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GAP-analysis: Integral Safety Education at Technical Universities in The Netherlands for the Construction Process Industry

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In this paper, we explore two key aspects of integral safety in technical education and practice. First, we examine the extent to which integral safety is incorporated into the curricula of Dutch technical universities - specifically, Delft University of Technology, Eindhoven University of Technology, and the University of Twente. Second, we investigate the safety-related requirements for key figures and project team members in the Construction Process Industry, particularly in infrastructure and construction projects. To bridge these perspectives, we conduct a GAP analysis. Our findings indicate that integral safety is not yet an established part of technical studies at Dutch universities. Notably, programs such as Civil Engineering and Architecture -both of which are fundamental to the Construction Process Industry- have yet to integrate safety into their curricula. This gap is significant, as graduates from these programs often take on key roles in the industry, where they are responsible for ensuring safety in practice. A foundational understanding of integral safety during their studies would better prepare them for this responsibility. Every engineer and architect should be equipped with knowledge of integral safety, encompassing all phases of the construction process. Our investigation takes a broad approach, considering the multidisciplinary and multidimensional nature of safety. We highlight various safety domains, including structural safety, traffic safety, machine safety, electrical safety, and external safety. Finally, we provide recommendations on how future engineers can be effectively trained in integral safety, ensuring that it becomes an integral part of their professional practice from an ethical standpoint.

Keywords: Integral Safety, Education, Construction Process.

1. Introduction

Safety is often primarily associated with construction safety among civil engineers and architects, who are key figures in the Construction Process Industry. If you ask a randomly selected professional from this field what safety entails, their answer will likely focus on construction-related aspects - such as the necessity of wearing personal protective equipment (PPE) on-site or the importance of preventing accidents during the construction phase. Some may also mention the need to ensure the structural safety of buildings. While these responses are valid, they represent only a limited view of safety.

Civil engineers are trained to design and construct buildings and infrastructure safely, following prevailing regulations. They specialize in creating stable structures and ensuring their integrity throughout both the construction phase and their long-term use. However, safety in the built environment extends beyond just structural and construction site safety, encompassing a much broader range of considerations. And civil engineers are not trained to manage safety risks in the vicinity of a construction site during the construction, renovation, or demolition phases. Additionally, they often lack awareness of how external environmental factors impact the safety of the structure being built. This gap in knowledge affects their ability to address integral safety throughout the construction process.

Moreover, civil engineers are typically not trained in safety domains beyond the structural system itself. Their expertise is primarily focused on ensuring the structural integrity of assets such as bridges, tunnels, roads, locks, and buildings, as well as the traffic safety of (rail)roads. Vrouwenvelder (2001) describes this as "*in ante safety*"- safety confined to the system itself. The depth of a civil engineer's safety knowledge largely depends on their area of specialization during their master's studies. In practice, civil engineers must also consider broader safety domains beyond the system itself, such as environmental safety, which Vrouwenvelder (2001) refers to as "*ex ante safety*" Addressing these additional safety concerns is crucial for ensuring the overall safety and sustainability of construction projects.

Architects, on the other hand, are even further removed from integral safety, as their training primarily focuses on designing and managing aesthetically pleasing buildings. Furthermore, integral safety is not yet integrated into the Architecture curriculum. Both civil engineers and architects must address safety issues in their projects after completing their studies. They play a key role in designing and managing future-proof, safe assets, guided by regulations such as the Dutch Building Decree (Bouwbesluit, 2012), which sets important boundaries for safe construction, use, and even demolition of assets.

Knowledge of integral safety -which encompasses all safety domains- remains limited among key figures in the construction process industry. As a result, civil engineers and architects often have minimal understanding of safety domains beyond the structural system itself. This gap, as previously mentioned, is significant. In this paper, we investigate the extent to which integral safety is integrated into the curricula at Dutch technical universities (Delft, Eindhoven, and Twente). We also explore how future professionals, such as civil engineers and architects, can be better equipped with integral safety knowledge during their education and how they can incorporate it into their daily work practices.

2. Research method

In this study, we employ the desktop research method, also known as secondary research. This approach involves gathering and analysing existing information and data from various readily available sources, such as university websites.

