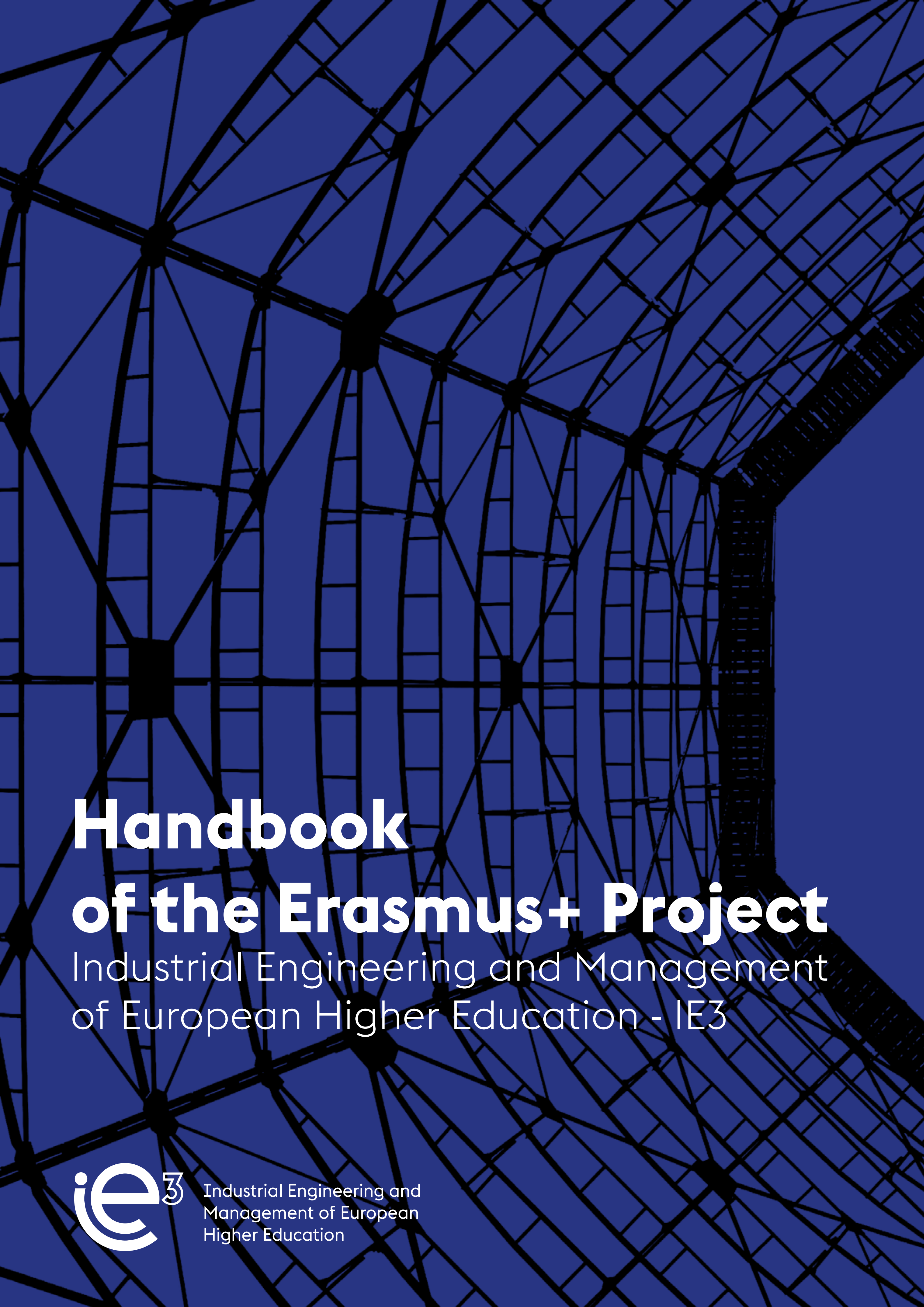

Handbook of the Erasmus+ Project

Industrial Engineering and Management of European Higher Education - IE3

ie3 Industrial Engineering and Management of European Higher Education

Industrial Engineering and Management of European Higher Education

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This document is the deliverable of the Erasmus+ Project "Industrial Engineering and Management of European Higher Education", and it represents the Result R5.2 of the project.

Note
For anyone interested in having more information about the project, please contact: info@ie3.eu

Co-funded by the Erasmus+ Programme of the European Union

The European Commission support for the production of this publication does not constitute endorsement of the contents, which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

IE3 ProjectPartners

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Introduction to the Handbook

The Handbook is a Guide for stakeholders interested in setting up or renewing innovative Master Programs in Industrial Engineering and Management (IE&M).

After introducing the reference paradigm (section 1) and hallmarks (section 2) of higher education in IE&M, guidelines for renewing Master Programs in I&M are provided (section 3). Finally, Guidelines are applied to define an example of innovative Master Program in IE&M (section 4).

The example is detailed and related documents, including the survey-based gap/need analysis, modules syllabi, up to e-learning modules and educational materials can be downloaded from the project site (ie3.eu) in the Results section.

