Teaching Transversal Competences in Civil Engineering Education

Tamás Lovas, Árpád Barsi, Balázs Nagy

EUCEET 2025 BUDAPEST, HUNGARY — 15.10.2025

Current Challenges in the Construction Sector

- **Construction contributes significantly to GDP but faces productivity stagnation.**
- **Low digitalisation and efficiency compared to other industries, development needed.**
- **Pressure from EU Green Deal, sustainability goals, and digital transition policies.**
- **Increasing complexity of projects requires collaborative, interdisciplinary work.**
- **Shortage of engineers with integrated technical and transversal competences.**
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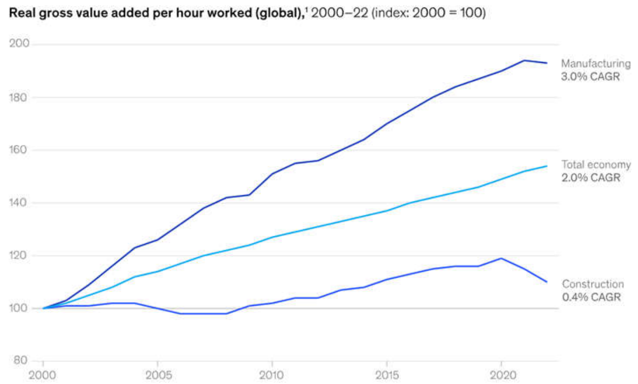
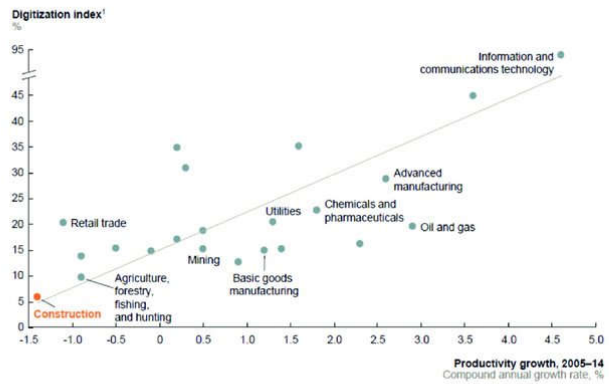


[1]Includes 42 countries with sufficient data availability; they account for >90% of 2022 construction value added.
Source: McKinsey analysis based on sources from IHS Markit, the International Labour Organization, OECD, the UN, and local statistical offices



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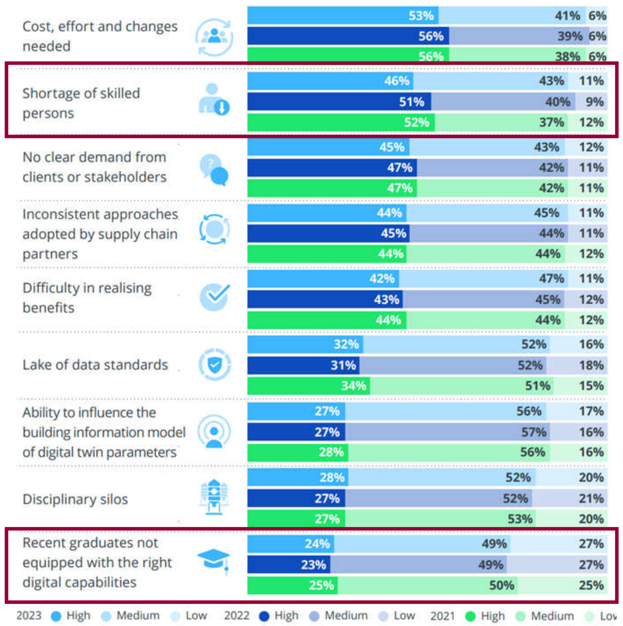