First, we examine the legal framework for integrating safety into the curricula of technical universities. Then, we explore the scope of safety education that should be considered for technical studies, focusing on the basic needs of future professionals and project team members in the construction process industry. Building on this, we assess the current status of integral safety at Dutch technical universities in. Here, we map the universities with departments / specializations on one axis, and the required safety scope for the construction process industry on the other. This analysis allows us to identify the gap, followed by conclusions and recommendations.

3. Legal base of integrating safety into studies

Several documents have highlighted the importance of incorporating safety into existing technical education programs, particularly for designers, namely:

1. The FIEC-Directive 92/57/EEC (1992) urges that knowledge regarding safety during technical studies is compulsory, especially for studies of architects and civil engineers.
2. The EU-report (2008) recommends that architects & engineers involved in design process should receive training in the prevention of occupational risks and training should be preferably a part of their university studies. This report evaluates the practical implementation of the EU directives on health and safety at work, such as 92/57/EEC (temporary & mobile construction sites) and 92/58/EEC (workplace safety) in EU.
3. One of the key principles of the Dutch Governance Code for Safety in Construction (GCVB) is strengthening the educational and training programs for safe design, realization, maintenance, and demolition as an integral part of training at all levels in the industry, see GCVB; action 3 of Chapter 5 (addressing higher education and the possibility of establishing a professorship in the field of integrated safety in construction).
4. The final report "Strengthening Learning Capacity" (2023) in of the National Dutch Safety in Construction Program discusses the safety knowledge preservation and accessibility towards people involved.
5. The Occupational Health and Safety Vision 2040 (2023) emphasizes the embedding of healthy and safe work practices in higher education. According to this vision, this is essential for the cultural change needed to work safely and healthily, and to overcome practical barriers to compliance with obligations.

To date, little research has been conducted in the Netherlands on how integrated safety can be incorporated into the curricula of Master's programs at universities or higher education institutions. Additionally, the recommendations outlined in the EU evaluation report (2008) have yet to be implemented. This brief note highlights how technical universities can play a pivotal role in preventing and reducing incidents, accidents, and unsafe situations.

Why focus on technical universities? By educating future leaders in the construction process industry -such as project team members responsible for safe design, construction, usage, and demolition- technical universities can make a significant strategic impact. This raises the question: what kind of safety knowledge is required for these key figures? The following chapter explores this in more detail.

4. The scope of safety for studies

When examining the construction process industry, civil engineers and architects are typically the primary professionals involved. This chapter aims to identify the minimum scope of safety education that should be incorporated into technical studies for these professionals at universities in the Netherlands, in alignment with relevant regulations. It is essential to understand that safety is a comprehensive concept, encompassing multiple dimensions and disciplines. In this chapter, we will explore the fundamental safety knowledge required by key figures in the construction process industry, such as civil engineers and architects. Sections 3.1 and 3.2 address the multi-dimensional nature of safety, while section 3.3 examines its multidisciplinary aspects.

4.1. *Division between social and physical safety*

In the survey by Vrouwenvelder et al. (2001), safety is defined as the condition of being adequately protected from harm or injury, and being free from danger or hazard. When considering the philosophy of safety, it can be classified into two main categories: social safety and physical safety (Suddle, 2023).

Social safety primarily refers to the behavioural and perceptual aspects among individuals. Factors such as crime incentives, spatial conditions, institutional influences, and the social characteristics of a given area are key components of social safety (Durmisevic, 2002).

Physical safety, on the other hand, encompasses both the likelihood of harm caused by natural hazards (such as adverse weather conditions, earthquakes, or floods) and man-made hazards (such as traffic accidents, incidents involving the transportation of hazardous materials, or accidents at nuclear facilities). It is important to note that the consequences of safety failures -such as increased costs, delays, compromised quality, and environmental damage- also a part of physical safety.

4.2. *Geographical approach towards safety*

For both civil engineers and architects, the representation in par. 4.1 may appear somewhat unclear. To provide greater clarity, a geographical classification could be helpful. Bruggeman & Hoogendoorn (2022) introduced a geographical approach to integral safety, which distinguishes between (1) object safety, (2) safety of the construction site, and (3) safety of the

This model highlights that an object is situated within a specific (built) environment or vicinity, which often includes roads or other buildings that remain in use during the construction phase. During construction or renovation, a construction site is established, typically enclosed by a construction fence, which is usually located within the same vicinity.