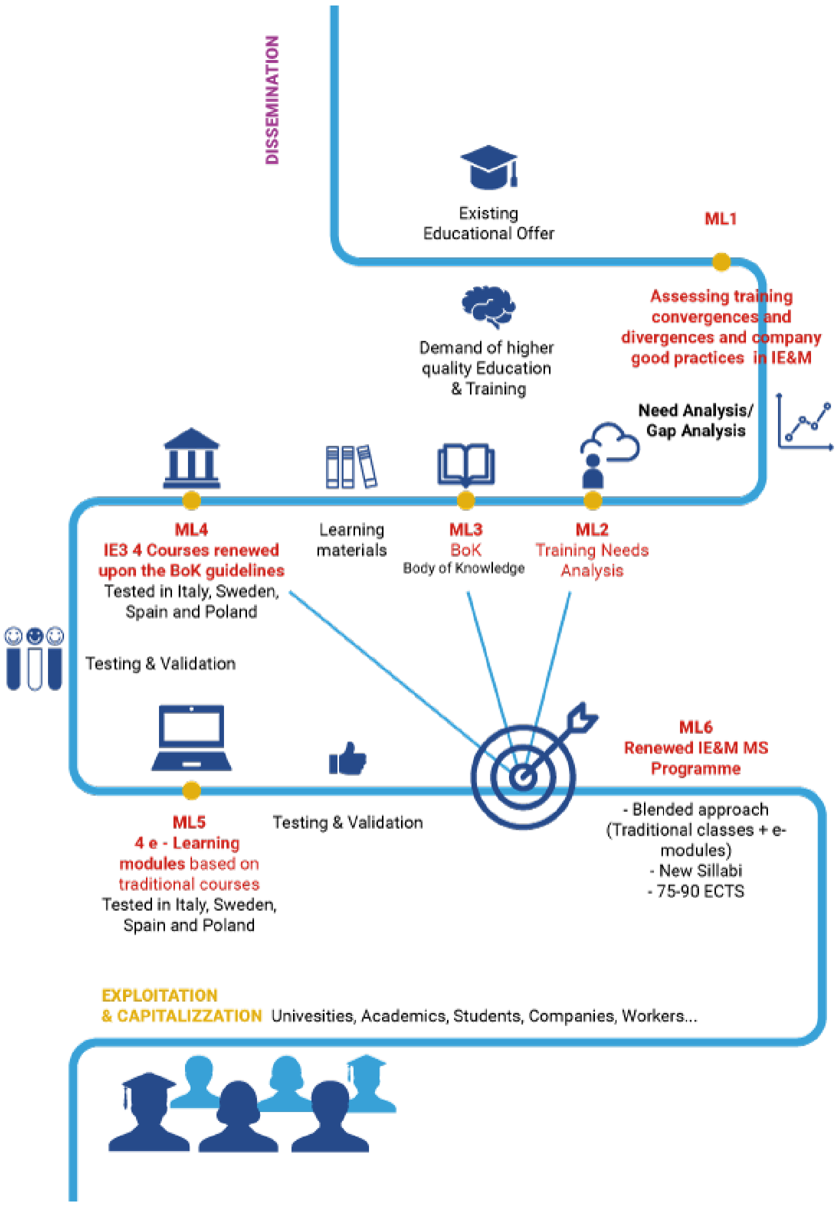


Figure 1 – The IE3 Project Framework

1. A New Paradigm for Higher Education in Industrial Engineering and Management

The context

Disruptive digital technologies, social and environmental challenges gave rise to profound changes in everyday life worldwide. Higher education systems and industrial sectors are jointly facing the green and digital transitions and the global competition for human capital.

A deep change is mainly observed in production systems where a new paradigm, shortly referred to as 'Industry 4.0', has taken place worldwide in the last decade. A pervading innovation in conceiving new products, organizing and managing hardware and human resources, and setting up new business models requires abilities to manage complex systems. Industrial companies demand workforce abilities to continuously reshape the added-value processes and manage technology innovations enabling innovated processes at a fast rate.

However, ten years after the "*Zukunftsprojekt Industrie 4.0*" firstly appeared in Germany in 2011, the new production paradigm shows criticalities in its implementation. A major criticality relies on a technological paradox that sees technological investments in production assets increasing faster than the increasing rate of knowledge transfer and human capital education. The mismatch between Higher Education Institutions' (HEIs) offers and industry knowledge demand, the inertia and the constraints of HEIs in innovating educational programs, the ageing workforce in Europe, and the new learning attitudes of young generations are major issues to be addressed to make higher education effective in supporting world-based competitiveness of industrial companies. The final consequence is an increasing shortage of knowledge workers and a fierce global competition for human capital. The gap of Knowledge Workers is a severe threat for European Companies.

Technological innovation and new business models generate the need to renew contents and tools for higher education by adopting (innovative and) more effective learning strategies for new generations. Renewal pertains to almost all fields of knowledge with particular emphasis on the areas of Industrial Engineering and Management (IE&M) whose competence and applications are strictly connected to the aforementioned production paradigms.