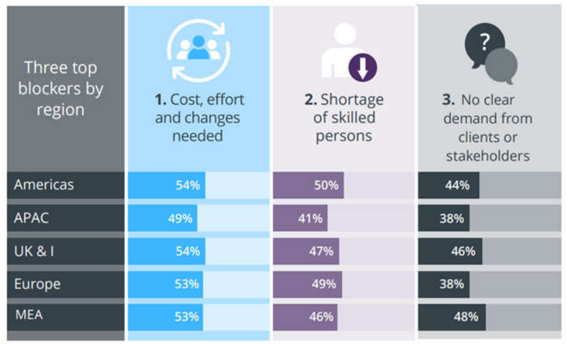

BME

Skilled Civil Engineers: Technical and Transversal Skills

- **Modern construction environments demand both technical and transversal skill sets and competences!**
- **Technical skills, e.g.: programming, numerical modelling, IoT systems, BIM, Digital Twins, automation, robotisation**
- **Transversal skills, e.g.: thinking, self management, social intelligence, responsibility, teamwork, communication, leadership, innovative entrepreneurship, adaptability, problem-solving, reasoning...**
- **Industry demands skilled civil and architectural engineers with sufficient IT and social skills**
- **Transversal skills enable efficient communication between civil engineering and IT domains**

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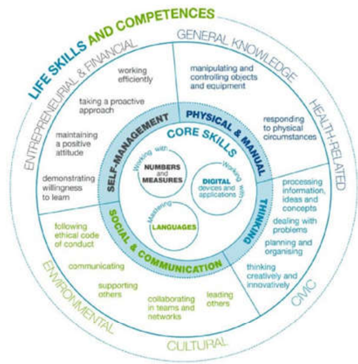

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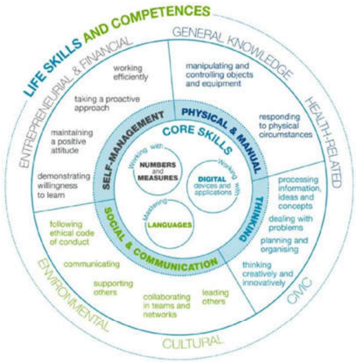

Construction Information Technology Engineering MSc

Duration: 3 semesters (90 ECTS), taught in English

Target group: civil/architectural & IT background students

Goal: produce professionals who can bridge construction & IT domains

Semester 1:
- Python programming and Database systems, or
- Building constructions and FEM basics
- BIM, IoT, Digital Twins fundamentals
- CIT engineering project – teamwork

Semester 2:
- Construction automation & digitisation
- Building electricity and HVAC
- BIM modelling laboratory practice
- Complex project continuation – teamwork
- Field practices (BTC week, EELISA Hackathon)

Semester 3:
- Advanced applications & elective topics, Thesis

MSc program in Construction Information Technology Engineering

	English Name	Code	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Core Subjects										
	Numerical Methods	BMEEOAFMB51	4			2			E	1
	Construction Information Technology Mathematics	BMETE90MX33	3	2					E	1
	Building Information Modelling	BMEEOFTMB51	3	2					M	1
	Decision Support Methods	BMEEPEKMB51	2	2					M	1
	Construction Information Technology Engineering Project	BMEEOOHMBSP	6				2		M	1
	BIM Modelling and Design	BMEEOFTMB52	5			4			E	2
	Civil Engineering Automation, Modelling	BMEEOHSMB51	5	1	2				E	2
	Construction Information Technology Programming	BMEVIAUM___B51	6	1	4				M	2
	Complex Construction IT project	BMEEOOHMBSK	6				2		M	2
	Argumentation, Negotiation, Presentation	BMEGT41MB51	3	2					M	3
	Technology Assessment	BMEGT41MB52	2	2					M	3
***	Diploma Project	BMEEOOHMB-D	20				1		M	3
Obligatory and recommended Elective Subjects										
	1st Obligatory Elective Subject*		8	2	4				E	1
	2nd Obligatory Elective Subject*		4	1	2				M	1
	1st Recommended Elective Subject*		4	2	1				M	2
	2nd Recommended Elective Subject*		4	2	1				M	2
	Optional subjects	BMEEO	5						M	3
		1st semester	30	9	6	2	2	0		
		2nd semester	30	6	8	4	2	0		
		3rd semester	30	4	0	0	1	0		
		Σ	**90**	**19**	**14**	**6**	**5**	**0**		

*Students with a BSc degree in Civil Engineering or Architecture (Student Group I.)