In this chapter, we adopt the definitions provided by The Dutch Operational Framework for Safety Management in the Construction Process (2023) for (1) object safety, (2) safety of the construction site, and (3) safety of the vicinity. The advantage of this approach is that it enables a holistic view of safety, ensuring that object safety, construction site safety, and the safety of the surrounding environment are all considered within a project.

4.2.1. *Object Safety*

The object safety is described as the safety of the object (building, bridge, road, railway, etc.) itself for safe use by users. Safety domains under this include, for example, structural safety, electrical safety, and fire safety of the building. This aligns with the definition in the Building Decree or the Environmental Structures Decree (Bbl) of the new Environmental Planning Act.

4.2.2. *Construction Site Safety*

Construction site safety refers to the protection of all individuals working on-site during the construction or renovation phases.

4.2.3. *Vicinity*

The safety of the vicinity refers to the protection of people (or assets) located near a construction site where an object is being built or renovated. This concept highlights the importance of integral safety throughout the construction process, emphasizing the need to consider both the site and its surrounding environment to ensure overall safety.

4.3. *Roles and relations*

Different roles, such as those of Employer and Employee or Client and Contractor, are crucial in ensuring workplace safety, as each party carries specific responsibilities and duties that collectively contribute to a safe working environment. In addition, safety is not only a legal obligation but also an essential aspect that must be viewed from various perspectives.

4.3.1. *Employer - Employee*

Safety is not only a legal obligation but also a fundamental element of fostering a positive and productive employer-employee relationship. By adhering to relevant safety regulations (such as Occupational Health and Safety (OHS) laws, EU directives like the Health and Safety Framework Directive 89/391/EEC, and specific regulations like 92/57/EEC, 89/654/EEC, and 2009/104/EC, or the Health and Safety at Work Act 1974 in the UK, and Workplace Safety Regulations in the Netherlands (Arbowet)), employers can protect their workforce, mitigate legal liabilities, and enhance the overall efficiency and performance of their organization. The employer-employee relationship is significantly strengthened when both parties take shared responsibility for maintaining a safe and healthy working environment. This mutual accountability fosters a proactive approach to accident prevention and effective risk management.

4.3.2. *Client - Contractor*

A clear delineation of roles between clients and contractors is essential for ensuring shared accountability & minimizing safety management gaps, especially in complex or collaborative work environments. Clients are responsible for setting safety standards and requirements for contractors, particularly when the project involves their property or resources. They must communicate any known hazards and ensure the contractor understands the specific risks associated with the site or project. Clients are also typically responsible for monitoring the contractor's compliance with agreed-upon safety protocols.

Contractors, on the other hand, must adhere to the safety standards established by the client and comply with all relevant regulations. While contractors are responsible for training their employees and raising awareness of risks and safety practices, they must also implement measures to control hazards arising from their activities or those introduced by the client.

4.3.3. *Asset owner / manager*

In a construction or renovation project, the asset owner or manager is responsible for ensuring the site is free of known hazards before work begins. Meanwhile, the contractor (e.g., construction firm) must train workers in safe practices and ensure the proper use of personal protective equipment (PPE). Both parties must collaborate closely to maintain safety throughout the duration of the project.

4.3.4. *Competent Authority*

The Competent Authority plays a crucial role in ensuring workplace safety by establishing regulations, enforcing compliance, and fostering the development of safe practices across various industries. These authorities are usually government or regulatory bodies responsible for overseeing occupational health and safety.

5. Status quo of safety at technical universities

5.1. *In general*

In the Netherlands, both technical universities and universities of applied sciences are increasingly recognizing the importance of integrating safety into their curricula. This integration helps ensure that future engineers and technical professionals are well-prepared to prioritize safety in their respective fields. Some examples include:

1. Specialized Master's Programs: Maastricht University offering a Master's in Occupational Health and Sustainable Work.
2. Dedicated Safety Programs: Institutions such as Hogeschool Utrecht and NHL Stenden

offer bachelor's degrees in Integral Safety Engineering.
3. Master's Modules: Hogeschool Utrecht provides a master's module in Risk Assessment Safety Health & Environment.

However, when specifically focusing on the construction process industry and its key figures, it becomes clear that these professionals are not equipped with the safety knowledge outlined in Chapter 4 and detailed later in this chapter and Appendix A.