A New Education Paradigm

A new paradigm is required for innovating higher education in IE&M with a higher emphasis on Master level programs, whose learning objectives best fit the entry level competence required by industrial companies. At the same time, industrial engineers, as knowledge workers, should be ready to operate in a creative work environment, generate new solutions and implement them under time and resource constraints, meeting economic, social and environmental goals. Consistently, a new higher education paradigm should have some distinctive key-drivers enabling to:

- continuous monitoring of knowledge demand and practical competence as they are expressed by industry and, at the same time, anticipating the knowledge needs perceived as prominent by industrial and academic research;
- structure the innovation process of higher education according to tested procedures for identifying knowledge needs, performing gap analysis and updating contents and methodological tools in higher education programs, with emphasis on master programs;
- introduce and merge competences and methodologies derived from physical and social sciences, hard and soft skills, in a knowledge path conceived to answer major challenges for modern societies;
- consider *'learning'* more prominent than *'teaching'*, taking into account the 'digital' attitudes and abilities of young generations;
- enable a 'learning-by-doing' approach, based on a robust framework of technical and theoretical knowledge;
- involve all stakeholders of higher education in IE&M belonging to:
    - Higher Education system (professors and students);
    - Industrial system including companies of both manufacturing and service sectors.

  Stakeholders must operate in a 'knowledge alliance' context and perspective, with common views and goals, considering talented human capital as the main asset of companies to compete worldwide and answering the main challenges of modern societies.

These are the premises and the ambitions of the IE3 Erasmus plus project 'Industrial Engineering and Management of European Higher Education/ IE3', funded by the program 'KA2: Cooperation for innovation and the exchange of good practices - Knowledge Alliances'. The project partners, supported by reputable associations of professors (European Academy for Industrial Management – AIM), students (European Students of Industrial Engineering and Management – ESTIEM) and industrial companies (Asociación Madrid Network), contributed to the IE3 project activities with full commitment, being aware of the project's ambition to strategically address both the educational and industrial challenges Europe is facing.

2. The Hallmark of Higher Education Programs in IE&M

The development in recent years has moved towards a broader interpretation of engineering and technology as concepts. Even within higher education, there has been a rapid development where various HEIs have designed their programs and course modules, so that they are both placed within classic engineering and technology subject areas and, at the same time, cut across the field in new ways. There has also been an almost explosive development of education with the intention of creating competence niches for those entering the new sectors in the labour market. Consequently, this has led to a need for a discussion on the delimitation of engineering and technology as educational fields.

The labour market today puts high demands on access to well-educated labour. There is reason to expect an increase for the right skills in the future, and the industrial sector will probably demand more graduated engineers than today.

What demands does professional life place on engineering education today and tomorrow? In terms of competence, employers often want graduated engineers to have a broad and basic education, while specialization can take place at the individual company. The industrial world would also like to see closer cooperation between companies and universities, which can be difficult to implement in a way that leads to good and concrete results. Some companies are of the opinion that, as of today, higher education engineering programs are too much geared towards students' wishes rather than providing companies with graduated engineers showing the competences their business activities need.

Important to Maintain the Conceptual Framework of IE&M

Education in the main field of IE&M is based on a combination of knowledge of mathematics, natural sciences, engineering, and social sciences. The training should lead to graduated engineers having the ability to solve technical, social, and economic problems with the help of an integration of those skills. Usually, this means that the education is designed according to the distribution 60% mathematics, science, engineering, and technology, and 40% industrial engineering and management subjects. This is of course not formally regulated, nor is the distribution absolute, as there is no precise definition of what should be counted in each category. On the other hand, the distribution is established within Europe as a norm or rule of thumb for the subject-wise balance within IE&M. However, it is also important to emphasize that proportionality is not an end, but rather a way to operationalize the purpose of the education and ensure that the education retains its distinctiveness and does not develop into becoming too purely technical or managerial. Education programs in IE&M must therefore be able to show a distribution that is compatible with this reasoning. Education with unique main areas (for example, production systems, logistics, business systems, quality technology, etc.) must, in addition to subject-specific in-depth study, have an engineering, mathematical and/or scientific content.

International comparisons indicate that some programs in IE&M do not convincingly train for the competence expected of a graduated MSc engineer in this subject area. Some institutions of higher education have reduced the number of engineering and technology-related course modules to a level that calls into question whether the education program can be rooted in the field of IE&M. The degree title "graduated engineer in Industrial Engineering and Management" is especially related to engineering and technology subjects.

Allowing programs and course modules in IE&M to gain the upper hand, at the expense of course modules in engineering and technology subjects, may lead to a situation where the unique and highly successful niche that IE&M programs have created and consolidated will be questioned and eroded. This could also have negative effects for other universities in Europe that offer similar education programs.

It can be questioned why some universities have chosen to classify certain education programs with unique main subject area as belonging to the technical/natural science domain. Within several of these programs, the proportion of mathematics/natural sciences and/or engineering/technology is too low at the expense of a high proportion of economics and management, or other course modules from social sciences. The training itself can show good results and can conceivably respond well to a demand of the labour market, but it is clear from the structure and content that these programs do not belong to the technical/natural science field.

All knowledge and skills derived from an academic education are not manifested in an independent work, such as the MSc thesis. This becomes particularly clear with regards to programs in IE&M. Often the independent work deals with various aspects of management, logistics, quality, production organization, marketing, financial analyses, etc. These reports rarely show any major elements of engineering/technical knowledge (more than that students in IE&M tend to carry out the independent work in industrial and technology-intensive companies). The degree projects, thus, do not obviously manifest what is unique in IE&M programs, but only parts of what constitutes the program. In other words, the breadth of competence traditionally included in a national and continental European degree in IE&M is not reflected solely in the assignment of the independent work.