Obligatory Elective Subjects (at least 12 credits to complete)										
	Programming	BMEVIHIA061	8	2	4				E	1
	Database Systems	BMEEOFTMB-1	4	1	2				M	1
Recommended Elective Subjects (at least 8 credits to complete)										
	Structural Dynamics	BMEEOTMMN-1	4	2	1				M	2
	Stability of Structures	BMEEOHSMT-2	4	2	1				E	2
	FEM for Engineers	BMEEOTMMB-2	4	1	2				M	2
	Numerical Methods in Geotechnics	BMEEOGMMB61	4	1		1			M	2
	Automated Survey Systems	BMEEOAFMB61	4	1	2				M	2
	Electrical Systems in Buildings	BMEVIVEM___B61	4	2					E	2
	HVAC Basics	BMEGEÉEM___B61	4	2					M	2

*Students with a BSc degree in Mechanical Engineering/ Energy Engineering/ Mechatronics Engineering/ Electrical Engineering/ Computer Science (Student Group II.)

Obligatory Elective Subjects (at least 12 credits to complete)										
	Building Constructions	BMEEOEMMB-1	8	2	4				M	1
	Finite Element Modelling	BMEEOTMMB-1	4	1	2				E	1
Recommended Elective Subjects (at least 8 credits to complete)										
	Construction Management	BMEEPEKMB61	4	2	1				M	2
	Civil Engineering Structures and Modelling	BMEEOHSMB61	4	2	1				M	2
	Constructions of Buildings and Structures	BMEEOEMMB61	4	2	1				M	2
	Modelling of Hydrosystems	BMEEOVVMV-1	4	2	1				M	2
	Electrical Systems in Buildings	BMEVIVEM___B61	4	2					M	2
	HVAC Basics	BMEGEÉEM___B61	4	2					M	2

Optional Subjects

**	Optional subject - internship (at company)	BMEEOOHMV02	5					20	M	3

Construction Information Technology Engineering MSc

- **Launched in 2022**
  - 10 international and 8 Hungarian students in the 1st year
  - 10 international and 11 Hungarian students in the 2nd year
  - 9 international and 6 Hungarian students in the 3rd year
  - 13 international and 5 Hungarian students in the 4th year
- **Involving 6 faculties of BME**
- **Technical skills**
  - BIM, Numerical modelling, Simulations
  - Building electricity, HVAC, Automation
  - IT (programming, DB management, IoT)
- **Non-technical skills**
  - Teamwork
  - LLL – autonomy – responsibility
  - argumentation – negotiation – presentation

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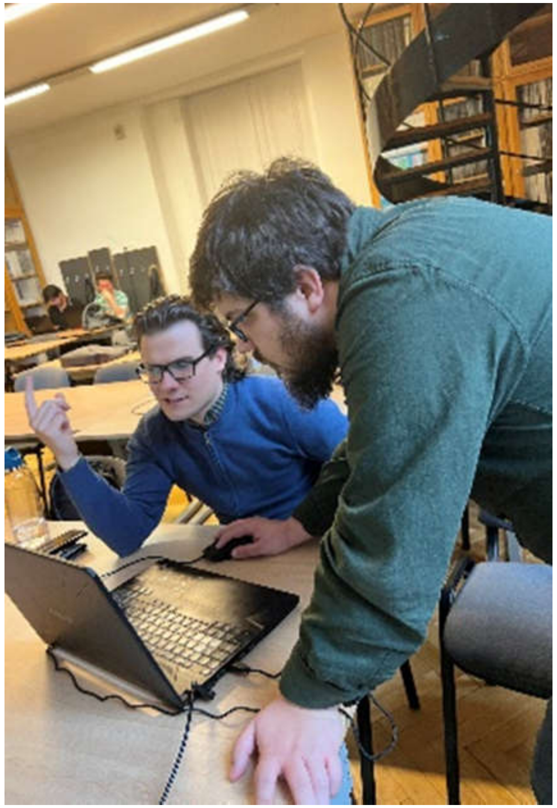
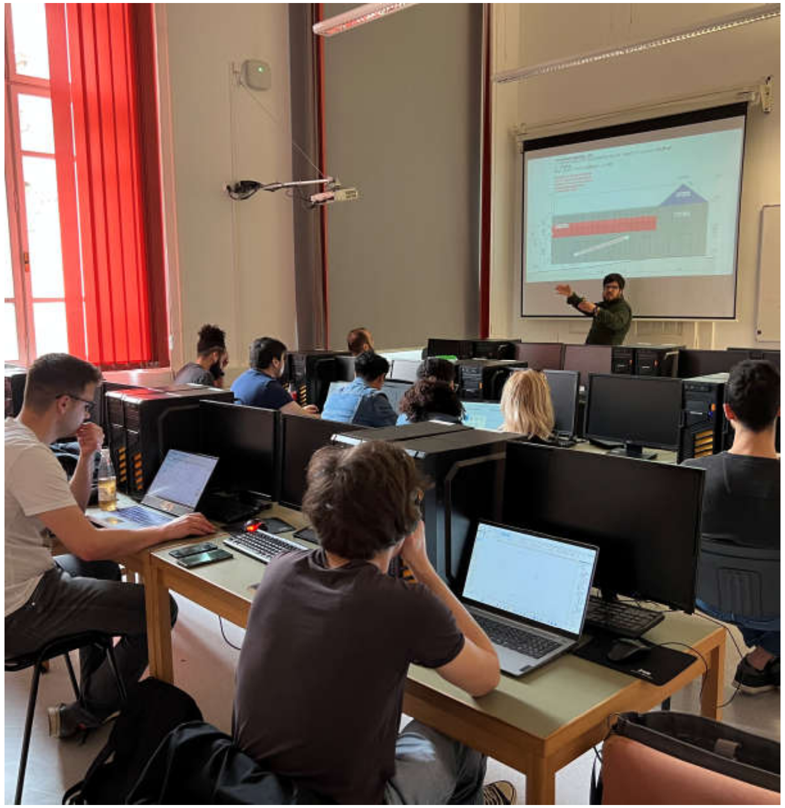
Digitalization of the AEC industry – Teaching technical skills

