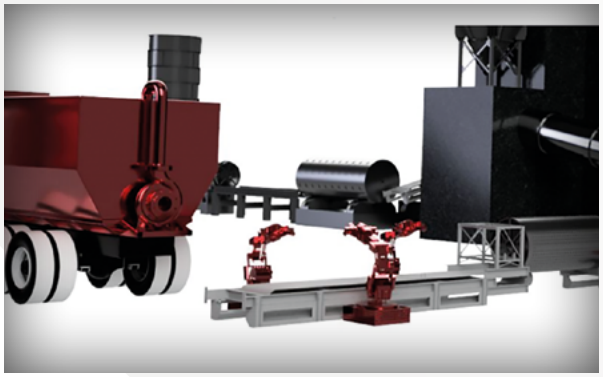
Step 9: **Final meeting**

Final meetings with the industrial partners and shearing results.

Similar approach of organisation was also followed in the coopertion with the industrial partner Red Fork.

Students mentored by industrial partners, professors and assistants included in the DYNAMIC project have created elaboration of an automated plant technical solution. Technical elaboration was created using CAD programme FUSION 360. Projected components are robotic arms, conveyors, silos and cylindrical rotary kilns. Other developed components are: a model of the mill, clutches and additional components with aim of better presentation of the fabrication process. Creation of technical documentation of all process components is also part of the practical activities. Idea concept also includes QR code, which allows the access to AR (augmented reality) of the plant. In this way we can see and walk through the virtual plant and see how it actually works. The final virtual reality model can be seen in the picture below.

Fig. 11. 3D model virtualisation, engineering process



The figure above presents the final CAD model after students have finished their traineeship in the Holcim Hrvatska. This is the final result from all student groups working on different parts of the model completing the phases of Analytics, CAD preparation design, Working in groups, VR environment design.

Institution	Technical University Varna
Department	Faculty of Shipbuilding
Domain	Transport, Navigation and Aviation
Specialization	Marine Engineering
Degree	Bachelor
Duration	8 semesters
Total workload	280 ECTS
Workload practical activities	
Language of instruction	Bulgarian
Industrial partners	MTG Dolphin

The specialised training of students in the programme "Marine Engineering" is provided by the Department of "Naval Architecture and Marine Engineering", part of the Faculty of Shipbuilding at the Technical University Varna. The Faculty of Shipbuilding is the only faculty of this kind in the civilian universities in Bulgaria, specialised in education in "Marine Engineering". The Department of "Naval Architecture and Marine Engineering" has a long tradition in training of engineers in the specialty of Marine Engineering. During their study at the Technical University of Varna, students in the specialty of "Marine Engineering" acquire profound engineering knowledge of thermodynamics, engineering mechanics, computer-aided modelling, marine diesel engines, steam boilers, steam and gas turbines, ship power plants, auxiliary machinery, ship systems, air conditioning and refrigeration systems, automation, the ship's electrical equipment, production technology, ship machinery installation and repairs, ship power plant testing, vibration and diagnostics, etc. Students gain practical knowledge and skills in metal turning, metal fitting, locksmiths, welding and maintenance of marine equipment. The main part of the practical training of students is conducted in the "Engine Room Simulator" at the Marine Engineering Department, Technical University Varna.

The education and training period for full-time and part-time students is 4 and 5 years (Bachelor's degree), respectively, including 6 months of training on board and production practice. The education period ends with state examinations in the specialty of "Marine Engineering" and in the English language. The students graduate with a Bachelor's degree and a professional qualification "Engineer in Marine Engineering". Besides this, they have the opportunity to obtain an internationally recognised certificate of competency. The graduates in "Marine Engineering" can apply their engineering knowledge as:

- marine engineers on ocean-going and river vessels, offshore rigs and marine facilities
- designers and technologists
- production managers in shipbuilding and ship repair companies
- researchers and lecturers
- supervisors, experts and consultants in institutions, companies and organisations in the public and private sector

The curriculum and programme in "Marine Engineering" must always meet the requirements of the International Maritime Organisation (IMO) for seafarers' competence STCW78 and are consistent with the strong requirements of the Executive Agency "Maritime Administration (EAMA). The programme "Marine engineering" is a regulated specialty in accordance with the uniform state requirements in the professional direction "Transport, Shipping and Aviation". The training is carried out according to a specified curriculum approved by the Maritime Administration Executive Agency and meets all national requirements for the qualification of seafarers. Excerpt from Ordinance No. 6 related to the Competence of Seafarers in the Republic of Bulgaria:

"Art. 3. (1) All seafarers shall be trained and certified as specified in this regulation and:
1. for sea ships – in accordance with the requirements of the International Convention on Watchkeeping and Seafarers Training and Certification Standards of 1978 (STCW Convention) and Directive 2008/106 / EU, as amended;
2. for river ships – in accordance with the recommendations for the training of shipowners and their provision of certificates of competence for international navigation by the Inland Transport Committee of the United Nations Economic Commission for Europe, the Danube Commission and Directives 96 / 50 / EU and 91/672 / EEC.
(2) National standards for the competence of seafarers shall be determined by an order of the Executive Director of EA MA and shall be published on the website of Maritime administration.
…
Art. 6. Seafarers shall acquire legal capacity if they have:
1. a diploma for completed approved education;
2. a certificate of prior competence, issued by Marine Administration, or confirmation of a certificate issued by a member state of the European Union, when required;
3. a document certifying the existence of navigational experience;
4. a certificate of successful completion of the preparatory course approved by Marine Administration when required;
5. a medical certificate of health fitness;
6. undergone navigation training and / or training record, documented in a practical training log when required… "

Students from "Marine engineering" – Bachelor's degree (4-year course of study) must complete 6 months of on-board training, which must be completed after the third year, when students start to study specialised subjects – marine diesel engines, compressors, pumps, marine steam generators, marine steam and gas turbines and others. In the course of training, a specialised practice in the industry is also envisaged. In Table 8 specifics related to the curriculum of "Marine Engineering" are presented. In addition, selected excerpts from the curriculum of "Marine Engineering" are given below, aiming at clarification of its main features, Table 9 and Table 10.

Table 8. Main peculiarities of the curriculum of "Marine engineering" (2016/2017)

Main peculiarities of the curriculum of "Marine engineering" (2016/2017)					
Semester	Disciplines	Total academic hours	Extra-curricular hours	Total	ECTS
1	8	195	585	780	30
2	9	315	585	900	33
3	9	285	570	855	31
4	9	270	585	855	32
5	9	315	570	855	33
6	8	270	675	945	35
7	7	345	480	825	30
8	6	255	420	675	24
Optional Subject*	1	0	960	960	32
TOTAL	**66**	**2250**	**5430**	**7680**	**280**

**on-board training or Shipyard training*

Table 9. Selected excerpts from the curriculum of "Marine Engineering" (2016/2017)

Selected excerpts from the curriculum of "Marine Engineering" (2016/2017)					
Optional subject	*	0	960	960	**32**
On-board Training					
Shipyard Training					

**The duration of the optional subject "On-board Training" or "Shipyard Training" is 6 months. It is conducted after the 4th, 6th and 8th semester/or partially during the preparation of the state exams preparation.*

Table 10. Optional courses for those students who intent to attend on-board training (2016/2017)

Optional courses for those students who intent to attend on-board training (2016/2017)				
Name of the discipline Disciplines	Total academic hours	Extra-curricular hours	Total	ECTS
Additional Training for seafarers in compliance with STCW Convention – Part 1	60	60	120	4
Additional Training for seafarers in compliance with STCW Convention – Part 2	26	34	60	2
Additional Training for seafarers in compliance with STCW Convention – Part 3	40	50	90	3
Additional Training for seafarers in compliance with STCW Convention – Part 4	40	50	90	3
Additional Training for seafarers in compliance with STCW Convention – Part 5	95	95	190	7

As full-time students have scheduled lectures and classes during the two semesters (for third- and fourth-year students: winter semester from mid-September to December – 15 weeks; summer semester – end of January to the first week of April – 10 weeks) of the corresponding year from their training, the on-board training must be covered during the summer holidays – in the months of June, July and August. After the completion of the fourth year, all students are required to pass specific state exams in English and a specialised examination in "Marine machinery", in accordance with the requirements of the Executive Agency "Maritime Administration" and in accordance with the STCW Convention (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers). The state exams are held in the second half of June. Therefore, it is almost impossible for students from the programme "Marine engineering" to pass their practical training during the summer vacation. In addition, emphasis should be placed on the fact that the content of each syllabus must follow the requirements of the Executive Agency "Marine Administration" (EAMA). EAMA checks

the content of each syllabus, compares it with the specified requirements and then these programmes are approved. Therefore, any changes in the curriculum and syllabus for various subjects will be associated with serious and time-consuming discussions with representatives of the EAMA and changes in basic laws related to the national educational system will be needed. In addition, it will be close to impossible to demand changes in the regulations of the International Maritime Organization (IMO). Official rules / regulations of the Technical University Varna, as well as the requirements of the Higher education legislations, state that the curriculum of a definite specialty cannot be changed during the course of study of students, enrolled for a study according to this curriculum; i.e. all students admitted upon a given curriculum must graduate in accordance with the same curriculum under consideration.

Taking into consideration the above described limitation factors for the curriculum flexibilization, the following decisions and planning have been made in order to integrate industrial training needs identified during the stakeholder interaction:

- all practical training (practices) included on the curriculum should not be conducted in the laboratories of TU Varna, but on the territory of an industrial partner company
- laboratory exercises in specialised subjects (if possible) will be conducted on the territory of an industry partner company
- the hours (respectively credits) planned for independent work on the curriculum of "Marine engineering" will also be incorporated into the industrial company training

The structure for pilot implementation of dual practice-integrated training for students in the programme "Marine Engineering" is accepted, considering the existing national and institutional legislation and the existing curriculum. A few specialised subjects from the approved ongoing curricula such as the subjects "Repair of Ship Machinery", "Metal turning" and/or "Metal fitting" have been selected for a pilot dual implementation between TU Varna and MTG Dolphin. Students from 1st, 2nd and 3rd year of study, can be accepted by MTG Dolphin for a practical training – 60 hours (metal turning, metal fitting, welding) in accordance with the curriculum for the current semester. In the winter semester (for students – full-time education, 4th year of study) for the first 13 weeks students must pass all their lectures and exercises. Students will spend the next 2 weeks in MTG Dolphin for their practical training in "Repair of ship machines and mechanisms".