Important to Maintain an Engineering and Technical Science Orientation

The education programs in the main area of IE&M are expected to have a pronounced technical science orientation and must be able to be safely identifiable from education programs that may, at first glance, seem similar but belong to other subject areas, such as social sciences. What makes education programs in the main area of IE&M referable to this main area is that they contain a significant proportion of engineering and technology-related course modules, and that the entire education has an industrial focus. Engineering and technology in industrial engineering and management can of course be what is traditionally defined as engineering and technology, but it can also be, especially at advanced level, a progression of the economics and management found at basic level, and which takes its starting point in mathematics/natural science and/or engineering and technology. With this approach, for example, advanced production management, management of supply chains and financial mathematics can be interpreted as technology-oriented course modules in the main field of IE&M. Such course modules show a clear distinctiveness of the main field of IE&M with expected learning outcomes. The course modules are also conducted in a context that takes its starting point in engineering and technical science. It is this type of course modules, together with mathematics and science, that makes it possible to formulate and communicate the specific nature of the main IE&M subject area. A clear marker is also that an IE&M student's unique competence lies primarily in the ability to integrate technology and engineering with management subjects. It is usually in a daily, practical application that engineering problems meet non-technological issues (e.g. economic, organizational, business, social and/or ecological sustainability), where mathematics and natural sciences, or even qualified engineering course modules, are not enough to constitute a high-quality IE&M. Industry wants qualifications to be more competitive in a new scenario. This is characterized by a combination of technical evolution and business revolution, and both must be key pillars in a broad engineering qualification.

IE&M is an eclectic subject within the faculty of Engineering. Education and research are carefully developed and realized in close cooperation with the industrial world, considering the evolution in terms of advanced production management for example. However, for a subject area such as IE&M, it is especially important to protect its anchoring in an engineering context.

3. Guidelines for Setting up / Renewal of a New Master Program in IE&M

The aim of this section is to present the guidelines conceived for setting up or renewing a MSc program in IE&M. Contents and teaching methodologies have been derived from the outcomes of the IE3 initiative "Body of Knowledge" (link). The guidelines presented below are of course not mandatory rules. Instead, they represent a set of advice stemming from IE3 project partners' experiences and the IE3 project results. Implemented guidelines should be accommodated to the existing university's /country's laws, rules, regulations, and constraints. The guidelines might be a support for universities/companies in the self-assessment process of the new/revised program in IE&M.

Practical Guidelines

Below are some practical guidelines to follow when setting up or renewing a MSc program in Industrial Engineering and Management.

1. Program structure:
   - 2 years; 4 semesters; 120 ECTS credits
   - Program modules amount to 90 ECTS credits, where core modules amount to 60 ECTS credits during 1st and 2nd semester
   - 2-3 specializations each of them of totally 30 ECTS credits during 3rd semester
   - Final MSc thesis and (optional) project Internship of 30 ECTS credits during 4th semester
2. Program language: the MSc program is taught in the home country's mother tongue, but, if recruitment of international students is a goal of the program, the language should preferably be English.
3. Program domain: it is important that the program's design and content without any question are categorized as belonging to "Technology and engineering with management subjects" at a potential quality assessment.
4. Define the program's learning outcomes expressed as the students' expected knowledge, skills, competencies and abilities by consistently taking industrial and social challenges into account.
5. Important characteristics of the program are multidisciplinary represented by knowledge, and interdisciplinary represented by methods, skills, and competences.
6. Define the program's profile by choosing relevant and challenging knowledge areas.
7. Before launching the new or renewed MSc program, a comparison of the final program's aim and learning outcomes with the learning outcomes of the program modules must be made, in order to avoid overlaps and to identify whether any gaps or missing knowledge exist.
8. Be sure that the program's aim, learning outcomes and content are presented fully in line with the recommendations of the ECTS Users' Guide (Guidelines 4 and 7).
9. Execute a continuous review of the program's aim, learning outcomes, and contents, including soft skills, at least every 3 years. The Body of Knowledge issued within the IE3 project might be a suitable starting point.
10. Implement teaching methods and learning tools based on preliminary or periodic as-

sessment on their effectiveness.

11. Try to integrate both synchronous and asynchronous training during the program.
12. It is important to carefully identify and describe the prerequisites for entering the MSc program in the official document presenting the program itself. A bachelor's degree in engineering or in STEM domain is recommended.
13. *Learning* instead of *Teaching* is the privileged approach here. For example:
    - Experiential learning;
    - Learning by doing;
    - Teaching/learning factories;
    - Learning labs;
    - Project and case studies (preferably together with industry partners).
14. Try to ensure a well-balanced flexibility in the program structure, in order to create individual learning paths that help reach personal and/or career objectives.
15. It is recommended to starting with common course modules in the first year and create more specialization in the second year.
16. Organize the second year's first semester with different specialization streams to promote both flexibility and a semester abroad to strengthen the program's international profile by giving the possibility to recognize learning outcomes and ECTS credits acquired at foreign universities, and to stimulate internationalization among students and staff.
17. When designing and running MSc programs in engineering it is recommended to involve representatives from relevant industrial companies. Such involvement might take the form of:
    - proposals of content and training methods to be included in the program;
    - lectures given by industry professors, if possible;
    - co-tutoring of internships and MSc theses;
    - active participation in projects and case studies in the program modules;
    - promoting relations with different industry associations.
18. It is also important to create an active involvement of the students following the program. Such involvement might take the form of:
    - assessment of the teaching and learning activities;
    - assessment of the effectiveness of different educational tools implemented in the program structure;
    - driving the motivation of students and staff involved in the realization of the program.