5.2. *Delft University of Technology*

Delft University of Technology (TU Delft) is committed to addressing complex and urgent societal challenges by educating highly qualified engineers who are creative, innovative, and responsible. The university achieves this by pushing the boundaries of technical sciences, developing innovative applications, and fostering entrepreneurship. This vision is outlined in the university's Strategic Agenda for 2024-2030, titled Impact for a Sustainable Society.

One aspect of TU Delft's mission is to prepare students for successful careers as professional, highly qualified engineers, while also nurturing technical leaders throughout their careers. The university promotes values such as diversity, integrity, respect, engagement, courage, and trust. However, it raises questions whether graduates are fully prepared for their careers, especially in terms of foundational engineering knowledge.

To investigate this, we examined the main educational structure of the programs at TU Delft. The university offers 40 technological and scientific disciplines, along with numerous specializations, all organized within eight faculties.

5.2.1. *Faculties related to safety in the construction process industry*

Faculties related to safety of the construction process industry providing the key figures of the of this industry with its specialisations are:

1. Architecture and the Built Environment
2. Civil Engineering and Geosciences
3. Mechanical Engineering
4. Technology, Policy and Management

The remaining four faculties of TU Delft with their technological & scientific disciplines together with their many specialisms are in fact related to safety during design stage. However, these studies are either more policy making oriented or are focused on the design of systems or system parts in a certain environment.

5.2.2. *Status quo of safety at TU Delft*

TU Delft incorporates safety education across various programs and offers specialized courses focused on safety and risk management. Examples include the Safety and Security Science Section, online courses on Safety, Risk, and Security, Road Safety, and the Safety & Security Institute. However, as shown in Appendix A, education centered on object safety is the only aspect effectively integrated into the Civil Engineering and Geosciences faculty's curriculum. Other safety aspects, as described in Chapter 4, are notably absent from the studies. The Architecture program, in particular, lacks integral safety knowledge, with no incorporation of topics such as the division between social and physical safety, design aspects of integral safety, or roles and relations.

It is also important to note that the Chair for the Safety and Security Science Section is part of the Faculty of Technology, Policy, and Management, under the Department of Values, Technology, and Innovation at TU Delft. This section focuses on socio-technical systems and decision-making processes related to technical, human, and organizational issues, with a specific emphasis on safety and security challenges. However, these chairs do not specifically address the Construction Process, as reflected in the table in Appendix A.

5.3. *Eindhoven University of Technology*

Eindhoven University of Technology (TU/e) is a prestigious research-driven institution that seamlessly integrates research and education. The university is renowned for its collaboration with advanced industries, with a particular emphasis on the Brainport region, which is celebrated for its high-tech excellence and serves as the heart of a dynamic, innovation-driven industry. The engineers trained at TU/e are not only skilled in engineering but are also effective communicators who recognize the importance of considering users and society when designing solutions and developing products. These graduates are prepared to tackle today's and tomorrow's complex societal challenges, including the sustainability transition, technological revolution, and the growing impact of technology on society. TU/e focuses on three strategic themes: talent, corporation and resilience. TU/e comprises nine departments, each focusing on specific areas of technology and engineering.

5.3.1. *Faculties related to safety in the construction process industry*

Departments related to safety of the construction process industry with its specialisations are:

1. Built Environment
2. Mechanical Engineering
3. Chemical Engineering and Chemistry

TU/e integrates safety-related education across various faculties and programs, highlighting the importance of safety in both engineering and research practices. Notable examples include the Chemical Engineering and Chemistry faculty, Laboratory Safety Training, Occupational Health and Safety Resources, and Fire Safety Engineering. These faculties are particularly relevant to the construction process industry, especially the Department of Built Environment and the Department of Mechanical Engineering, making them highly pertinent to the scope of this paper.

5.3.2. *Status quo of safety at TU Eindhoven*

When examining how integral safety is incorporated into relevant studies for the construction process industry, it becomes clear that its presence is minimal. While some guest lectures are organized on the topic, there is a significant lack of lasting safety knowledge retention, as discussed in Chapter 4. This is further illustrated in Appendix A.

5.4. *University of Twente*

The University of Twente (UT), located in Enschede, is a renowned research university recognized for its emphasis on technology and interdisciplinary approach. Established in 1961, UT integrates engineering, natural sciences, and social sciences to tackle societal challenges. The university is celebrated for its entrepreneurial spirit, cutting-edge research, and strong industry partnerships. UT offers a diverse range of Bachelor's, Master's, and Ph.D. programs across five faculties, with specialties in engineering technology, computer science, social sciences, and geo-information science. The university's vibrant campus promotes innovation and collaboration, positioning UT as a hub for forward-thinking education and research.

