Erasmus + Project: Crisis Resistant Digital Education and Training

Intellectual Output 3 – Framework Evaluation

Case Study: Relocation of all Faculty Facilities

DISCLAIMER

"The European Commission support for the production of this publication does not constitute an 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."

1. INTRODUCTION

This report describes the plan for tailoring and conducting a Computer-Aided Design course which will be held at the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, in the summer semester of academic year 2022/2023. The emerging crisis situation our University is exposed to is not a traditional one, since it is not directly related to any disease or other catastrophe types. Due to the complete refurbishing of the Faculty buildings, there is a need to relocate all Faculty facilities and associated activities. This relocation of the Faculty buildings in the forthcoming months (planned for April/May 2023) will influence a plethora of teaching, research and industrial collaboration activities. For this reason, many educators and researchers started to conduct several precautionary measures in order to reduce potential negative consequences on their daily, weekly and monthly activities. As such, significant attention is given to educational activities, which will have to be modified given the relocation conditions. Due to the tight deadlines (related to tenders, contracts and financial issues), the start of the semester is planned for the last week of February (one week ahead compared to the previous academic year plan). Also, it has already been announced that the lectures and tutorials will be performed on Saturdays and that the teaching staff should prepare for online teaching during the last two weeks of the semester (until the 8th of May, see Figure 1). However, there is a possibility that the online period will have to be extended. Such situation requires properly preparing for several scenarios and allowing us the flexibility to tailor our course delivery approach. However, we have enough time, and this situation is significantly different from the COVID-19 one. In addition, there are many lessons learned which can be implemented to provide a better learning experience for our students.

	Feb.	March				April				May					June		
Mon	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19
Tue	28	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20
Wed	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21
Thu	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22
Fri	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23
Sat	4 Mon	11 Tue	18 Wed	25 Thu	1 Fri	8	15 Mon	22	29	6	13	20	27	3	10	17	24
Sun	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25

Figure 1: The proposed schedule for the summer semester:
green – additional lectures on Saturdays for each day of the week
yellow – period intended for moving out from the current location
orange – start of the exam period
red – non-working days and holidays

Within this report, we explain how the proposed crisis-related framework can be used for a given purpose and the advantages and disadvantages of this application. In addition, it will provide alternative scenarios for delivering the selected course in the following semester (at the exact location, at a different location or online). Although we still do not know the final

decision (related to the lecture and tutorial locations), this report should explore different course design and implementation alternatives and prepare for the worst-case scenario.

The course that will be analysed and tailored is Computer-Aided Design. The main objective of this first-year (2nd semester) course is to acquire knowledge about creating 3D computer product models using CAD tools. A detailed list of learning outcomes can be found in Section 2.2. This course includes lectures that provide students with theoretical background in CAD modelling, while tutorials instruct students on using CAD tools. Lectures are delivered by university lecturers, while external associates (from Croatian industrial companies) and university teaching assistants (typically PhD students) are responsible for delivering tutorials. Previous year's assessments and examinations were organised through two theoretical exams from the lectures, 13 small CAD modelling exams (about 20-30 minutes each), and one overall CAD modelling exam (about 1.5h). The two theoretical exams were conducted using Moodle quiz and held in computer rooms (usually seven of them with 15-20 seats) in the dedicated timeslot (usually Saturday due to unavailability of students and computer rooms). CAD modelling exams (both small and overall ones) were also held in the computer rooms during the tutorial timeslots.

Overall, this first-year course enrols 550 students and involves 14 tutorial instructors (led by two course leaders and two PostDocs). Consequently, this number of involved participants causes many organisational and logistical issues and requires significant planning efforts.

It is important to mention that this report was prepared in February 2023. As such, it resulted in several modifications of crisis conditions and proposed course alternations, which were reflected in different aspects of the framework application. However, the logic of using the framework remained the same despite modifying crisis conditions several times during the report preparation period.

2. APPLICATION OF THE FRAMEWORK

In order to tailor the execution of the Computer-Aided Design course and proactively adapt it to the "crisis situation" which is about to happen, we decided to follow the proposed crisis-adaptation framework. The application of the framework will also serve for its overall validation as well as for the validation of the consisting steps/elements. Obviously, it is essential to emphasise that this situation that we experience at the University of Zagreb is not a "real crisis", and for that reason, we have enough time to adapt and react. Nevertheless, this transition might lead to unexpected changes in the earlier phases of the course. For example, the semester is starting earlier than usual and there might be uncertainty regarding the number of students that will take the course. Next, comptures used for the tutorials are partially owned by another institution that could move the comptures before the planned moving-out date. In addition to these, there are many other issues that may emerge during this forthcoming period. Hence, we believe the same framework can be applied and could result in many valuable insights on organising our transition for this inconvenient series of events. With this example, we may showcase that the proposed framework offers an additional value even outside the

extreme crisis situations, and that it can help to systematically update and upgrade a course design and implementation by following a dedicated set of steps (Figure 2).

2.1. CRISIS DOMAIN

Within the initial crisis domain, the forthcoming situation needs to be explored and characterised in the context of crisis-related restrictions. Based on the conducted analysis of the crisis scenario and its severity, the next step continues with selecting the necessary level of digitalisation to successfully deliver this course. To facilitate this, we used the proposed list of generic crisis conditions to guide the process of conducting the Crisis Domain steps (Table 1). Since Knowledge Hub, a planned platform that provides experience reports on how other educators adapted to crises, is still under development, we used the preliminary lessons learned and best practices extracted from the literature to aid the decision-making related to course planning.