A coherent example of a new master program is in section 4.

4. A New Master Program in IE&M

Programs in Industrial Engineering and Management can be built in different ways with different program modules and different profiles. However, a program in IE&M need to fulfil common aim and common learning outcomes, which are what students gain for modules in different ways. We here present the program aim and learning outcomes, a feasible program structure, and links to external educational and e-learning materials.

Training need analysis

The training needs and gap analysis is a key point in the definition of the new IE&M program. The analysis can be carried out mainly through surveys involving four main stakeholder categories: Academics, Students, Alumni, and Companies.

In a first step, the survey can be organized as semi-structured interviews with companies mainly located in the Country where the program is offered. In a second step, a quantitative survey should be carried out based on questionnaires addressed to all the stakeholders of the IE&M knowledge areas: Academics, Students, Alumni, and Companies. The second step of the survey can allow evaluating (on a quantitative basis) the training needs and the gap between the industry needs and the Master Level Academic Programs in the IE&M offered by European Universities. Four questionnaires and an action plan, designed to support IE3 project partners in reaching pre-defined targets (one for each stakeholder type), can be found at this link in the section "Training Needs Analysis".

The questionnaires are focused on:

- knowledge, skills, and competencies
- knowledge transfer methodologies
- learning activities

The survey activities performed by the IE3 Project led to the results described in the document "Training Needs Analysis".

Program Aim

The MSc program in industrial engineering and management focuses on how to identify, analyse, solve, and communicate complex interdisciplinary problems in industry, integrating engineering and management knowledge and skills, by using mathematical tools and technological applications, and by knowing how to critically assess applied methods, procedures, and practices.

A graduate from the MSc program has the individual and professional capabilities and attitudes to take on a leading role in dynamic, industrial environments; the graduate can identify, formulate, and examine complex engineering and managerial problems in a systematic and sustainable way, both quantitatively and qualitatively. By using relevant literature and performing quantitative, as well as qualitative, empirical studies, the graduate can readily apprehend new knowledge and skills. Quantitative empirical models based on hypotheses can be tested in experiments as well as through statistical analyses. Qualitative approaches, such as case studies, can be used to create both theoretical and effective constructs and propositions.

Students are trained to work collaboratively on complex problems and tasks. Interpersonal skills, teamwork, and communication are therefore of utmost importance.
This training includes contributing to group effectiveness, actively taking part in the work, creating clear roles and responsibilities, sharing knowledge, and collaboratively achieving desired goals.

At the end of the educational path, graduates can communicate, orally and in writing, in a correct, inspiring way orientated towards achieving goals. Effective communication is comprised of both task-related and relationship-oriented skills. Graduates must also be proficient enough in English to consider the state-of-the-art knowledge within the field and, based on this knowledge, understand, analyse, compare, and reflect on complex engineering and managerial problems, both in written text and orally.

Program Learning Outcomes

After having completed the whole program, the graduated engineer will be able to:

1. Identify, formulate, analyze and solve complex engineering as well as human and managerial related problems, using relevant methodology and advanced qualitative and quantitative tools, applicable to the different industrial sectors;
2. Handle complex decision-making processes, by using both computer-based facilities and software tools to find and implement solutions on different engineering and managerial issues in a company or in an organization;
3. Use and apply what is available in the modern digital landscape of today and tomorrow, based on broad and deep technical knowledge, to support the technical development and business environment of the company;
4. Show insight into the possibilities and limitations of technology, its role in society and the engineers' responsibilities for how it is used, including social and economic aspects as well as ethical and work environment aspects;
5. Demonstrate the ability to develop and design products, processes and systems related to society's goals, conditions and needs for sustainable development;
6. Identify and learn how to handle operational risk management and information security;
7. Work in dynamic environments with changing expectations and moving goals, and to manage projects of different size and complexity;
8. Execute leadership and team management for different teams of experts in various areas, by setting goals, delegate tasks and be responsible for results;