Building Information Modelling and Management, Simulations



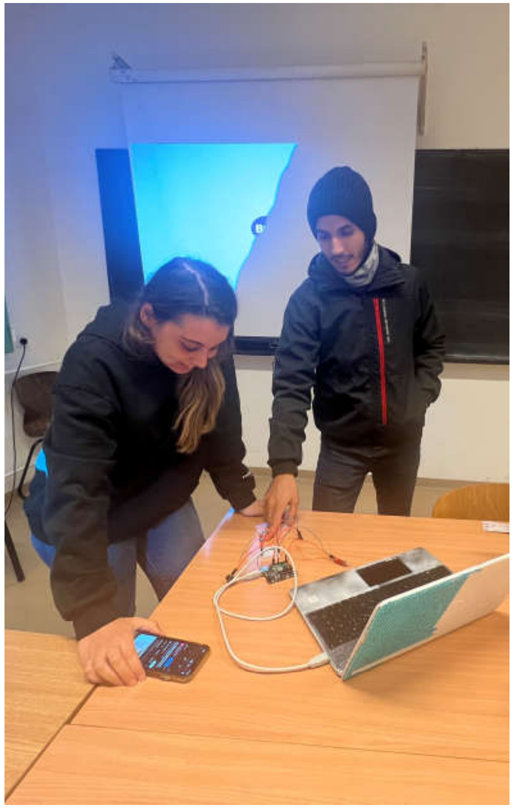


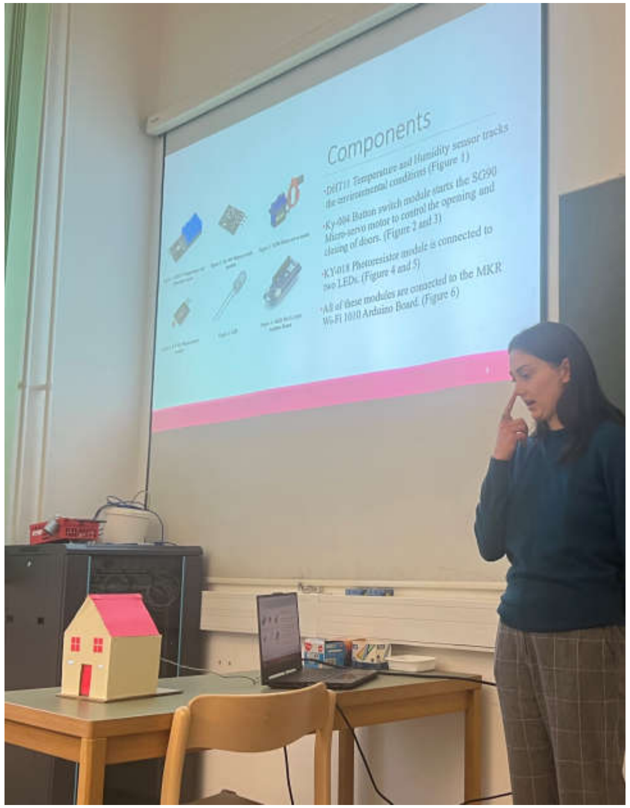
Digitalization of the AEC industry – Teaching technical skills