5.4.1. *Faculties related to safety in the construction process industry*

Departments related to safety of the construction process industry with its specialisations are the following:

1. Behavioural, Management & Social Sciences
2. Engineering Technology
3. Geo-Info Science & Earth Observation

It should be noted that, as of October 1st, 2024, the Executive Board has appointed a professor to the Chair of Safety Aspects of Energy Transition in the Built Environment at the Faculty of Engineering Technology, Department of Civil Engineering and Management. As indicated by the title of the chair, the focus of the professor's education and research activities will be on the safety aspects of the energy transition in the built environment, rather than on the construction process industry as discussed in Chapter 4.

5.4.2. *Status quo of safety at TU Eindhoven*

The UT integrates safety-related topics across multiple courses and programs, demonstrating its commitment to addressing safety from diverse disciplinary perspectives. In the Master's program in Psychology, specializing in Conflict, Risk & Safety, students explore the psychological aspects of safety, examining physical, psychological, and social dimensions. The curriculum includes courses on group dynamics, advanced research methods, psychology and crime, and the psychology of sustainability. Students also participate in internships and research projects related to risk communication, (cyber) crime, conflict mediation, and safety perceptions.

The Safety by Design course, offered within the Faculty of Engineering Technology, focuses on designing safe products, equipment, and systems. Students tackle real-world cases, applying proactive safety measures and using various tools and methods to identify safety requirements throughout the project lifecycle.

Additionally, UT offers several masterclasses and courses centered on safety and risk management. Although some studies incorporate aspects of safety, no substantial evidence was found indicating that integral safety, specifically in relation to the construction process industry as described in Chapter 4, is being taught or researched.

6. The GAP

While TU Delft, TU/e, and UT provide a solid foundation in safety across various fields, the construction industry requires more specialized, integrated safety education that addresses both technical and human aspects of safety management throughout the construction process, as discussed in Chapter 4. Universities could strengthen their offerings by developing focused tracks that address the unique challenges and risks faced in modern construction projects. The lack of adequate safety knowledge is outlined in Appendix A. The gap between the needs of the construction sector and the current state of integral safety education at Dutch technical universities can be attributed to several factors. These include the level of specialization in safety-related courses, the integration of real-world, construction-specific scenarios, and the alignment of academic programs with the evolving demands for safety in the construction industry. The sector is facing increasing demands for comprehensive safety integration, behavioural and cultural safety, and legal and regulatory compliance.

7. Conclusions and recommendations

The main conclusion of this study is that the integration of integral safety into the curricula of Dutch technical universities does not meet the requirements of the construction process industry. This conclusion is further substantiated in Appendix A. To address the gap between industry needs and current academic offerings, universities could take the following steps:

- Expand interdisciplinary safety curricula that integrate engineering, social sciences, psychology, and management to address both the technical and human factors of safety in construction.
- Develop dedicated construction safety programs, offering specialized tracks or courses focusing on site safety, risk management, health and safety regulations, and emergency response protocols specific to construction projects.
- Collaborate with industry partners to provide real-world case studies, internships, and hands-on training that expose students to actual construction sites, where they can practice safety management.
- Integrate new technologies into safety training, such as Building Information Modelling (BIM) and digital twins, to enhance construction safety planning & site management.

These recommendations require further research and prompt implementation in the programs that educate the key figures and project team members of the Construction Process Industry. Specifically, the faculties of Civil Engineering and Architecture at TU Delft should prioritize this integration. Additionally, the Faculty of the Built Environment at TU/e, as well as certain programs at UT, should also be considered for similar attention.