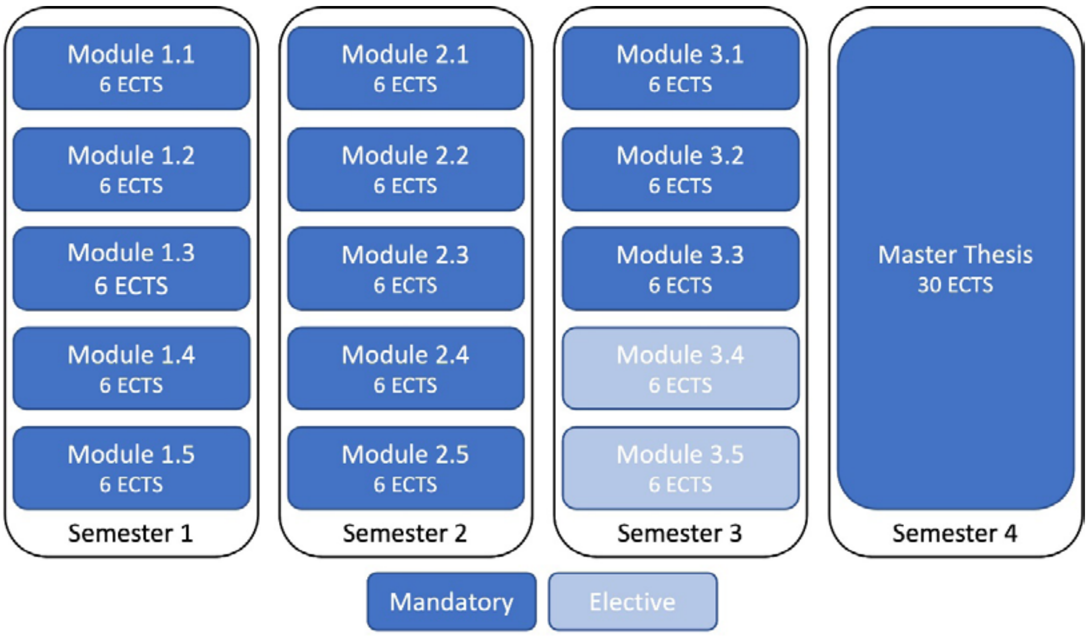
9. Develop an entrepreneurial mindset and demonstrate innovative skills in technical and organizational environments;
10. Be an autonomous learner, able to identify the need for additional knowledge and constantly embrace, develop, and implement new competences.

Program Structure

The structure of the program can be designed in different ways. The IE3 project suggests mainly program modules of 6 ECTS credits each following the regular structure as shown in Figure 2 below.

The regular structure is based on five 6-ECTS program modules each semester, in which modules cover different subjects that characterize a modern MSc program in IE&M (see Figure 2). Typical subjects are "Operations Management", "Industrial Marketing", "Innovation Management", etc. Subject areas from earlier semesters are coming back during the following semesters with a clear progression in both breadth and depth. In the third semester, one or more electives/ specializations can be introduced so that the number of program modules in the specialization subject increases. Finally, a thesis/dissertation must be written, presented and defended, preferably in the chosen specialization.

Figure 2 - Program Structure



Tables 1 to 4 show examples of the program modules each semester. In Table 5 the ten Program Learning Outcomes are mapped towards the different Program Modules.

Details of the modules' syllabi are in the document "A New Master Program in IE&M".

Table 1: First semester

First Semester						
Module		M/E	ECTS	Keys	Characteristics	Program Learning Outcomes
1:1	Information Systems in Industrial Engineering and Management	M	6	- Data from processes - Local and cloud workflows - Data storage and process flow - Machine learning	- Business intelligence tools - PLCs and wearables - Digital controllers - Beacons and BLE - e-Learning labs	2 3 5
1:2	Big Data Analytics	M	6	- Big data in cloud - Deep learning modelling - Distributed processing and microservices - Elasticity - IT security - IT ethics and compliance	- ISO 2700x, ISO 35030, ISO18045 and ISP 24760 - ISO 26000 - e-Learning labs - e-learning module	1 2 3
1:3	Quantitative Methods in Industrial Engineering and Management	M	6	- Mathematical programming - Advanced statistics - Discrete event simulation	- Theoretical concepts - e-learning labs - Self-evaluation	1 2 3 5
1:4	Quality Management	M	6	- Organization of quality departments - Cost of quality - Total quality management and the Six Sigma methodology - Statistics for quality - Continuous improvement of products, processes, purchasing and supply chain management	- Flipped classroom. - Theoretical concepts - Exercise on statistics for quality - Group assignment - Self-evaluation	1 3 5
1:5	Problem Solving and Decision Making	M	6	- Fundamentals of decision theory - Payoff matrix - Decision tree - Multicriteria decision making	- Theoretical concepts - Work cases - Critical thinking and discussion - Team working	1 2 3

Table 2: Second semester

Second Semester						
Module		M/E	ECTS	Keys	Characteristics	Program Learning Outcomes
2:1	Operations Management	M	6	- Traditional and innovative paradigms of operations management - Forecasting methods - Theoretical and practical tools for medium and short-term production planning and control	- Flipped classroom. - Theoretical concepts - Work cases - Factory virtual tour - Team working - Teaching / Learning Factories - Self-evaluation	1 2 3 5
2:2	Lean Production and Continuous Improvement	M	6	- Value creation and lean concepts - Performance measures and improvements - Information-based monitoring - Lean re-design of production systems	- Flipped classroom. - Theoretical concepts - Work cases - Factory virtual tour - Team working - Teaching / Learning factories - Self-evaluation - e-learning modules	1 2 5
2:3	Digital Manufacturing	M	6	- Technology overview on Industry 4.0. - Digital processes - Digital factory - Fundamentals of extended reality - Fundamentals of additive manufacturing	- Cases - Individual & group assignments - Individual / group evaluation - Experiential learning - IEC 62264 - ISO 22400	1 2 3 5
2:4	Advanced Project Management	M	6	- Complexity dimensions of a 'Project' - Project Planning & Control - Resource allocation - Risk management - Digitalization in PM	- Flipped classroom. - Project and case studies - Discussion and score based on participation - Practical usage in the practical module - Team working - Self-evaluation - e-learning module	4 6 7 8 9
2:5	Occupational Safety and Health	M	6	- Accidents and work diseases: concepts and statistics - Safety in quality systems - Risk assessment: theory and methodologies - Case studies	- ISO 45001 (OHSAS 18001) - Work cases - Experiential learning - Team working - Self-evaluation	4 6