Students from "Marine Engineering", in the 4th year of their study, from the Bachelor's Degree programme, have a subject "Repair of Ship Machinery" during the winter semester. The programme has been rescheduled to free two weeks at the beginning of December for practical training in the partner company MTG Dolphin. During this period of two weeks, the students pass their practical training directly involved in the repairs of marine machines and mechanisms. This is very important for the students, as they are going to meet face-to-face the specifics of the marine machinery repair process in order to be able to carry on their duties on-board. During the training, the students are full-time at the company for two weeks, which has been formalised by a contract signed between the students and MTG Dolphin. A contract between TU Varna and MTG Dolphin has also been signed in advance before the training.

Students in "Marine Engineering" in their 1st and/or 2nd year of education could be considered to undergo for the second part of their practical training on "Metal turning" and/or "Metal fitting" at MTG Dolphin.

General rules for implementation of the dual practice-integrated training have been elaborated. These rules cover procedures of the enrolment, selection and assessment of students as well as the preparation, implementation and documentation of the practical training.

Institution	Technical University Varna
Department	Faculty of Shipbuilding
Domain	Transport, Navigation and Aviation
Specialization	Design of Marine Power Plants and Systems
Degree	Master
Duration	4 semesters
Total workload	116 ECTS
Workload practical activities	
Language of instruction	Bulgarian
Industrial partners	Industrial Holding Bulgaria – "Ship Design" – associated partner

Additionally, students from a new specialty, "Design of Marine Power Plants and Systems" have been included to the DYNAMIC project. The Master's program is in professional field 5.5 "Transport, Navigation and Aviation" and has a duration of three semesters of academic study and one semester of pre-thesis graduate internship. The training ends with a diploma thesis.

The majority of students in "Design of Marine Power Plants and Systems" were accepted by "IHB Ship Design" for dual education in a specific subject. For the purposes of the dual education at the associated partner company Industrial Holding Bulgaria – "Ship Design", a contract for outsourced training between the Technical University of Varna and its office in Varna was signed.

Students accomplished training at the IHB Ship Design in the following subjects:

- "Computer systems for design of ships and marine equipment" – Part 1 – 45 hours exercises (in accordance with the curriculum and additional hours training)
- "Design of systems and devices for ships and marine equipment" – 30 hours of lectures / 15 hours of exercises
- "Design of ship pipelines" – 30 hours exercises (in accordance with the curriculum and additional hours training)
- "Computer systems for design of ships and marine equipment" – Part 2 – 60 hours exercise (in accordance with the curriculum and additional hours training)

Students filled out training logbooks considering their tasks and developed new skills and knowledge.

Students had the opportunity to get theoretical and practical training in the field of design of marine machinery and systems, to get acquainted with specific software products on the premises of the company IHB Ship Design. Besides that, mentors revealed for them some undescribed in reference books approaches and secrets of design in the area of marine machinery and systems.

Students not only started work for the company IHB Ship Design but also passed their undergraduate internship of 60 hours. Additionally, students completed their diploma thesis at IHB Ship Design. Its topic was closely related to their work for the company and the tasks provided. All that provided them with a deeper look at the idea of dual training.

Both students and mentors from IHB Ship Design are impressed by the dual training system, which has not been known to them so far. The mentors expressed the opinion that they would like to continue working in the way required by the dual system and thus have the opportunity to meet their potential future colleagues and help them train and grow in the profession.

4.4 Common limitations, comparison of the approaches, similarities and common parts

In the three countries of pilot implementation, different approaches have been followed in the curriculum development, respectively curriculum adaptation process. In all cases, the approach has been guided by the national higher education regulations and determined by the degree of institutional autonomy in the implementation of the national rules. In the case, where international regulations are in force, such as the case of the programme "Marine Engineering" at the TU Varna is, amendments in the ongoing curriculum are even more compounding. Initiating a bottom-up curriculum update approach in such case is less motivating due to prolonged and sometimes bureaucratic communication chain.

Regardless of the different conditional framework in all national cases, it was possible to establish or to expand existing university-business-cooperation forms. Cooperation readiness and communication between academic and industry stakeholders played a determinant role in the success of the solution-finding process despite the restrictive regulatory environment. While national higher education law and institutional rules were a common challenge for establishing dual higher education programme in all three countries, the creativity and cooperation spirit of the stakeholders have led to a suitable solution in each country-specific context.

A comparative analysis was conducted during the DYNAMIC project with the aim to identify similarities and common parts and highlight major differences between the dual models developed and piloted in Romania, Bulgaria and Croatia. The comparison was guided by the following criteria:

- total amount of ECTS for the entire study
- total amount of ECTS for the practical activity
- duration of practical activity
- number of semesters for practical activity
- main subjects
- beginning
- rotation principle
- selection criteria for choosing students
- payment
- contracts and logbooks.

The results of the comparison analysis indicate the following similarities and common parts of the three country-specific models and curriculum development/adaptation approaches:

- Mandatory practical components in the ongoing curricula such as internships or industrial practices have been allocated in the partner companies
- Syllabus of specialty subjects has been updated in collaboration with industry stakeholders
- Where deemed suitable, laboratory exercises have also been allocated in the partner companies
- Where possible, planned hours (respectively credits) for independent work, were also incorporated into the industrial company training
- Allowed flexibility rules have been applied to increase the workload of practical activities, where possible

- ECTS basis is used to integrate the practical phases on the curriculum
- The final thesis must be completed on a practical topic co-supervised by the partner company
- Similar documentation is used for the documentation of the practical activities and for the assessment process
- Reference letter, reflecting the student performance during the work in the company, shall be issued to each student by the hosting company at the end of the programme
- Industrial experts hold lectures at the university
- Study visits at the partner companies
- Although a selection process has been established in the programmes, the partners strive to offer dual learning opportunity to as many students willing to be involved as possible. In the programmes with lower number of students enrolled, it was possible to involve the entire cohort in the pilot (e.g. case Bulgaria)

Among the differences in the presented models count the rotation principles which have been determined by the curricular approach for each programme and the semester organisation in each university. In addition, the contractual agreements and payment schemes differed from one another depending on the national labour laws and company remuneration practices.

As a closing remark, it shall be mentioned that the described pilot models of practice-integrated dual study programmes in Romania, Bulgaria and Croatia have been developed within a limited timeframe defined by a project-based schedule and with limited project resources. Due to circumstances implying a partner change in Croatia, the model presented for this country has been developed in the time frame of one calendar year only. Therefore, the presented models cannot be considered as an end product but rather as a prototype subject to continuous improvement and further development.

5. Pilot implementation of practical training

This chapter provides a synthesised overview of the pilot implementation of the developed dual models described in the previous chapter. The sections below present practical examples in terms of student selection criteria and procedures, preparation of the participants and the mentors, rotation principles and examples for practical activities, student assessment and evaluation of the practical phases. Finally, the communication between the academic and industry mentors and their relationship during the pilot implementation is described.

5.1 Student selection process

In all cases described in the previous chapter, the practical training has been based on a voluntary choice by the students and afterwards approval by the industrial partners. The selection procedures have been jointly agreed on by the universities and the partner companies.

In the undergraduate programme "Mechatronics" at the University Lucian Blaga, Sibiu, the students in the academic year 2018-2019 were able to choose between the regular form and the dual form of the "Mechatronics" specialisation. All students started as regular students. They learned about the dual option after admission. At the very beginning of the semester, there was a faculty meeting where the dual option was introduced. After the presentations of the companies, students had one week to decide if they wanted to become dual students

and to which company to apply. A limited number of places were allocated to the dual study specialisation, and the selection of the students was done according to a selection procedure proposed and agreed on between LBUS and the industry partners. Starting with the academic year 2018-2019, the students from the "Mechatronics" study programme were organised in 3 study formations:

- One formation (37 students from MECH-RO, dual study)
- One formation (23 students from MECH-RO, regular study)
- One formation (4 students from MECH-RO dual plus 4 students MECH-RO regular)

The student selection process was based upon a selection procedure, agreed on between LBUS and the partner companies Continental and Marquardt. The selection was unfolded by means of a combined approach, consisting of the following:

- An interview which assessed the willingness of the candidate to pursue the dual study option of the programme (with a weight of 70% in the final grade)
- Academic results – admission grades (with a weight of 30% in the final grade)
- Distance from student's home to the receiving company location, taking into consideration that for the dual study programme the practical activities will take place during the summer holidays when student dormitories are closed, thus the receiving companies must provide accommodation for students outside Sibiu

Finally, the companies decided to accept a much larger number of students than the one agreed on at the initial phase of the project (initially 5 students for each company). The final number of students accepted for the dual study programme was 41.

A similar selection approach was applied in the pilot programme in Bulgaria. The procedure of students' selection was oriented to quality and successful practice fulfilment. Students' selection involves a rigorous evaluation of knowledge, skills, and motivational aspects. The process of selection included the presentation of a CV, grades during the course of education, motivation letter and an interview with the candidate where the merits were assessed. The interview was the most important part of the selection process. For the programme "Marine Engineering" in TU Varna (Bulgaria), it was decided to make the practical training in the discipline "Repair of Marine Machinery" mandatory for every student. Due to the limited number of students in this specialty, it was possible to divide students in groups in not more than 10-12 students (the biggest group), so that the entire group for every year could be accepted for a practical training at MTG Dolphin. Similar circumstances explain the opportunity provided to all students from the programme "Mechanical Engineering" at the University Juraj Dobrila Pula in Croatia to apply, and if accepted by the partner companies, to attend practical training. The selection criteria applied in the case of Croatia included academic results, a motivation letter, an interview with the students in order to assess the student determination and motivation and previous knowledge and skills in the field of CAD modelling, technical documentation, and production engineering.

5.2 Preparation

Each student was obliged to conclude a relevant contract and sign a declaration according to the General Data Protection Regulation (EU) 2016/679. The contractual templates have been prepared according to the national labour and education legislation. The partner German Chambers of Industry and Commerce acted as advisors during the negotiation of the cooperation and training agreements. Experience sharing from the partners in Germany and Austria was also involved in the process.

The preparation of the students included informational workshop that familiarised students with the conditions for the practice within their company. Each company organised then a separate kick-off at its premises at the beginning of the first practical phase and conducted work safety training for the students.