Building electricity, HVAC, Automation, Robotization

Digitalization of the AEC industry – Teaching technical skills

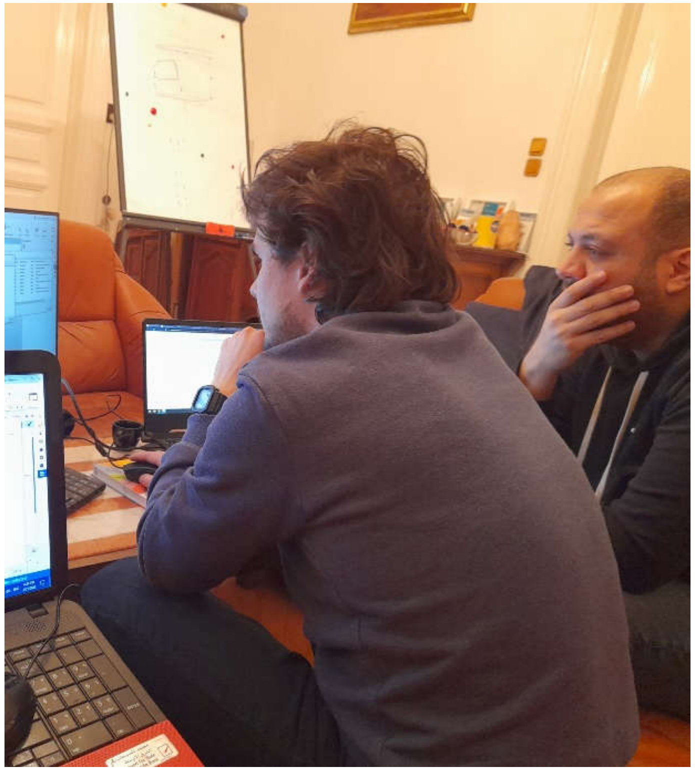
IT (programming, DB management, IoT project)





Non-technical skills – in the classrom

Non-technical skills (e.g. teamwork, thinking, presentation)

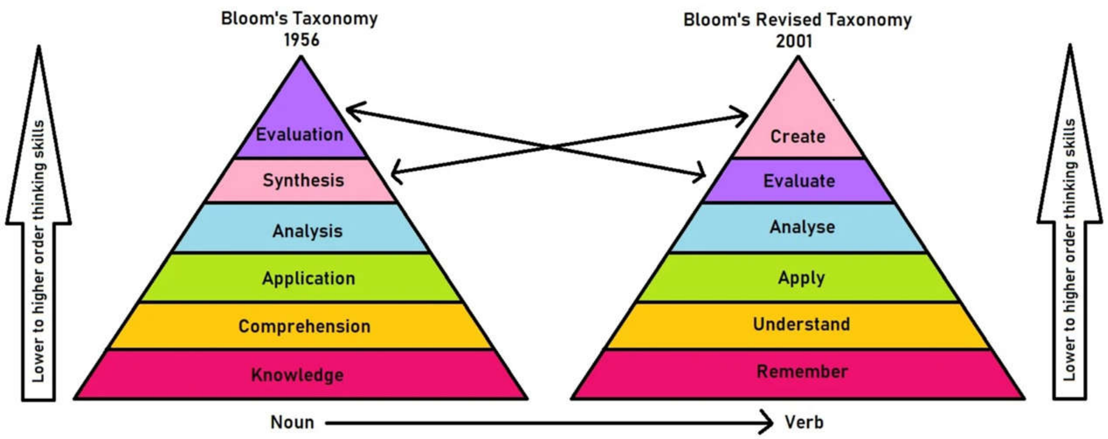


Non-technical skills – outside the classroom

Non-technical skills (e.g. interpersonal, social, communication)