Table 3a: Third semester

Third Semester						
Module		M/E	ECTS	Keys	Characteristics	Program Learning Outcomes
3:1	Innovation in operations management: value chain management in a global context	M	6	- Innovation in operations. - Smart I4.0 - Value creation and lean concepts in global contexts - Smart production and smart maintenance - Servitization	- Cases - Individual & group assignments	2 3 5 10
3:2	Innovation and Strategic management in a global environment	M	6	- Organizational business models - Transformation of the OBM by technology - CSR and values. - Transparency driven by technology - Case studies	- Cases - Individual & group assignments. - Practical usage in the practical module as proposal for organization of operations. - Introduction to research methodologies	2 3 5 8 10
3:3	Sustainable Production Systems	M	6	- Sustainability and social issues - Corporate social responsibility - Environmental management systems (EMS) - Environmental performance evaluation (EPE). - Life cycle assessment (LCA)	- Introduction to and use of standards: ISO 14000, EMAS - Cases - Individual & group assignments	1 2 4 5
3:4	Business in an interconnected world	E	6	- Technology as an opportunity - Strategic analysis of corporative decisions - Impact of Industry 4.0 - Sources and tools for corporate funding - Real options and project finance	- Cases - Individual & group assignments. - Practical usage in the practical module as proposal for organization of operations	3 6 9
3:5	Communication, Leadership and Entrepreneurship	E	6	- Human resource management - Communication techniques - Leadership and entrepreneurship - Business models for innovative ventures (start-ups) - Intellectual property	- Individual & group assignments - Individual / group evaluation - Experiential learning	3 4 7 8 9

Table 3b: Third semester

Third Semester						
Module		M/E	ECTS	Keys	Characteristics	Program Learning Outcomes
3:6	Digital Business	E	6	- Strategic analysis for digital business - Lean-start up and financing - Data driven analysis - Business process reen-gineering - Digital market and digital marketing - Marketing planning - Digital organization and HRM	- Cases - Individual & group assignments - Individual / group evaluation - Experiential learning	2 3 6 9
3:7	Cyber Security in Industry	E	6	- Background and fun-damentals on cyber-se-curity - Architecture and vul-nerability of operating systems, data driven analysis - Cyber security and industry standards	- Cases - Individual & group assignments - Individual / group evaluation - Experiential learning	1 2 3 4 5 6

Table 4: Fourth semester

Fourth Semester						
Module		M/E	ECTS	Keys	Characteristics	Program Learning Outcomes
4:1	Master Thesis	M	30			1 2 4 5 7 8 9 10
4:2	Internship	E	-			5 7 8 9 10

Table 5: Program Learning Outcomes mapping for each Module

	Module	1:1	1:2	1:3	1:4	1:5	2:1	2:2	2:3	2:4	2:5	3:1	3:2	3:3	3:4	3:5	3:6	3:7	4:1	4:2
	Program Learning Outcomes	Enterprise Information Systems in IE&M	Big Data Analytics	Quantitative Methods in IE&M	Quality Management	Problem Solving and Decision Making	Operations Management	Lean Production and Continuous Improvement	Digital Manufacturing	Advanced Project Management	Occupational Safety and Health	Innovation in operations management: value chain management in a global	Innovation and Strategic management in a global environment	Sustainable Production Systems	Business in an interconnected world	Communication, Leadership and Entrepreneurship	Digital Business	Cyber Security in Industry	Master Thesis	Internship
	(M) Mandatory/(E) Elective	M	M	M	M	M	M	M	M	M	M	M	M	M	E	E	E	E	M	E
1	Identify, formulate, analyse, and solve complex engineering as well as human and managerial related problems using relevant methodology and advanced qualitative and quantitative tools, applicable to the industrial sector		X	X	X	X	X	X	X					X				X	X	
2	Handle complex decision-making processes by using both computer-based facilities and software tools to find and implement solutions on different engineering and managerial issues in a company or in an organization	X	X	X		X	X	X	X			X	X	X			X	X	X	
3	Use and apply what is available in the modern digital landscape of today and tomorrow based on broad and deep technical knowledge to support the technical development and business environment in the company	X	X	X	X	X	X		X			X	X		X	X	X	X		
4	Show insight into the possibilities and limitations of technology, its role in society and the engineers' responsibilities for how it is used, including social and economic aspects as well as ethical and work environment aspects									X	X			X		X		X	X	
5	Demonstrate the ability to develop and design products, processes, and systems regarding society's goals, conditions, and needs for sustainable development	X		X	X		X	X	X			X	X	X				X	X	X
6	Identify and know how to handle operational risk management and information security									X	X				X		X	X		
7	Work in dynamic environments with changing expectations and moving goals and to manage projects of different size and complexity									X						X			X	X
8	Execute leadership and team management for different teams of experts in various areas by setting the goals, delegate the tasks and be responsible for the results									X			X			X			X	X
9	Develop an entrepreneurial mindset and demonstrate innovative skills in technical and organizational environments									X					X	X	X		X	X
10	Be an autonomous learner identifying the need for additional knowledge and constantly embrace, develop, and implement new competences											X	X						X	X

