



# **DYNAMIC**

dual engineering curricula



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# **DYNAMIC**

## *DUAL ENGINEERING CURRICULA*

Towards responsive engineering  
curricula through europeanisation of  
dual higher education.

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# PREFACE

Dear Reader,

The close cooperation between academia and business is essential for the alignment of educational provision with the needs of the world of work. With this booklet we aim to highlight the successful engagement experience between universities and industrial enterprises 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 education models that are feasible for the country-specific conditions and regional needs. We would like to share with you some of lessons we have learnt from the past 3 years of international cooperation and invite you to join us in our future endeavours to promote and further develop dual higher education.

Wish you a pleasant read!

Evgenia Mahler

# THE CHALLENGE

## *PROBLEM STATEMENT*

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 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 reflecting of these in the learning - can be realised through a practice-integrated dual study education programme that is able to strengthen the supply-demand feedback loop between business and academia.

*There is a need for flexible and responsive engineering curricula to keep pace with the rapid technological advancement and increasing innovation pressure.*

# PROJECT DYNAMIC

## OVERVIEW

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 courses of study 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, Shipbuilding and Construction 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 enterprises and a chamber of commerce and industry for each country of the pilot implementation.

### ***3 Country Pilot Dual Study Programmes***

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

# PROJECT DYNAMIC

## STRUCTURE & TIMELINE



**#1**

*Curriculum  
development*



**#2**

*Toolkit with  
templates*



**#3**

*Train the  
trainer*

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



## **# 4**

*Pilot  
implementation*



## **# 5**

*Transferable  
guidelines*

for documentation and assessment of the practical training for use by academic supervisors. To strengthen the training capacity and capabilities of the enterprises 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 “Methodological guidelines for design and implementation of practice-integrated dual higher education programmes in engineering studies” in the context of Bulgaria, Romania and Croatia.

# PROJECT DYNAMIC

## CURRICULUM ADAPTATION

The curriculum adaptation process in the three partner universities has been conducted jointly based on the requirements of the industrial partners. All adaptations had to adhere to the regulations of the national accreditation bodies. Therefore, the most suitable way to adapt a curriculum for the dual study specialisation in alignment with the identified industrial training needs, is to adapt or change the syllabuses of

**Step 1** *Adapt/change the syllabuses of specialty subjects*

**2** *Add supplementary amount of practical activities to the existing ones*

**3** *Mandatory extracurricular courses are organised by the companies*

existing courses accordingly. Once certain pertinent specialty subjects were selected, syllabuses for the practical learning components in the companies were designed and supplementary hours for these practical activities allocated/assigned. In the case of Romania and Croatia, a further difference between the regular and dual form of study is that students from the dual study programmes are also required to attend extracurricular courses organised by the companies. Typically, the final thesis will also have to be completed with one of the partner companies.

4

*New syllabus for practical activities*

5

*New rules for assessing the students for the practical activities*

6

*Final thesis must be undertaken at the company*

# PROJECT DYNAMIC

## CURRICULUM ADAPTATION

### Case Romania

*Bachelor in Mechatronics - Dual curriculum*

S1	Courses and laboratories W1-W14		Exams W15-W17	Holidays W18	Exams W19
S2	Courses and laboratories W1-W14		Exams W15-W17	Holidays W18	Exams W19
S3	Courses and laboratories W1-W14		Exams W15-W17	Holidays W18	Exams W19
S4	Courses and laboratories W1-W14		Exams W15-W17	Mandatory practical activities 3 weeks	
S5	Courses and laboratories W1-W14		Exams W15-W17	Holidays W18	Exams W19
S6	Courses and laboratories W1-W14		Exams W15-W17	Mandatory practical activities 3 weeks	
S7	Courses and laboratories W1-W14		Exams W15-W17	Holidays W18	Exams W19
S8	Courses and laboratories W1-W12	P-PD W13-W14	Exams W15-W17		

Holidays  
W20-W21

Mandatory practical  
activities  
9 weeks

Exams  
W21

Mandatory practical  
activities  
9 weeks

Exams  
W21

Mandatory practical  
activities  
9 weeks

S semester  
W week from academic year start

# PROJECT DYNAMIC

## IMPLEMENTATION PREPARATION

### Academic and Industrial Mentoring

An effective mentoring system and the adequate qualification of mentors is an indispensable element of the dual education model. For this purpose, targeted skills training and provision of supporting implementation materials for academic and industrial mentors was a key aspect of delivery within the scope of the DYNAMIC project.