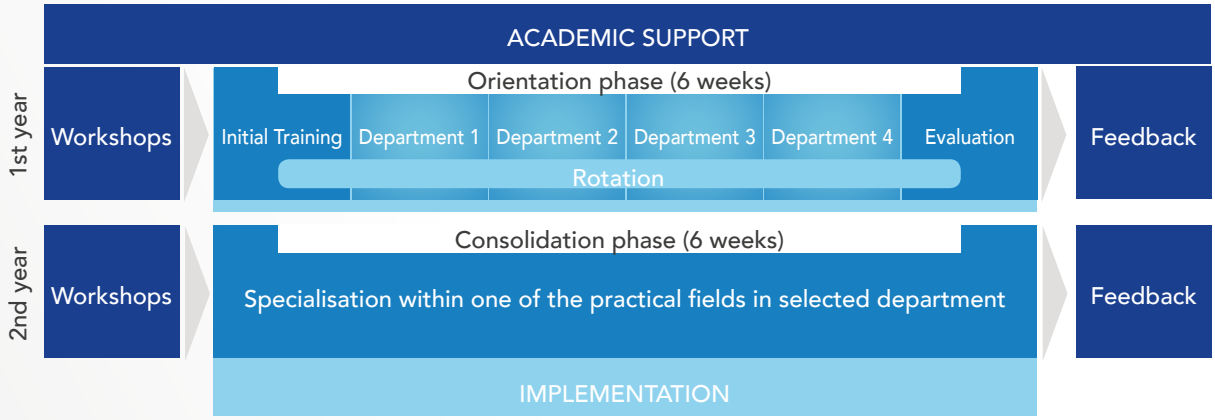
The implementation preparation phase also included training of the academic and industry mentors involved in the practical training and supervision of the students. For the training of the academic mentors, a special Toolkit for implementation and documentation of dual higher education programmes has been developed in the scope of the DYNAMIC project. The Toolkit aims to support the mentoring at the companies. It consists of templates of necessary standardised documents such as practice report – diary, evaluation and assessment of the students´ performance, a feedback questionnaire for the student, application for Bachelor thesis, procedure of the visit in the company – a checklist (info folder and visit schedule) as well as the protocol for the mentor meeting in the company. All documents support the mentors during the mentoring process and make their job easier as well as more transparent in compliance with the quality assurance aspects. A few samples from the above listed templates have been provided in the annex section of this document. The experience of the academic mentors after the pilot implementation is presented at the end of this chapter.

The German Chambers of Industry and Commerce in Romania and Bulgaria are using an approved by the Association of German Chambers of Industry and Commerce (DIHK) training programme for industrial mentors to acquire basic pedagogical and psychological knowledge and skills in working with trainees in a real work environment. The programme is intended for mentors in enterprises in conducting dual education and includes: objectives of the training, structuring of the study time, content and expected learning outcomes. The programme explains the legal framework for dual education (dual training system) as well as the planning, implementation and evaluation of practical training. A detailed description of the Train the Trainer course for industry mentors is also provided at the end of this chapter.

5.3 Rotation principle

The rotation principle of the practical phases follows a block model. The theoretical cycles at the university during the semester are changing with practical phases in the companies mostly during the semester breaks. Even if the practical activities are unfolded in different companies, there are many similarities in their general structure. At the beginning of the programme, and then of each semester, an informational workshop is jointly organised by university lecturers and company representatives on the campus. The workshop delivers information about the dual model, explains the rotation principles and presents the organisation and schedule of the implementation. During the first introduction workshop, all companies explain how the practical training will be implemented in each company. Then students decide for which company to apply. Once selected by the company of choice, the students must complete all practical phases with the same company. The first practical phase in the company mostly has the function to familiarise the students with the company and its operation as a general. During this orientation phase the students spend time in all company departments to get impression about the processes and operations performed in each department. The orientation practical phase is followed by a regular semester at the university. Prior to the second practical phase, the students have a consultation with the HR department in order to identify the department and team in which they best fit in. The consequent practical phases take place in the selected department. Each practical phase ends with a feedback round for each student in the company and afterwards in the university. During the practical phases, the academic mentors remain available for questions and support to students.

Fig. 12. Example of practical phases organisation from the dual Bachelor in Mechatronics



The programme with short practical phases with duration of two weeks also starts with an introduction event in the university jointly organised by academic mentors and company representatives. During the first day in the company, the students must complete a work safety training. During the remaining days, students are split into different groups guided by an industry mentor. Every day stars with an introduction of the daily tasks provided by the mentor in charge. The academic mentor has the obligation to control the conduct of the internship. This control is carried out through communication with trainees by telephone or through on-site visits. The short-term practical phases end with a student-company feedback and evaluation of the training dairies/logbooks by the academic mentors.

5.4 Participants

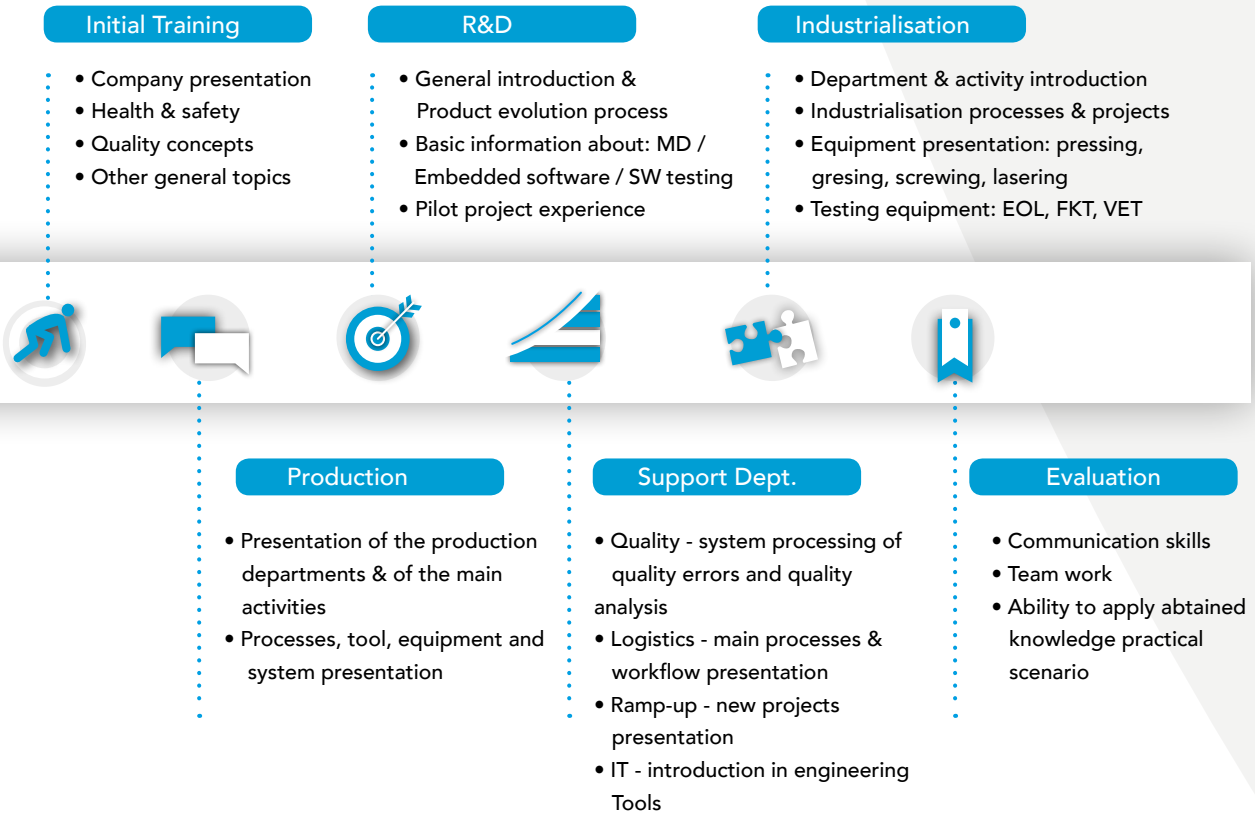
Due to the highest number of participants selected from one dual programme, the distribution of the selected students will be presented with the example of the case dual "Mechatronics" in University Lucian Blaga, Sibiu, Romania. All students enrolled at "Mechatronics" specialisation (57) were presented the possibility to follow the programme in a dual system, by means of a dedicated presentation at LBUS and a visit at the two partner companies. A number of 41 students was selected by the companies. Finally, a total number of 35 students attended and finalised the internship.

The participants (students from the dual programme "Mechatronics"), were selected by means of a selection process described in section 5.1 and divided as:

- 26 students at Continental Automotive Systems Sibiu (CASS)
- 9 students at Marquardt Schaltsysteme SCS Sibiu (MSS)

Because all students were enrolled in the 1st year, both companies decided that they should start with a Rotation Plan and try out more activities afterwards, after getting familiar with the structure and activities of the host companies. Figure 13 presents the Rotation Plan for the students at Marquardt Schaltsysteme SCS, Sibiu (MSS).

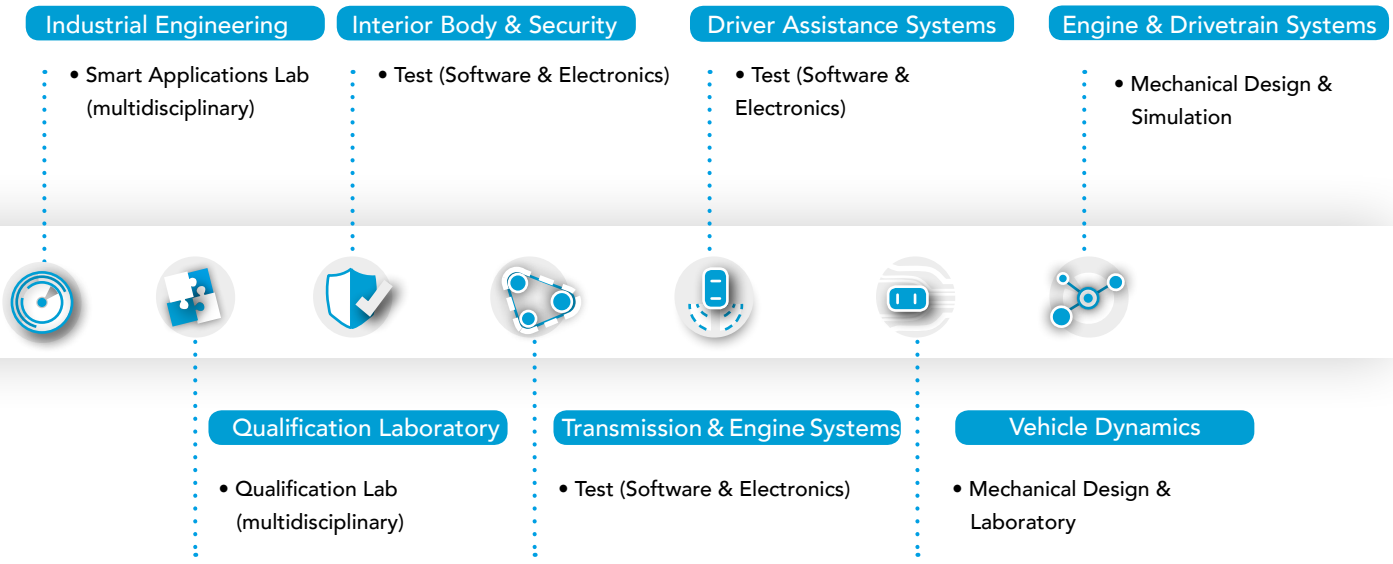
Fig. 13. General structure of practical activities at Marquardt Schaltsysteme in Sibiu



Source: MSS

Figure 14 presents the departments included in the Rotation Plan for the students at Continental Automotive Systems Sibiu (CASS).