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Appendix A: GAP-analysis

			Division between social and physical safety		Design aspects of Integral Safety			Roles and relations in relation with Integral Safety			
		Related to Construction Industry	Social Safety	Physical Safety	Object Safety	Construction Site Safety	Safety of the Vicinity	Employer - Employee	Client - Contractor	Asset owner / manager	Competent Authority
Delft University of Technology (TUDelft)											
1.	**Aerospace Engineering**	No									
2.	**Applied Sciences**	No									
3.	**Architecture and the Built Environment**	Yes									
	Architecture	Yes	V	X	X	X	X	X	X	X	X
	Architectural Engineering & Technology	Yes	~	~	~	X	X	X	X	X	X
	Management in the Built Environment	Yes	X	~	X	X	X	X	X	X	X
	Urbanism	Yes	X	X	X	X	X	X	X	X	X
4.	**Civil Engineering and Geosciences**	Yes									
	Engineering Structures	Yes	X	~	V	~	X	X	~	X	~
	Geoscience & Engineering	No									
	Geoscience & Remote Sensing	No									
	Hydraulic Engineering	Yes	X	~	V	~	~	X	X	~	X
	Materials, Mechanics, Management & Design	Yes	X	~	V	X	X	X	X	~	X
	Transport & Planning	Yes	X	~	~	X	X	X	X	~	X
	Water Management	Yes	X	~	V	X	X	X	X	~	X
5.	**Electrical Engineering, Mathematics and Computer Science**	No									
6.	**Industrial Design Engineering**	No									
7.	**Mechanical Engineering**	Yes									
	Biomechanical Engineering	No									
	Cognitive Robotics	No									
	Maritime & Transport Tech	Yes	X	~	V	~	X	X	X	X	X
	Materials Science & Engineering	Yes	X	~	X	X	X	X	X	X	X
	Precision & Microsystems Engineering	No									
	Process & Energy	No									
	Systems & Control	No									
8.	**Technology, Policy and Management**	Yes									
	Engineering Systems & Services	Yes	X	~	X	X	X	~	~	X	~
	Multi Actor Systems	Yes	X	~	~	X	~	~	X	~	X
	Values, Technology & Innovation	Yes	~	~	X	X	V	~	~	~	~
Endhoven University of Technology (TU/e)											
1.	**Applied Physics**	No									
2.	**Biomedical Engineering**	No									
3.	**Built Environment**	Yes									
	Architectural Urban Design and Engineering	Yes	X	~	X	X	~	X	~	~	X
	Building Physics and Services	Yes	X	~	~	X	X	X	~	~	
	Structural Engineering and Design	Yes	X	~	V	~	X	X	X	X	~
	Urban Systems and Real Estate	Yes	X	X	~	X	X	X	X	X	X
	Sustainable Urban Mobility Transitions	Yes	X	~	~	X	X	X	X	X	X
	Smart Mobility Data Science and Analytics	No									
4.	**Chemical Engineering and Chemistry**	Yes									
	Chemical and Process Technology	Yes	X	X	X	X	X	~	X	X	X
	Molecular Systems and Materials Chemistry	Yes	X	X	X	X	X	~	X	X	X
5.	**Electrical Engineering**	No									
6.	**Industrial Design**	No									
7.	**Industrial Engineering & Innovation Sciences**	No									
8.	**Mathematics and Computer Science**	No									
9.	**Mechanical Engineering**	Yes									
	Computational and Experimental Mechanics	No	X	~	V	X	X	X	X	X	X
	Dynamical Systems Design	Yes	X	~	V	X	X	X	X	X	X
	Thermo Fluids Engineering	No									
	Manufacturing and Maintenance	Yes	X	~	V	X	X	X	~	V	X
	Micro and Nano Engineering	No									
University of Twente (UT)											
1.	**Behavioural, Management and Social Sciences**	Yes									
	Communication Science	No									
	Psychology	No									
	Public Administration	Yes	X	X	X	X	X	X	X	X	X
	Educational Science & Technology	No									
	European Studies	No									
	Environmental & Energy Management	Yes	X	~	X	X	~	X	X	X	~
	Risk Management	Yes	X	X	X	X	X	X	X	X	X
2.	**Engineering Technology**	Yes									
	Biomechanical Engineering	No									
	Civil Engineering and Management	Yes	~	~	~	X	~	X	X	X	~
	Design, Production and Management	No									
	Mechanics of Solids, Surfaces & Systems	No									
	Thermal and Fluid Engineering	No									
3.	**Electrical Engineering, Mathematics and Computer Science**	No									
4.	**Science and Technology**	No									
5.	**Geo-Information Science and Earth Observation**	Yes									
	Earth Observation Science	No									
	Applied Earth Sciences	No									
	Urban and Regional Planning and Geo-information Management	Yes	X	~	X	X	~	X	X	X	~
	Natural Resources	No									
	Water Resources	No									
	Geo-information Processing	No									