#### ..... Organisational skills

taking on an additional, responsible and time-consuming task alongside their main professional task in the company

proper communication and appropriate approaches to addressing trainees

#### Social skills .....



## Methodological skills

selection and  
preparation of  
appropriate  
practical tasks and  
training materials

managing the work and  
learning situation and  
process, enforcing  
appropriate order and  
discipline

## Managerial skills

In order to ensure a high-quality learning experience of the students and to facilitate the smooth mentoring process during their placements, a [Toolkit for implementation and documentation of dual higher education programmes](#) has been developed. The toolkit consists of templates and necessary standardised documents - student diary and practice report, checklists for evaluation and assessment of the student performance, company visit procedures, a feedback questionnaire for the student, application form for a bachelor thesis etc.

# PROJECT DYNAMIC

## *IMPLEMENTATION PREPARATION*

A specialised training course for industrial mentors has been developed and implemented by the German-Romanian and German-Bulgarian Chamber of Commerce and Industry. The training gives the participants (existing or new student placement mentors) the pedagogical competency at the level required by the German System.

Customised training materials, considering the specifics of the higher education sector, have been developed and integrated into the training offering for enterprises. This training specifies how both pedagogical and professional skills can be combined with activity-based and process-oriented content. It also informs participants of the methods of training available to them, with particular attention given to didactical conversation and to the on-the-job session.

Main Topics covered by the training course for mentors:

Obtaining and holding the students' attention, facilitating understanding, motivation

*Principles of effective learning, the process of learning, factors that hinder learning*

**Organising and managing a training session – practical activity**

*Evaluating work and how to give feedback*

## HIGHER DUAL EDUCATION SYSTEM IN EUROPE

### THE MENTOR'S ROLE AND RESPONSIBILITY

*Planning and delivering a training*

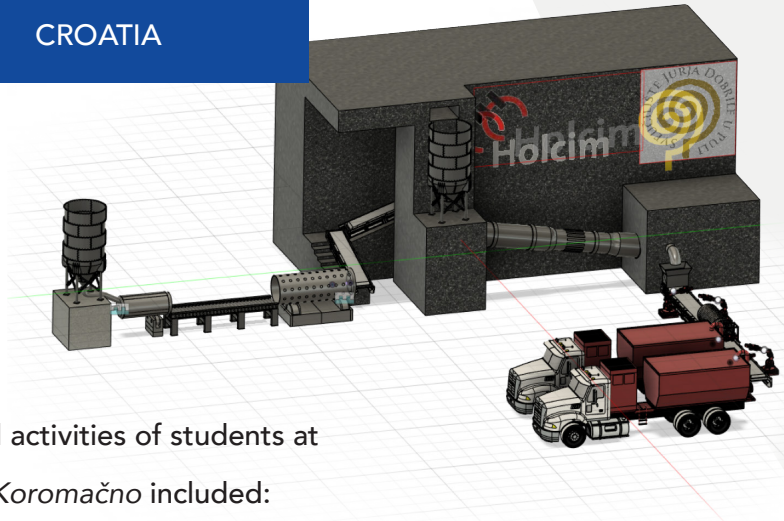
Types of training aids  
- how to make and use them

*Methods of training - the right method for the dual education field*

# PROJECT DYNAMIC

## EXAMPLE PILOT IMPLEMENTATION

CROATIA



Practical activities of students at  
*Holcim Koromačno* included:

- regular visits to the concrete plant for on-site education
- generating 3D CAD models for an automated production of cement
- making relevant part and assembly drawings of the models
- generating technology and learning documentation - student diary
- using the CAD models to create a virtual reality of the automated cement plant.