Fig. 14. Rotation Plan at Continental Automotive Systems Sibiu



Source: CASS

The students were paid during the internship. The amount of the payment was agreed on between students and companies, according to the laws and regulations. Accommodation was also offered by the companies for the students living outside Sibiu.

5.5 Practical activities

The content of the practical activities was tailored to both the requirements of the industry partners and the new syllabus designed by the universities. Each of the activities performed by the students had to be registered and described in the student logbooks/practice diaries, which they filled in during the practical phases. For example, the content of the practical exercises and activities in the programmeme "Marine Engineering" in the TU Varna, Bulgaria, included the following assignments: repair of marine boilers and boiler elements – evaporators, super-heaters, etc.; burners; main diesel engines and other marine machinery, depending on the ships accepted at the yard. These assignments correspond to elements of the subject "Repair of Marine Machinery", according to the syllabus of specialty "Marine Engineering".

Fig. 15. Example for practical activities in the field of shiprepair

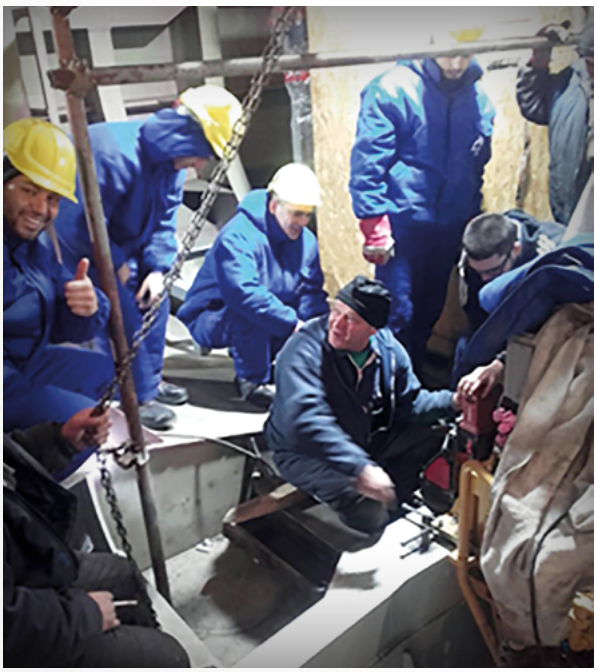
Implementation

TASK: SHIPREPAIR

Boiler safety valve is an extremely important equipment fitted on the steam drum of the boiler. When steam pressure inside the boiler drum is not regulated correctly, boiler explosion may occur. During ship repair at ship repair yard all boiler safety valves are disassembled, rust cleaned, gaskets replaced, assembled and tested.

In the picture, students are disassembling few boiler safety valves. The day task is to disassemble, clean, replace all gaskets and seals and test the valves after assembly.

The procedure of marine gear installation involves three basic steps: installation, alignment and mounting of marine gears. The alignment is process where the axis of power transmitting elements is made collinear. The alignment must be within specified tolerances for satisfactory transmission service life. In the photo, students learn practically how to measure alignment between gearbox and propeller shaft on a new build vessel. During their practice, they passed through all steps of marine gear installation procedure. disassembling few boiler safety valves. The day task is to disassemble, clean, replace all gaskets and seals and test the valves after assembly.



In "Naval Architecture and Marine Technology" for each of the participants specific areas of the manufacturing process, in which to conduct practical training, were defined. These areas included: Fabrication and assembly of sections; Plasma cutting; Installation of ship mechanisms. During the practical activities, students were permanently mentored by tutors from the companies involved in the dual study programme. Each of the students has the task:

- to get acquainted with the safety measures and the requirements in the respective activity
- to get acquainted with the organisation of work
- to examine the responsibilities of all participants in the process
- to participate in various operations and activities
- to seek additional information on all accompanying activities
- to compare the obtained theoretical knowledge with the practice that is adopted in the company
- to be able to formulate relevant topic connected with the area of training to be the subject of future diploma thesis

Dedicated practical activities have been developed according to the syllabus of the specialty subjects that have been selected for dual implementation. The syllabi have been agreed on between the academic and industrial partners. The industry mentors from the respective department have been involved in the activity development, student instruction and direct supervision during the activity execution. The figure below illustrates examples of practical activities in the company Marquardt Schaltsysteme SCS Sibiu, Romania.

Fig. 16. Examples of practical activities in Marquardt

Implementation

TASK: ASSEMBLY RULES AND REWORK

The students had to disassemble a product, to identify the number of components, the function of each one and they had to build an assembly sequence scheme. In this way, they learned some basic few rules of product-assembly. They had to sketch the execution drawing of one part by own choice.

Students had to identify defects on a product and they had to find solutions to solve the existing problems. For this, they had to adjust by manual rework and to modify the real product's geometry.

The practical activities performed by students had the specific objective to develop new industry-related skills and improve the knowledge they have acquired during their study. The students that were involved in practical activities with the company HOLCIM Ltd, acquired skills specific for the cement industry and improved their existing skills for CAD modelling

and in making technical and assembly drawings. The students that were involved in practical activities with the company RED FORK, acquired new skills in the area of biotechnology, additive technology and IT science as well as improving skills for CAD modelling and in making technical documentation and assembly drawings. The figures below illustrate examples of practical activities in the companies Holcim Hrvatska Ltd. and RED FORK, Croatia.

Fig. 17. Examples of practical activities in Holcim Hravatska and RED FORK

Implementation

TASK: CAD MODEL

The final CAD model after students have finished their traineeship in the Holcim Hrvatska. This is the final results from all student groups working on different parts of the model completing the phases of Anaylitics, CAD preparation design, Working in the group, VR environment design.

Implementation

TASK: ASSEMBLY RULES AND REWORK

Practical activities from students at Red Fork included:

- designing and modeling specific components used for making a 3D printer that can print custom supplementation pills
- choosing the right materials for the components
- generating technology documentation – student diary
- 3D printing the prototypes for those components

The student's evaluation take place at the end of the practical activities. The first step of the student evaluation process takes place in the training companies. Mentors from each department included in the Rotation Plan evaluate the students. At CASS, the tutors had to evaluate students by filling up the table presented below.

Table 11. Evaluation table at CASS

Evaluation table at CASS						
Student	Depart ment	Direct superior	Overall performance of Summer Intern	Contact Decision	IF Prolongation (ending date of the contract)	TLs Comments

Source: MSS

At MSS, several criteria were defined for the evaluation, and the tutors had to fill up the following table. The appraisal scale used was 1-10, similar to the one used at the university.

Table 12. Evaluation table at MSS

Evaluation table at MSS									
Competences applied during the internship	Appraisal								
	R6D Dep.	OP6 Dep.	OP3 Dep.	OM Dep.	LO Dep.	IEE Dep.	IEI Dep.	IT Dep.	OPS Dep.
Communication skills									
Teamwork									
Independent decision making									
Ability for evaluation and self-evaluation									
Cooperation with specialists/ experts from other domains									
Ability to apply obtained knowledge in practical scenarios									
Ability to adjust to new situations									
Caro for obtaining quality									
Execution of complex tasks									
Appraisal result									

Source: MSS

Feedback meetings were organised to assess the students' feedback regarding the first results of the internship programme. Feedback questionnaires were distributed to the students.

After completion of their practical training, students also filled out feedback questionnaires provided by the university. The purpose of these questionnaires was:

- students to share their experience from the industry
- students to share experiences and impressions from the practical training
- to provide ideas for the development of the dual training and possible improvements of the dual models
- to share ideas on how to improve the cooperation with the industrial partners

The following aspects of training were most appreciated by the majority of the students who filled in the questionnaires:

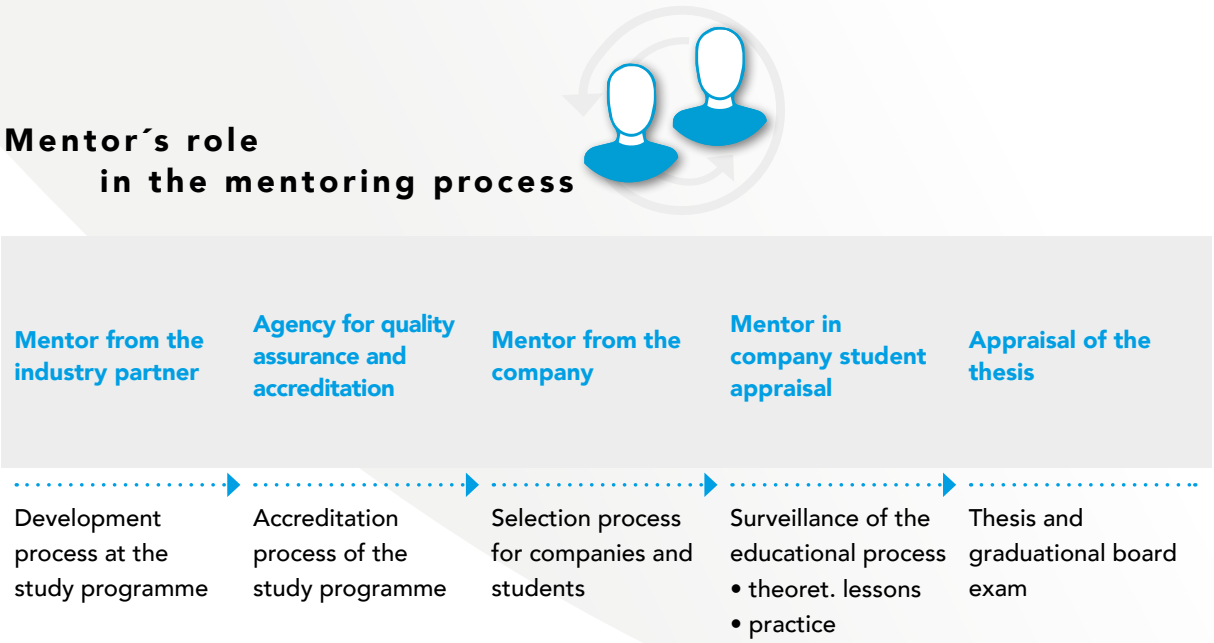
- gained valuable engineering job experience
- enhanced personal skills such as self-confidence, self-efficiency and self-motivation
- upgraded technical skills
- successfully supported by both academic and company mentors
- felt more competitive for the future career

During the entire practical phase, every day students have to fill in a diary in which they keep records of their daily assignments with explanation of provided and solved tasks. At the end of the practical training, the diaries are endorsed by both the industry and university mentors. The mentors from the industry and academia are asked to complete evaluation reports for students' work and the gained practical knowledge and experience; share their opinion and recommendations (if any) on the overall practical training. The practice diaries and the mentors' reports provide the basis for student assessment and grading of the practical part of the dual study.