Turning training courses into e-learning courses

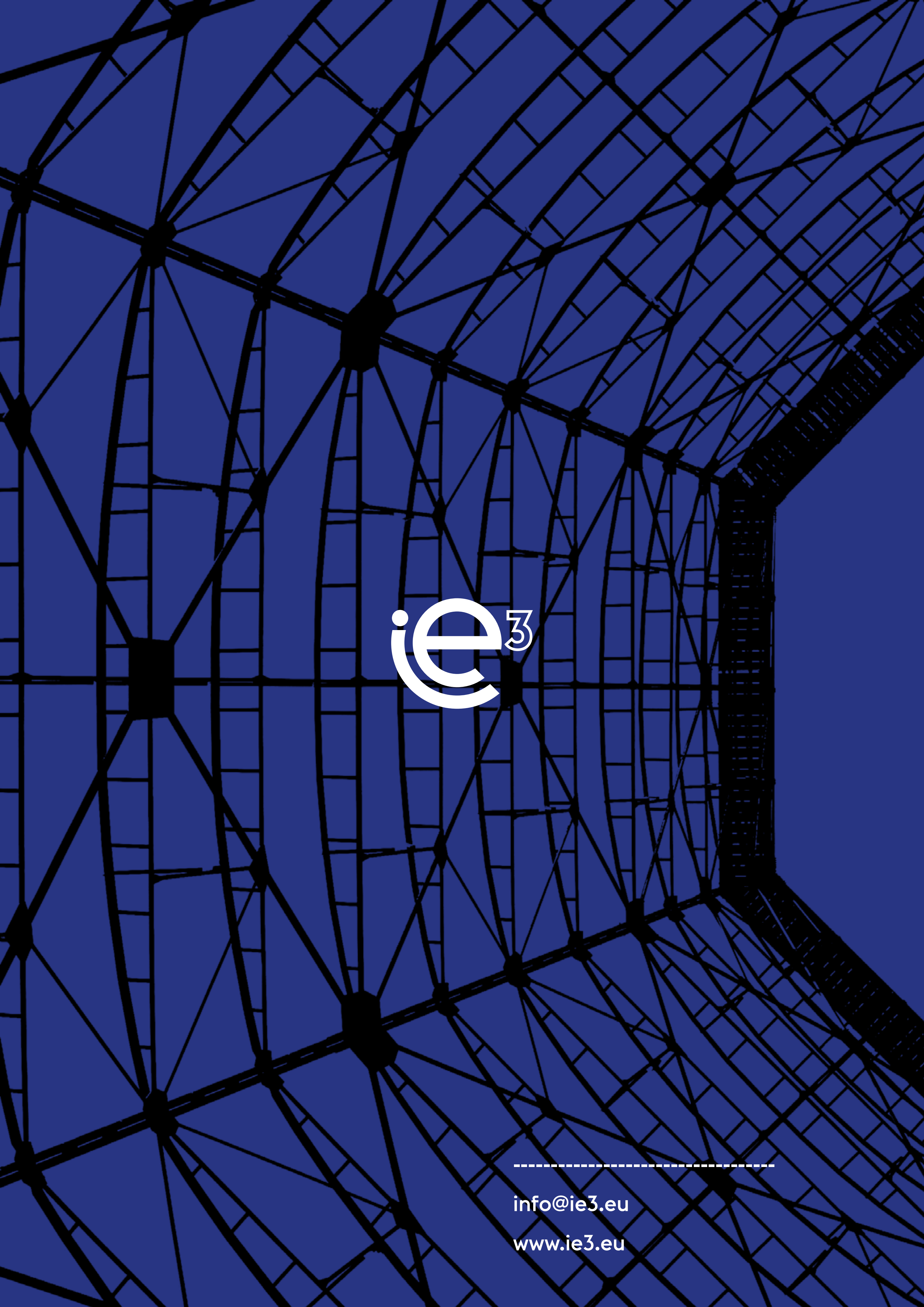
Preparing e-learning modules starting from already tested and used training materials is an effective educational activity. Also, referring to existing e-learning modules is an opportunity to carefully assess the quality of the content and the educational methodology. The effectiveness of blended learning courses (providing traditional classes and e-learning modules) needs to be tested. The pedagogical model involving e-learning modules (e.g. flipped classroom, learning factories, university labs) should be defined, and the effectiveness of knowledge transfer has to be assessed periodically.

An agreed action plan, including the description of the e-learning modules and the assessment of the effectiveness of knowledge transfer, will make it possible to monitor the effectiveness of the pedagogical choices made.

Beyond the pedagogical model, specific consideration must be devoted to the intended usage of the learners' platform (duration, foreseen interactions, etc.), and which non-standard elements would be required (gamification, etc.). These aspects are closer to the adopted methodology, and they are connected to the added value (strengths) of the e-learning modules.

Industrial contribution to the realization of e-learning modules is recommended. According to the experience in the company, technical staff at management level can cooperate in different ways depending on the focus of the module and their specific skills. Mutual trust between academic Institutions and companies is needed to run and assess the effectiveness of e-learning modules.

The IE&M program designed in this project (see tables 1-5), will benefit from four e-learning modules available at the project's website through this link, using the Moodle compressed xml format to easily enable the usage. Although experimental, and following different pedagogical models, they give a comprehensive picture of different topics that can be developed within an IE&M MSc programme.



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