## ROMANIA

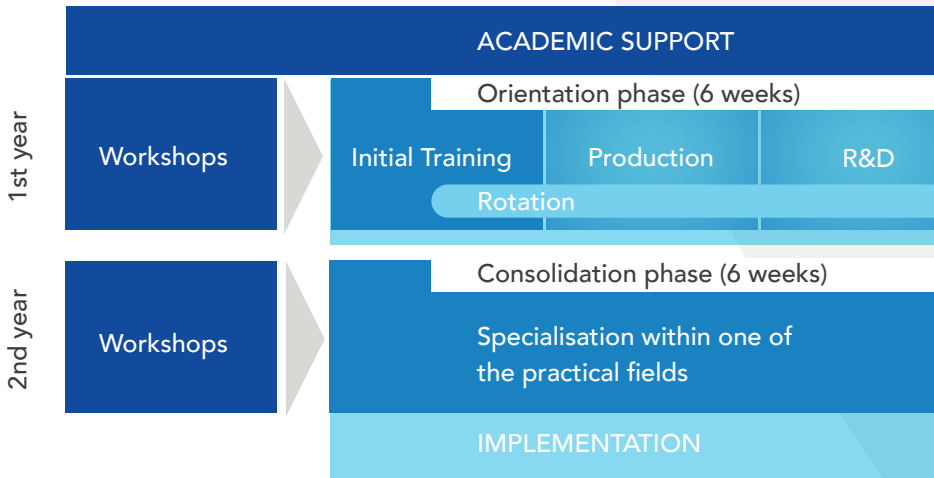
Example of practical activity at *Marquardt*: The students had to disassemble a product, to identify the number of components, understand the function of each one, and they had to build an assembly sequence scheme. In this way, they learned several key basic rules of product assembly. They also learnt to sketch the execution drawing of one of the parts of their choosing.



# PROJECT DYNAMIC

## EXAMPLE PILOT IMPLEMENTATION

### Case Romania - Dual Bachelor in Mechatronics



In Romania the implementation plan for the placements was organised using a rotation model, with all the students were enrolled in their first year of studying in their dual programme. By using the rotation plan the students had the opportunity to experience a range of different activities after first having become familiar with the company's structure and organisation. During the practical phases the students also received payment for their



work, according to the laws and regulations and as set out in an agreement between the university and the companies. Both partner companies, *Marquardt* and *Continental* evaluated the students using tables with performance and competences requirements. Annual meetings also provided the students with an opportunity to receive formal comments on their performance and to share their views and satisfaction with aspects of the placement.

# LESSONS LEARNT

## EXPERIENCE FROM THE DYNAMIC PILOTS

In Romania, Bulgaria and Croatia the dual study model is a new model of higher education delivery. It is still being practiced in a pilot mode form at institutional level. Due to its innovative character, the key stakeholders involved need to engage in a continuous learning and improvement process in order to establish a reliable and recognised framework for long-term provision of dual higher education.

Eleven lessons learnt from the  
project DYNAMIC:

**1** *Strong 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 competitive advantage for the job market after graduation*

3

*Deeper insight into the world of work is valuable for career 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, with first-year students, with still limited knowledge and professional specialisation, already able to meaningfully contribute to the idea generation process in the department team they were assigned to*

# LESSONS LEARNT

## EXPERIENCE FROM THE DYNAMIC PILOTS

6

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

7

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

8

*Regular communication and feedback loops between academic and industrial mentors also contribute to improving the quality of the regular programmes (not just the dual ones)*

9

*Mentoring is a central element in the dual education model, nevertheless requires time before an effective mentoring environment, based on smooth communication and close cooperation between academic and industrial mentors, can be fully established*

10

*Targeted training of industrial mentors and practicing in student-orientated communication techniques are 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 especially a challenge for academic mentors as long as the dual study form is not officially recognised and the workload not yet adjusted to the new teaching methods***

# IMPACT

## *DUAL ENGINEERING CURRICULA*

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 transnational level will furthermore 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 **flexibilisation 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 a 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.

# THE WAY FORWARD

## OUTLOOK

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 suggest 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 a 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 mentioned in this brochure,

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.*