5.7 Communication between academic and industrial mentors

An effective mentoring system with well-qualified mentors in the groundwork is an indispensable element of the dual education model. The smooth communication and good collaboration between industry and academic mentors are the backbone for successful design and implementation of dual education forms. The relationship between both parties covers the whole process chain from the need analysis, curriculum development, content elaboration and development of practical assignments, selection, guiding and supervision and assessment of students up to career development guidance. The figure below illustrates the relationship between the mentors representing the two learning locations – the university and the training company.

Fig. 18. Exchange between academic and industry mentors



The relationship between the academic and industry stakeholders within the DYNAMIC project can be described as proactive and collaborative. The companies Continental and Marquardt have an established ambassador system appointing a company representative to coordinate and deal with all matters related to the cooperation with the university. Similar to the ambassador system in Romania, representatives of the Bulgarian partner companies actively participate in the university advisory boards and professional councils at the Technical University Varna. For example, the company representatives are members of the professional council for the Naval Architecture and Marine Technology programme and support the accreditation process.

In addition, the following means were put in place during the DYNAMIC project:

- Quarterly meetings with faculty managements
- Project meetings as project partners
- Lectures given by company experts in the university
- Academic staff visits in the company
- Informal meetings during events in the university and the city

During the implementation of the practical phases the communication between the academic and business partners took place via telephone mainly or personal meetings.

Most of the above-listed communication forms between the universities and the partner companies have been established in the course of an already existing cooperation, which was expanded by the partnership in the DYNAMIC project. With particular focus on the newly developed dual models, it has been recognised that there is a need to intensify the communication at operational level between the academic and industry mentors, directly involved in the supervision of students. It is therefore recommended to introduce communication activities between the mentors such as company lunch or visits of faculty members in the company during the practical training. The continuous exchange between academic and industry mentors is important for the quality assurance and programme improvement process. A template of a protocol for documentation of exchange between the academic and industry mentors is provided in Annex 2.

6. Academic mentors

The role of academic mentors today demands more than conventional teaching and pedagogical training and experience. It is no longer enough to master a teaching subject well. An academic mentor should create a learning environment that provides more opportunities for students to think specifically in dialogue with each other. The result should be a learning community that shares its ideas, questions and solutions.

Students should be:

- encouraged to create relationships between events and objects, to apply the principles of divergent thinking when solving problems, to take an intellectual risk in solving problems
- allowed to directly monitor the results of their own efforts and actions with the material (a link must be created from learning to the students' life experience)
- encouraged to use activities that directly influence the development of knowledge and skills

Very often the academic mentor takes on the role of a facilitator who provides guidance and helps learners in the process of learning and changing. An academic mentor must respect students' abilities and peculiarities and encourage altruism and social activity. For this purpose, the academic mentor needs different methods, techniques and exercises.

The role of the academic mentor defines the general requirements for the professional expertise, including:

- Up-to-date knowledge of technologies, tools and machines. Understanding the new educational paradigm in the knowledge society based on new technologies and how it is affecting teaching-learning models.
- Usage of interactive teaching methods. Implementation of mobile learning and multiplatform methodologies so that contents can be accessed through the use of different mobile devices and other technological platforms.
- Didactic knowledge related to the use of new technologies during the teaching.
- Skills to develop content and practical cases for online teaching.
- Social competencies.
- Skill for working with documentation.

Practical training, part of any holistic curriculum, gives the possibility to place theoretical knowledge, skills, attitudes and values into a real work context. The practical training can be perceived as a 3-stage process – preparation, implementation and evaluation, and each of them sets certain requirements for the academic mentor. A short list of the duties may include:

- To prepare a syllabus for the dual training together with the company
- To control the organisation and conducting of the training
- To visit the company on a regular basis and sign student's diary together with the company's mentor
- To assess student's work together with the company's mentor on the basis of jointly established evaluation criteria

The academic mentor's responsibilities and activities can be divided into three groups: before, during and after the training in real working environment.

The preliminary preparation and planning of practical training are prerequisites for its effectiveness.

At this stage, the focus should be on the purpose of training, namely the development of professional skills and attitudes that are synchronised, on the one hand, with the acquired knowledge from the student and on the other hand, with the skills needs of the industry. The training is aimed at the development of skills specific to the profession as well as to the social competence of the students. To achieve synchronisation, the academic mentor needs to be in close contact with the relevant company mentor who is competent in both profession and company specifics. The academic mentor can jointly develop a quality in-company syllabus only by integrating mutual competences. In the preparatory phase, special attention should be given to clearly identifying ways of communicating with the direct participants: students, mentors, other industry specialists. For the evaluation process, the available assessment system in the company can be used, taking into consideration that the young people are in the process of learning. For quantitative assessment, there must be standardised forms, and the student's individual diary can used for qualitative assessment.

The monitoring of practical training in the company starts at the moment in which the student enters the working environment. The monitoring guarantees that the student is being trained in the way it was planned, that's why it is recommendable to create certain procedures and tools which allow a systematic and periodic monitoring of the training received. The persons responsible for the monitoring are the company mentor and the academic mentor. The monitoring from academic mentors is recommended to be carried out through face-to-face visits at the company within defined intervals. There can be an initial, a final meeting, and various intermediate ones (from a monthly meeting to an intermediate one, depending on the training periods carried out in the company).

The quantitative or qualitative information sources for carrying out the monitoring would come from:

- Meetings with the mentors and the students (face-to-face, via telephone, mail, on-line)
- Monthly report of the students' activity
- Partial evaluation of the students made by the trainers of the company

The evaluation models could be classified as follows:

- Model in which the percentage of the mark obtained at the company is applied in the same way to all the formative modules for obtaining the final mark of the student
- Model in which the percentage of the mark obtained in the company is weighed taking into account the learning outcomes of the different professional modules that have been worked in the activities and tasks carried out in the company

As pointed out at the beginning, the academic mentor's profile integrates multiple roles. One of them is to be a mediator – to make the connection between university, students and companies. Research confirms the claim that the effectiveness of the dual education depends more on teacher/mentor relationship and less on supervisory methods used. That is why the academic mentor needs to be very active in the process of communication between the participants in the process. The trainings conducted in a real working environment under the guidance of academic mentors and company mentors are aimed at increasing the opportunities for the students for future professional realisation and meeting the needs of the business. Therefore, practical training should be structured to meet the needs of both learners as well as employers and in general the labour market. The desired learning outcomes can be achieved if they are carried out with the necessary professionalism and competent approach and in close cooperation between the company and the university.

The programmes to be developed jointly by the academic mentor and the company mentor should be consistent with and include the requirements of the engineering sector, comply with the national regulatory requirements for each country, reflect the relevant state educational standards, and reflect the most up-to-date practices and achievements in the sector.

The duties and responsibilities of the academic mentors through the stages of preparation, training implementation and after training completion are summarised in the table below:

Table 13. Duties and responsibilities of academic mentors

Duties and responsibilities of academic mentors	
Before the training:	• Maintain connection with responsible representatives from the company for the given profession/specialty from the sector and with company mentors • Be familiar with the necessary legal provisions related to the practical training of students/trainees in a real working environment • Acquaint the company mentors with the syllabus for the practical training of the students in the respective profession and specialty(s) • Participate with the mentors in the development and updating of practical • Training programmes in a real work environment • Contribute to development of a plan and timetable for the practical training
During the training:	• Support the company mentor in developing visual, didactic and other materials necessary for the training • Familiarize each student with the university and company's internal rules for conducting dual education and carry out instructions on the rules for ensuring healthy and safe working conditions • Support the adaptation of each learner in the working environment • Regularly check to see if the workplace for each student is provided with the necessary technical and technological documentation, tools, machines, appliances, equipment and materials for the safe implementation of practical training • Control the implementation of the assigned tasks, give practical advice on time of work and assesses the quality of performance together with the mentors • Get feedback from learners • Get feedback from company mentors • Ensure the observance of the developed plan and the timetable for the practical training. If necessary, make adjustments and changes with the mentors • Keep the necessary documentation regularly • Maintain connection with the company through the company mentors
After completing the training:	• Complete the necessary documentation for the completion of the training • Summarize and analyse learning outcomes; offer, if necessary, changes and updates of the training programmes for practical training in the respective profession • Prepare the analysis of the results achieved – to what extent they meet the requirements for obtaining a professional qualification for the respective degree in a given profession/specialty • Track the realization of the trained persons and their degree of satisfaction with the training.

For the pilot implementation of the models developed in the project DYNAMIC, assistant professors who are involved in the students' training in the same disciplines have been selected for academic mentors. The appointed academic mentors possess a strong academic background and already well developed organisational and time management skills. The latter is crucial to the quality of the mentoring processes. To prepare the mentors for their role, a workshop "Introduction into specifics of mentoring" has been collaboratively designed and implemented by learning advisors from the university's academic learning support services and the qualification centre. The learning advisors were invited to contribute to the workshop as they had researched mentoring and coaching widely and were experienced in training staff in relation to a wide range of learning and teaching activities. The workshop introduced the selected academic mentors, more broadly, to the characteristics of effective mentoring programmes and specific strategies for effective mentoring. The academic mentors were acquainted with the importance of reflection and the role of written reflections in the project data collection process. Additional training took place at transnational level during a training workshop in Graz, Austria, where the academic mentors were trained to use the developed tools and templates for documentation, monitoring and evaluation of the practical phases. The mentors' experiences, both positive and negative, were discussed after the pilot implementation with the aim to elaborate specific programme/approaches for successful mentoring. These results will have implications for the development of future mentoring programme, particularly in terms of a better mentor's preparation. Personal experience, shared ideas and outcomes from the mentoring periods include:

- need to understand students' expectations and needs
- need to possess strong knowledge and teacher's background
- need to learn how to fit cognitive (what to learn), affective (why learn), and metacognitive (how to learn) parts of the learning process and present them to the students
- academic mentor must be able to engage students in an ongoing dialogue, monitor their progress on a daily basis, and adapt information to student needs
- an academic mentor must focus on self-regulated learning
- frustrations: worries over failing to engage with particular mentees; possible difficulties with contacting students, especially if some are still on-board for training and unavailable to present during the preparational phases for industrial training (e.g. students in "Marine Engineering"); insufficient time for mentoring many students
- need for detailed discussions and collaboration with industry mentors in order to identify students' needs, possible problems and clarify ways to overcome possible problems and showstoppers

In conclusion, the benefits for the academic mentors can be summarised in satisfaction of a well-done job, development of two-way communication between mentor and students; development of lifelong professional knowledge, fostering the student-mentor connection and gaining new personal insights.