Project-based learning embedded in technical curriculum

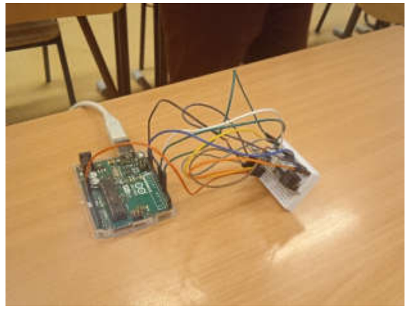
- **Integrates Bloom's taxonomy - moving from knowledge acquisition to evaluation and creation**

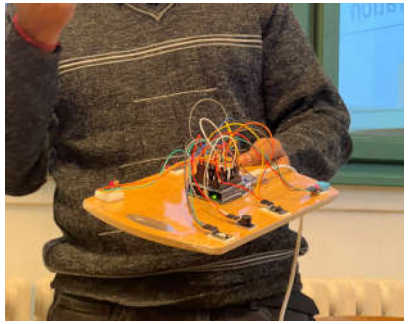


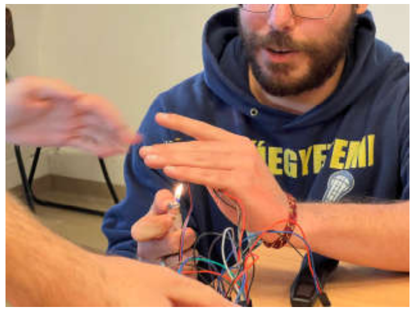
- **Fall semester**
  - IoT Projectwork
- **Spring semester**
  - Applied programming
  - Complex IT Projectwork
  - BTC week
  - European Engineering project, EELISA week & Hackathon

Spring semester: CITE project-based learning

- **Early exposure to hands-on tasks and challenges**
- **Realistic scenario: “Build your smart home IoT”**
- **Emphasis on problem definition, teamwork, data analysis, presentation and communication**
- **Students learn microcontrollers, sensor networks, wiring, networking, bid data literacy, and integrating data streams**
- **Collected data is used in programming and database courses**
- **Building a common digital language between civil engineers and IT experts.**





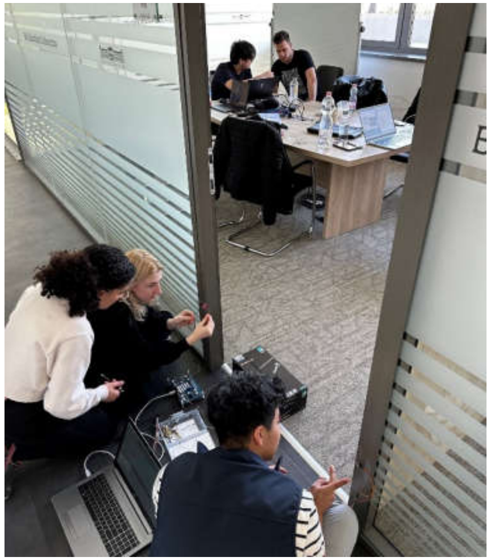


Fall semester: BTC week, „Field practice”

- **One-week immersive field exercise 120 km away in Balatonfüred Knowledge Centre**
- **Students live and work together off-campus**
- **Sponsored by industrial partners**
- **Tasks mirror real project environments (data collection, troubleshooting, reporting)**
- **Team building and intercultural communication skills are emphasized**
- **High student satisfaction and strong community formation**

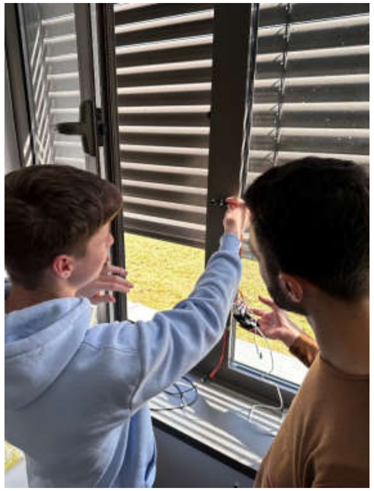
Fall semester: BTC week, „Field practice”