7. Industrial mentors

The mentor in the company gets a special position and task which needs a certain amount of background knowledge. The industry mentor has the duties of education, which have to be aligned to the interests of the company, and what is even more important, to represent the bridge between the university and the company. For this reason and position, the industry mentor needs a special training to gain the prerequisites for these tasks. First of all, the industry mentor supports the university in the development process of the study programme

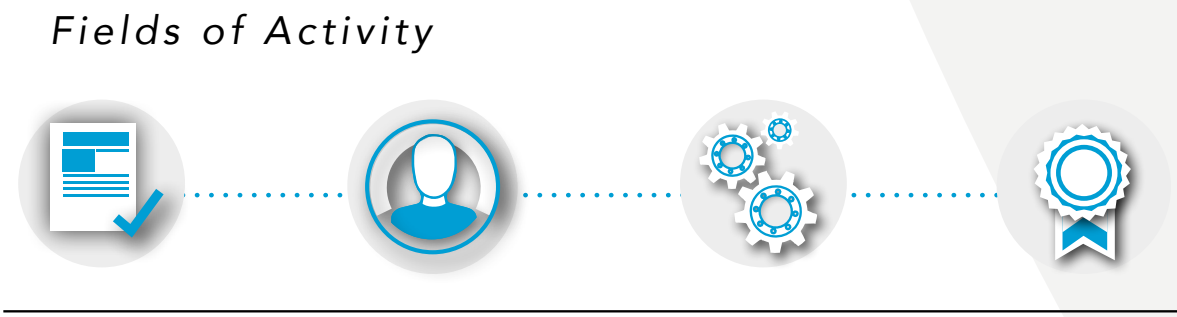
(curriculum), so that it is oriented at the current needs and state of the art in industry. The industry mentor is also involved in the selection process of applicants – students´ recruitment, and works actively as a committee member performing the interviews with future students. While the students are working at the company, he/she is fully involved into the mentoring process and organises the practical phases and departments of the internships, evaluates and mentors the daily/weekly progress of the mentored student, assesses the student´s performance and gives at the same time feedback to the student. In addition, the industry mentor also plays a significant role in the career development of the student and can be involved in the choice of Bachelor or Master thesis. As the good and successful cooperation between university and company is crucial, the industry mentor is the link or interface in this cooperation process participating at meetings, seminars, job fairs and different events. Therefore, a competent trainer has many responsibilities and roles. First, the mentor is technically up-to-date and represents an expert regarding the professional skills, the knowledge and experience, which have to be shared with the next generation. The mentor's instructions are understandable, if he/she has didactic competences. Management skills are also one of the mentor's strengths, because if something doesn't go according to the plan, he/she has to understand the dynamic of the group and to know strategies of solving the conflicts. The social component is also included in the requirement profile. Only those who can work in a team, will be able to create a good atmosphere for the trainees. If all these requirements are met, nothing stands in the way of a successful training. The Train the Trainer Training held by the AHK Romania and Bulgaria within the Dynamic project meets these needs of the industrial mentors.

Fig. 19. Skills categories acquired through TTT course

The German Chambers of Industry and Commerce in Romania and Bulgaria are using an approved by the Association of German Chambers of Industry and Commerce (DIHK) training programme for mentors to acquire basic pedagogical and psychological knowledge and skills in working with trainees in a real work environment. The Train the Trainer Training course, which has been running in Romania and Bulgaria, follows the German model of Ausbildung der Ausbilder (AdA Training) because a crucial element of the Dual Vocational Training is the qualification of company trainers. By assuming responsibility for providing training content, they have an important key role in the company. In Germany the TTT Training, as a part of the Dual Vocational Training System, is based on the Trainer Aptitude Regulation (Ausbilder-Eignungsverordnung – AEVO). The programme is intended for mentors in enterprises

in conducting dual education and includes: objectives of the training, structuring of the study time, content and expected learning outcomes. The programme explains the legal framework for dual education (dual training system) as well as the planning, implementation and evaluation of practical training. The training specifies how vocational and professional skills can be combined with an activity-based and process-oriented content. The training prepares the future mentors/trainers for their task as tutors in the practical workout. The training involves the following 4 Steps or fields of activity:

Fig. 20. Fields of activity targeted in TTT course

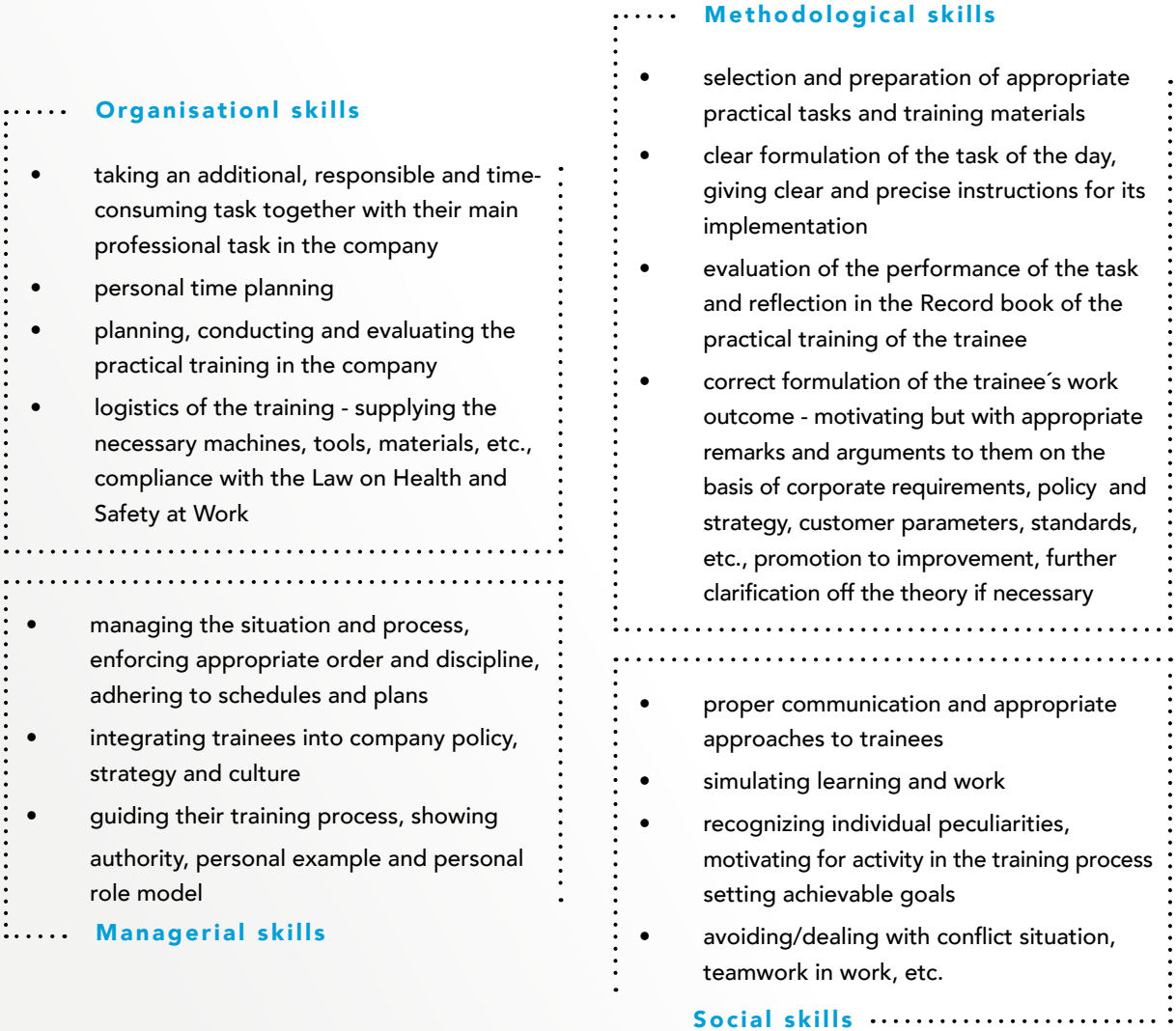


Main aims of the Train the Trainer Training:

1) To acquaint the mentors shortly with the general regulation of vocational training in the country, additional documentation related to the training, etc.
2) Introduction to dual vocational training: essence, application, role of the enterprise, responsibilities of the mentor, trainees, etc.
3) Developing skills for successful planning, conducting, controlling and evaluating on-the-job training
4) Acquisition of general knowledge and practical skills in the field of vocational and labour pedagogy and andragogy, in particular acquisition of methodological, didactic, organisational and social (communication, teamwork, conflict management) competencies, obligatory for the training supervisors
5) Personality development: acquiring of personal qualities important to the trainer – responsibility, patience, flexibility, learning attitude, endurance, etc.

So, the Train the Trainer Training (TTT) is an essential course for all those promoted to a training supervisory role as well as to all industrial mentors who are interacting with pupils from dual education, students or new employees during the on-boarding process. The course covers a variety of topics which are fundamental for the industrial mentors, such as elaborating a training plan for the internship as well as offering an overview of effective training skills. Moreover, the course deals with effective training practices and procedures and emphasizes the importance of methods which are used in the industrial environment, such as the 4 steps method. This course equips the participants with the necessary skills to handle questions and manage difficult trainees. It is ideal for the industry mentors who want to improve their training skills. This is a master class course for industry mentors, persons who have supervisory role, training managers, Human Resources staff and professionals responsible for the development of staff competence level as an integral part of the overall business development strategy.

Fig. 21. Set of skills acquired through TTT course



The course focuses on the following thematic areas:

- The roles and responsibilities of the mentor. Communication and its aspects. Creating conditions for stimulating learning and motivating learning culture. Types of training methods and selection of training methods. Motivation and Leadership. Learning difficulties. Assist trainees with learning difficulties through individual design of the training and learning counselling. Feedback.
- Training arrangements and documentation of the training conditions.
- Determining and evaluating the results and controlling the success of the training.
- Necessary knowledge, skills and competences and ways to acquire additional qualifications; support and existing opportunities for continuing education.
- Promote social and personal development of trainees, identify problems and conflicts in time and work towards a solution, promote intercultural skills.
- Specifics of the curricula for vocational training in different fields/sectors (theory-practice ratio).
- Ensuring the necessary engagement of trainees in real work activities – challenges, legal obstacles, decisions addressing the needs of trainees.

- Assessment of the quality of the practical skills acquired by the students/trainees as a result of internship/practice/training in a real work environment in a company.
- The degree of coincidence of learning outcomes at school and in the real work.

Companies can benefit directly from the Train the Trainer course, as dual training could help to solve problems with finding qualified staff by training certain employees of the company to acquire additional qualifications as mentors. The availability of trained staff for conducting effective on-the-job training is one of the main criteria for participating in dual training. Indirect benefits are the potential to improve the quality of the workforce and the opportunity for growth and innovation in the long term. The results of the training in the partner countries Romania, Bulgaria and Croatia show that the development of an effective mentoring system is vital for the company, as in the long run it helps the company to increase the competitiveness and work efficiency of employees, contributes to the satisfaction of the individual and the entire team. A mentoring system is an indispensable tool in the transfer of knowledge in an organisation. It is one of the key ways to preserve the intellectual capital of companies.

Implementation in national context – the example in Romania

In the DYNAMIC project the German-Romanian Chamber of Commerce and Industry (AHK Romania) has the role to develop training materials customised for the higher education sector and to integrate the results in a customised TTT training offering for enterprises. A very important element in the dual education is the qualification of mentors. This training specifies how pedagogical and professional skills can be combined with an activity-based and process-oriented content.

In Romania, the companies involved in the dual education should also provide mentors for the students and after the practical phases they have to write an evaluation for them. There is no legislative indication that the mentors should have a pedagogical background or studies. Usually, in Romania there are a lot of students working during their studies, so they already have practical experience within the companies. That is why the TTT Training is so important for the companies. The TTT Training, under the DYNAMIC project, gives the participants or new mentors the pedagogical competency according to the German System known as a best practices approach in the field of dual education.

The key aspects of the implementation of the TTT Training in Romania were as follows:

1) Assess training needs

The first step in developing the TTT Training programme in Romania was to identify and assess the needs of the mentors and employees from the two companies involved in the project: Marquardt and Continental Sibiu. As the two companies had confidentiality clauses, AHK Romania decided to hold 2 separate trainings in order to reach better the needs of the participants. Each training was running for 3 days and reached 25 participants in overall. A need which was identified to all participants was to clarify the structure of the dual education system and to assure the match between what is taught in the universities and which competences should be built by the industry mentors.

2) Set organisational training objectives

During the discussions with Continental and Marquardt, AHK Romania focused also on the objectives which the company has within the DYNAMIC project and turned the training aim into the organisation's training objectives, respecting the organigram and the profile of the participants. So, the main objectives of the TTT Training in Romania were:

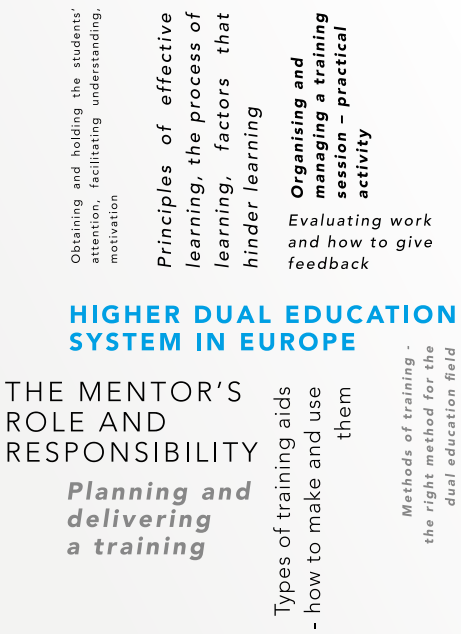
- to develop and encourage the professional and the pedagogical skills of the mentors in order to train efficiently the students involved in the dual education system
- to introduce the participants to the basic principles of learning and to establish fully the responsibility of the mentor

- to inform participants of the methods of training available to them, with particular attention given to didactical conversation and to the on-the-job session (4 steps method)

3) Create training action plan

AHK Romania created a comprehensive action plan which included learning theories, instructional design, content, materials. The training programme comprised of 3 days, of which the first one was dedicated to the dual education system, learning principles, objectives and the role of the trainer.

Fig. 22. Main topics of TTT course in Romania



4) Implement training initiatives

The two training sessions were delivered in-house in the companies. The methodology used during the training was highly practical and participative with hands-on approach that included real job examples. The focus was on learning in an interactive environment knowledge that is applicable to the real contexts.

5) Evaluate & revise training

In the end, the programme has been evaluated by the participants to determine if it was successful and met training objectives. Analysing the feedback from the companies, it can be concluded that the expectations of the participants have been met. An excerpt of the participants' feedback acquired by the means of the mentimeter tool is illustrated in the figure below.

Fig. 23. Feedback from participants (via Mentimeter)

Implementation in national context – the example in Bulgaria

As a part of the worldwide network of 140 German foreign chambers in 92 countries, the German-Bulgarian Chamber of Industry and Commerce (AHK Bulgaria) engages in dual education and aims to contribute to its implementation, dissemination and sustainable development in the country as a consulting and coordinating organisation between business and training institutions. Youth unemployment, migration and the lack of qualified workforce are problems at national and European level. Through the model of dual vocational training, AHK Bulgaria gives young people in Bulgaria an opportunity for professional development in their home country and is trying to improve the quality of their professional knowledge through working in a real environment, including conducting quality internships, expanding apprenticeships and a dual training system.

AHK Bulgaria is using an approved by DIHK training programme for mentors to acquire basic pedagogical and psychological knowledge and skills in working with trainees in a real work environment. The programme is intended for mentors in enterprises in conducting dual education and includes: objectives of the training, structuring of the study time, content and expected learning outcomes. The programme explains the legal framework for dual education (dual training system) as well as the planning, implementation and evaluation of practical training.

The training includes 40 hours (4 days a 10 h) and contains 4 modules. During this period, future trainers have the opportunity to form the knowledge and skills of mentors of students and adults, depending on the particularities of the economic sector and the characteristics of the trainees. The modules combine theory and practice – a normative base of the dual training system, basic pedagogical and psychological knowledge, skills, planning, implementation and evaluation of training through work and discussion of case studies and good practices. Upon successful completion of the course, mentors are expected to acquire knowledge, social, organisational, leadership, methodological skills and a set of personal qualities to achieve successful mentoring in the dual training system.

According to the last changes in Ordinance No. 1 of 08.09.2015 regarding the conditions and the order for conducting of education through work (dual education), all mentors in Bulgaria have to be obligatory trained to be allowed to work with trainees in the companies. In this connection, AHK Bulgaria is continuously offering the TTT course to all companies implementing dual education. Within the DYNAMIC project, the partners and dozens of member companies have been trained.

The benefits of mentoring in the organisation:

- Promoting the competencies and potential of employees
- Enhanced understanding of work, goals and relationships through clarification and support
- The process is action-oriented, not theory oriented
- The resources and potential of the supported employee are used
- Aspects such as relationships and values are included to help get an overall picture of the organisation

The role of the mentor:

- creates relationship, based on trust and respect
- gives different point of view
- encourages
- clarifies the big picture and the goal
- is a role model
- gives feedback and constructive criticism.

Mentoring in the workplace leads to:

- on-boarding
- employee satisfaction
- employee retention
- productivity
- knowledge management
- quality
- synergy

Using the German standards of training and quality of offered services, the courses of AHK Bulgaria are preferred not only by the German companies in the country, but also by many big and small international and Bulgarian companies.

8. Evaluation of country-specific implementation and lessons learnt

Evaluation was a continuous process that took place during the whole duration of the DYNAMIC project. It was organised in several cycles such as joint evaluation of the focus group meetings related to the curriculum development process as well as self-evaluation of the partners (implementation reports) and peer reviews related to the implementation phase. The evaluation of the country-specific pilot implementation of the dual higher education programmes in Bulgaria and Romania has been reflected in the research paper "Evaluation of practice-integrated dual study models in Bulgaria and Romania and implications for cross-border European cooperation between universities and business" submitted and accepted for open access publication by the scientific journal "Vocational Education" (https://vocedu.azbuki.bg/en/). The paper presents a summary of the findings from the evaluation of the pilot programmes. The data evaluated have been collected in each country by means of a peer review in the implementing institutions with the participation of the three main stakeholder groups involved – students, academic staff and industry mentors. Qualitative data collection tools and interpretative data evaluation methods have been applied in this research. The set of methods include table-based group exercises with each stakeholder group combining open-ended questions, semi-structured group discussions and observation. The inductive research approach has been applied in the evaluation of the collected data. The results of the evaluation are presented in the form of lessons learnt and are summarised on the figures below.

1 *High interest of students towards new learning models and desire for more practice orientation in higher education*

2 ***High motivation to gain work experience, establish a sense of self-confidence and create a completive advantage for the job market after graduation***

3 *Insight in the world of work is valuable for carrier orientation and personal development*

4 *Regularity of training in the same company allows students to gain more extensive professional knowledge and specialisation in the company processes*

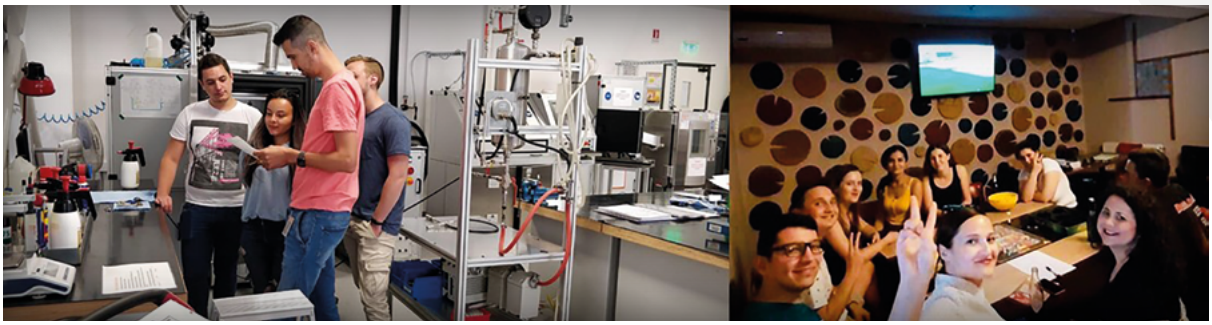
5 ***Students possess valuable innovation potential for the companies as even first year students with limited knowledge and professional specialisation could meaningfully contribute to the idea generation process in the department team they were assigned to***

6 *Improved engineering education by increased understanding in the taught subject area and more motivated student participation after the practical phase in the company*

STUDENT TESTIMONIALS

"I met a lot of people that are friendly, open-minded and ready to answer every question a summer intern would have. I had the opportunity to see how a cobot is working, how tests on the components are made".