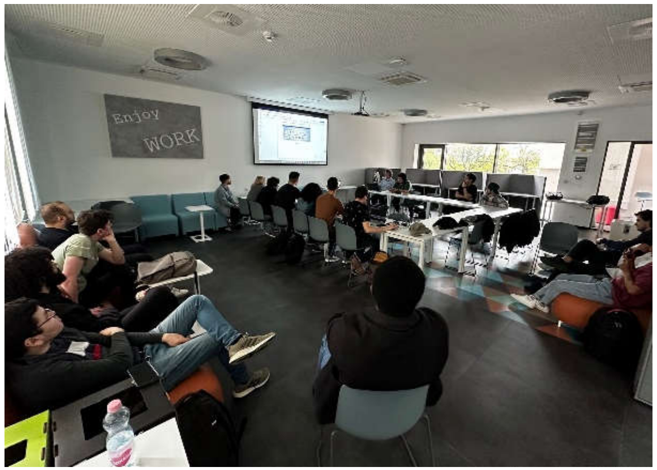
- **Break from traditional classroom setting → high engagement**
- **Teams must plan, delegate, and execute autonomously**
- **Teaches resilience, problem solving under pressure, and negotiation**
- **Peer learning and mentoring play a key role**
- **Reflection and feedback sessions integrated**
- **Outcomes feed directly into semester projects and assessments**



Short video about BTC Weeek (by Balázs Liszi)

Pictures and videos from the first cohort (2022-2023)





European Engineering Projectwork (EELISA course)

- **5 ECTS course embedded in Semester 2**
- **Framework based on ENAEE & SEFI guidelines**
- **Students form 3-4 person teams to develop a virtual product or a service, acting as a startup**
- **Skills targeted:**
  - **Collaboration, problem solving**
  - **Project management, methods and tools**
  - **Business model development**
  - **Entrepreneurship, pitching and debate**
  - **Documentation and presentation**
- **This course includes a week-long EELISA Worshop and Hackathon abroad as final event**

ENAEE

1. Thorough knowledge and understanding of the basic sciences and engineering, and associated mathematical, numerical and experimental methods.
2. Skills in identifying, formulating and solving complex engineering problems, using appropriate methods, including design and analysis techniques.
3. Ability to develop and use models to describe, analyze and predict the behavior of engineering systems and processes.
4. Skills to design innovative, efficient and sustainable solutions, taking into account technical, economic, environmental, social and ethical aspects.
5. Ability to communicate effectively, both in writing and orally, with colleagues, partners, and customers, using appropriate tools and languages.
6. Skills to work in a team environment, contributing to a collaborative work environment and adhering to professional and ethical standards.
7. Project management skills, including planning, organizing, coordinating, and controlling technical activities and required resources.
8. Ability to engage in lifelong learning, updating knowledge and skills in response to changing technologies, methods and standards.
9. Awareness of the engineer's social responsibility, considering the impact of engineering solutions on society, the environment and the economy.
10. Knowledge and understanding of the impact of cultural and international considerations on engineering practice.

SEFI

1. Technical skills: Engineers should have a sound technical knowledge in their field of expertise.
2. **Problem Solving Skills**: Engineers must be able to identify problems and find creative and effective solutions to solve them.
3. **Communication Skills**: Engineers must be able to communicate effectively with colleagues, customers, partners and other stakeholders.
4. **Collaboration Skills**: Engineers must be able to work in teams and collaborate effectively with other professionals from different disciplines.
5. **Leadership Skills**: Engineers must be able to lead and supervise projects, teams and processes.
6. **Ethical Skills**: Engineers must be aware of their social and environmental responsibilities and be able to make ethical decisions in their work.
7. Personal Development Skills: Engineers must be able to adapt to changing situations and continue to develop professionally throughout their careers.