"Practical experience is the best, and internships give us that hands-on experience that we need. This was a quality internship and essential to develop key skills that we can't get in a classroom".



7 *Dual education has proved its potential to foster personalised education and training in higher education and shape the individual career pathway of students*

8 *Regular communication and feedback loops between academic and industrial mentors contribute to improving the quality of the regular programmes too*

9 *Mentoring is central element in the dual education model but requires time to establish effective mentoring environment based on smooth communication and close cooperation between academic and industrial mentors*

10 *Targeted training of industrial mentors and practice of student-orientated communication techniques is essential for the professional fields in which complex technical information needs to be transferred to students*

11 ***The lack of mentoring experience and additional time effort related to the mentorship of the dual students is a challenge for academic mentors as long as the dual form is not officially recognised and the workload is adjusted to the new teaching methods***

9. Impact discussion

Alignment of education provision with market demand for the **latest industry skills** through co-development of curricula is expected to strengthen innovation capacity in both universities and companies. The exposure to actual business problems is essential for students in order for them to acquire industry-related skills and to gain initial practical experience in a real work environment. By creating a methodology for joint development and implementation of dual higher education programmes, the main stakeholders – academia and business, enter a commitment to collaborate over the long-term towards the common goal of continuous improvement of education and training. Better links between universities and industry at a transnational level will further help to improve relevance and quality while fostering innovation in engineering practice. Engineering skills are portable internationally, thus such types of international collaboration are expected to enhance the employability of engineering graduates and encourage technology and skills transfer into industry. The DYNAMIC project has demonstrated that the driving force for the successful implementation of dual higher education is a relationship of trust and good cooperation between universities and their partner companies. The evaluation of the DYNAMIC pilot dual programmes indicates that the **flexibilization of higher education** through integration of company-based learning components is possible but warns that the process can be slow. It confirms that the broader education challenge, of ongoing curricula allowing for only moderate changes or adaptations, can be addressed with maximised impact if programmes are designed as dual studies. The project also shows, however, that political support to the transformative agenda, in the form of an appropriate regulatory framework, is necessary if we are to establish quality assurance measures, transparency and certification of dual higher education over the medium term.

For the target group of the students as one of the main stakeholder group, dual higher education is expected to contribute to higher level of **graduate employability** in the medium term. An attractive feature of the dual model is that students are already selected by a company and have got a training contract for the duration of their study, which often switches to a regular employment contract after successful graduation. In addition to processing their own projects according to the requirements during the study with additional support from the teaching staff, the dual students should be largely incorporated in the normal working process. At the stage of pilot implementation, it is difficult to make projection on graduate employability in relation to the dual study model. Especially in Romania, all the students involved in the dual study programme are enrolled in the 1st year of study, thus employment rate cannot be estimated for them yet. However, it must be noted that most of them are working part-time for the partner compnies, which are offering them a flexible working programme, in order not to interfere with their academic timetable. During the summer practice students were hired as engineering interns, with the optional possibility to continue part-time during the academic year, and most of them had chosen that option.

In the case of Bulgaria, the first 6 students who were involved in the pilot implementation are engaged with their post-graduation practice at maritime companies. Two of them are engaged in industrial companies from the maritime sector, however not at the partner MTG Dolphin, as they were proposed leading positions in other companies. The other 11 participants are at the end of their 4th study year and are preparing for the state exams. The dual higher education has demonstrated potential for **improved student retention rate in the region**, which is of great importance for the development of the maritime industry in the country. Currently, the sector suffers not only a stronger pressure from Asian competitors but also a brain-drain problem, as many graduates trained locally prefer to pursue career pathways abroad. In the region of Varna, there are limited number of companies – about 6 design offices and about 3 companies active in ship building and repair. These companies do not see each other as direct competitors in operations but are competing for employees. Therefore, dual education is an opportunity for the companies to build early connection to the students in order to establish more aggressive, proactive and pertinent relationship with potential employee still through the years of study. Dual education is also an opportunity to **increase the number of students available** by making the maritime field of study more attractive in terms of learning experience and career perspectives. To achieve these objectives,

companies are still experimenting with different models in working with the academia. The difference reached through the project DYNAMIC is seen in the possibility of more flexible work between university and the partnering companies as well as in the opportunity for the **students to become more specialised** moving away from the previously practiced common stream of students. In order to better promote the networking and active cooperation with companies, the partner university in Varna also emphasise the necessity to formalise dual higher education at national level.

Last but not least, the positive impact of establishing dual higher education in Bulgaria, Romania and Croatia is revealed in the **promotion of permeability** between education and training systems. The dual higher education provides applicants from the dual system implemented in the vocational middle schools a particularly attractive option to complete a university education. Concrete measures for the promotion of permeability consisting of:

- Targeted advertising in already existing training companies also by information activities of the students with their colleagues with apprenticeship as well as by supporting the apprenticeship of students
- Targeted training companies with successful apprentice programmes (additional benefit: There is a great understanding in these companies of the opportunities and framework conditions of the dual study course)
- Consideration of operational experience and special qualities of apprenticeship graduates in the admission interview through the involvement of experts with a business background
- Targeted mentoring by company executives who can support students through additional learning times
- First year of study without interruption by a practical phase as an orientation period. For students who come from a company, the employment relationship is maintained

Nevertheless, to achieve permeability between the systems, the opportunity of different access routes represents a special challenge under the current framework conditions.

10. Implications for the cooperation at EU level

The Bologna Declaration started a coordinated activity to establish a common European Higher Education Area (EHEA) by meanwhile 48 signatory countries, including Bulgaria, Romania and Croatia, with the aim to increase transparency, mobility and mutual recognition. (Heitmann, Kretzschmar 2017, p.13) The adaptation of the pilot programmes for dual implementation has been guided by the Bologna principles and the integration of the practical activities followed the logic of nationally and institutionally approved curricula design and approval procedures. In the case of dual higher education, the in-company training is mapped to learning outcomes and the workload is calculated with the ECTS methodology. Curricula adaptation and training design approach based on the EHEA instruments allows transparency and comparability of the pilot programmes. Thus, the pilot programmes demonstrate a high degree of transferability and adaptation in other national settings within the EHEA.

Since the pilot programmes have been developed and tested within the existing national legal framework applying minor curricular changes that are in line with the Bologna system, a student mobility component could be integrated without significant recognition obstacles. Moreover, the practical phases are assigned in the summer months so that the usual semester plan, confirmed at ministerial level, could remain unchanged. Such timely arrangements allow two types of student mobility, using the Erasmus+ mobility schemes (Mahler, 2021):

1) mobility for practical training in a company subsidiary abroad
2) mobility for academic semester in partner university

Beside the mobility implications, the piloting of the dual higher education models in Bulgaria, Romania and Croatia result in an added value for the university-business research community at European level. The new cooperation models between industry and academia provides new practitioner cases and new country-specific examples that contribute to the discussion of student employability and skills development in respect of future industry needs.

11. Outlook for further cooperation

Employability considerations and providing engineering graduates with the most appropriate skills needed for carrying out their future jobs in the most promising sectors of manufacturing requires new methods and mechanisms if higher education institutions are to be the most relevant places of production of learning that is expected of them. The DYNAMIC project suggests that dual studies at the tertiary education level can make a significant contribution to enabling the recognition and teaching of such skills to be regularly reflected in engineering courses of study. Universities and enterprises that understand the vision for promoting such a model of modernisation of higher education across Europe can play part if their involvement is facilitated by the educational authorities and policy making bodies at national level. The efforts at piloting such solutions, by the experimenters and pioneers from Central, Eastern and South-eastern Europe cooperating in the DYNAMIC project, may inspire others to build on the achievements to date and especially protect the foundations of such an approach that is being threatened by the current situation. The COVID-19 virus pandemic has caused a global learning crisis that is having a particularly strong effect on dual and vocational education. In contrast to theoretical contents, that could be quickly adapted and delivered in an online mode, practical training in companies has been widely postponed or even cancelled. Economic uncertainty and the need to reallocate and optimise organisational resources have had a considerable effect on the recruitment outlook of the companies. In order to mitigate the negative impact of the pandemic on university-business cooperation, there is a pressing need for new approaches that provide for student practical experience facilitated by digital means (Mahler 2021).

The DYNAMIC consortium intends to further explore the application of digital technologies in dual education and we encourage interested stakeholders and potential partners to join us in this endeavour.

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Annexes

Annex 1. Student Practice Diary for documentation of practical phases

Practice Diary					
Name: Period: Company:					
Date	Department or area and/or mentor	Activity/ Project/ Task	Suitable for lecture or module	Notes to learning reflection (not obligatory)	Notes on used literature, photos, tables (sources, links...)

Annex 2. Protocol for mentors' meeting and planning of practical phases

Protocol for Mentor Meeting in Company	
Date	
Company	
Location	
Student	
In-company mentor	
Academic mentor	
Miscellaneous	
Short company tour	☐Yes ☐No
Visit of the current working place	☐Yes ☐No

Feedback / Development	
General (Internship assessment)	
Technical	

Internship planning /report	
Internship overview (Training plan, module report)	
Internship planning (Training plan, module report)	
Idea for bachelor thesis / master thesis	

Point of Criticism and Suggestions	
Teaching content (overview of lectures)	
Organisation	
Miscellaneous	

To-Do-List	
Teaching content (overview of lectures)	
Organisation	
Miscellaneous	

To-Do-List		
What	Who	Till when
Admission of additional PTO Students planned?	☐Yes ☐No	

Contact person:	

DYNAMIC

DUAL ENGINEERING CURRICULA

Towards responsive engineering curricula through europeanisation of dual higher education

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