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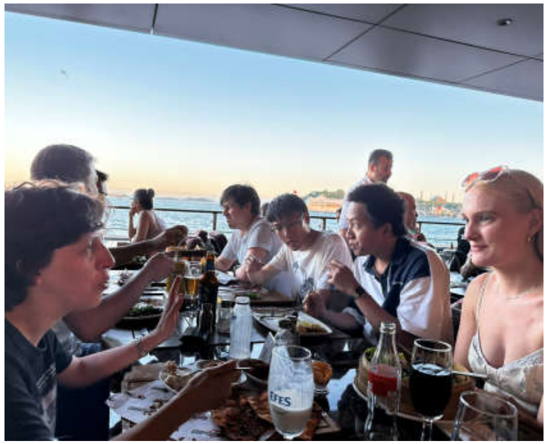
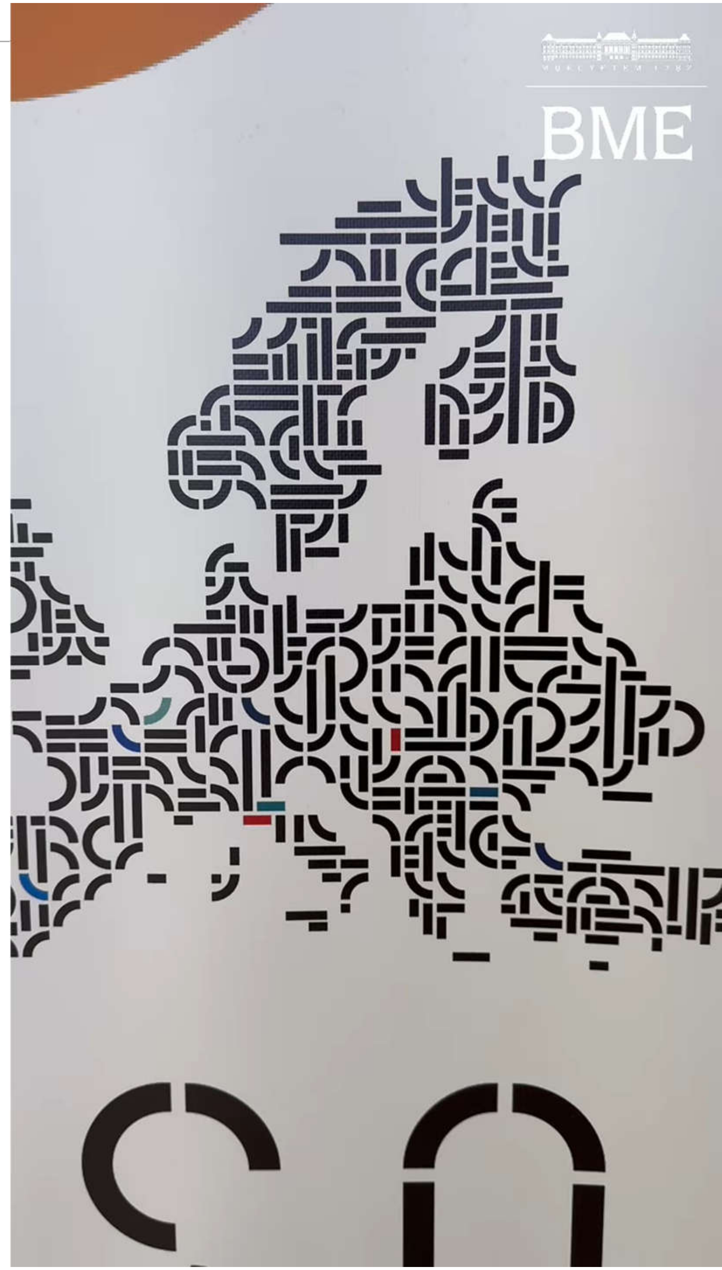
EELISA Week and Hackathon

- **Focus on developing Transversal Skills**
  - **Communication & teamwork:**
    collaboration with students from multiple countries
  - **Critical thinking & adaptability:**
    fast problem framing and solution design
  - **Leadership & coordination:**
    shared responsibilities in time-constrained settings
  - **Presentation & pitching:**
    elevator pitches to “virtual investors”
- **Students produce technical output + social media communication package**

Short video about EELISA Week (by Dóra Szagri)

Pictures from second (2023-2024) and videos from the third cohort (2024-2025)





Summary and lessons learned

- **Technical knowledge alone is insufficient**
- **Embedding transversal skills development throughout the curriculum is essential**
- **Transversal skills must not be treated as "extra" but as core learning outcomes**
- **Project-based, interdisciplinary methods can be adapted widely**
- **Projects, Field practices, Hackathons and international collaboration drives skill formation, enhance employability, and increases student motivation and resilience**
- **Recommendation: integrate transversal competence modules into MSc programs in construction and engineering domains**

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Thank you for your attention!

Balázs Nagy
nagy.balazs@emk.bme.hu

EUCEET 2025 BUDAPEST HUNGARY
BUDAPEST, — 15.10.2025.

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