As stated above, the initial step in the Crisis Domain is to categorise a crisis scenario and assess its severity. For the crisis characterisation, we used information received from the Faculty Administration in January 2023.

To support this characterisation activity, we explored the lists of generic crisis conditions and associated degrees of severity. These lists helped us better understand individual elements and what is required to consider when describing the underlying crisis conditions (and associated consequences) and planning such a transition. In addition, the detailed representation of our response to crisis conditions helped us to describe relocation issues and how this reflects on the course delivery (Table 1.).

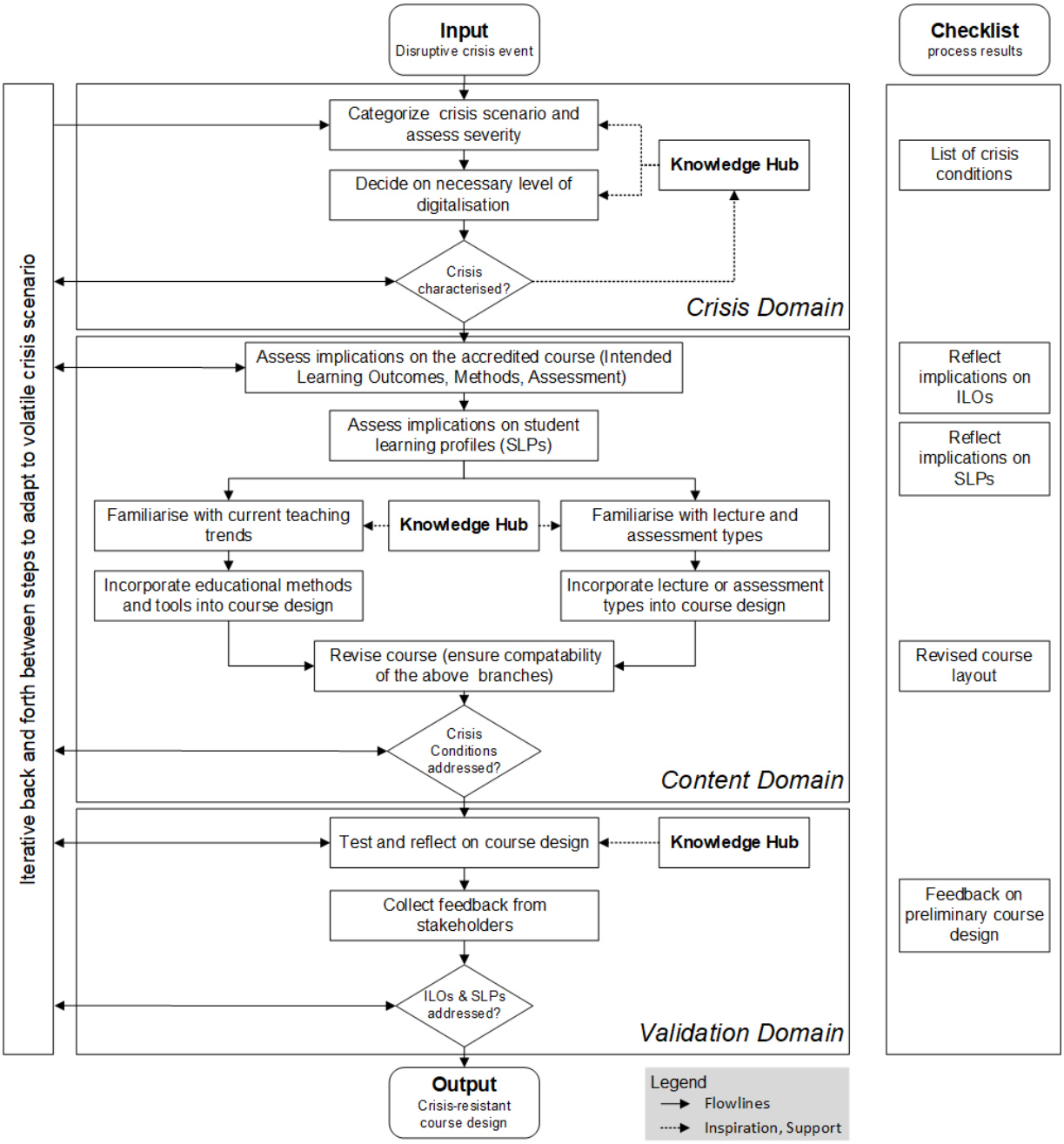

Figure 2: Framework contextualised for the Computer-Aided Design course (UNIZAG)

Table 1: Crisis characterisation

Movement	**Geographic limitations**	In general, the movement of educators and students is not restricted. However, faculty facilities will be distributed at different locations, which could cause difficulties in commuting and travelling between locations (and cause delays). Although we still do not have confirmation of the final sites where exactly lecture halls, laboratories, and admin staff will be located, we received preliminary information about the considered locations (3 different complexes), which is not positioned centrally within the city context. This means some educators and students could experience commuting difficulties due to the new situation. Still, most relocated facilities will be relatively close to each other, facilitating movement between locations. In terms of lectures and tutorials, they should all be positioned in one building. It is important to emphasise that the majority of educators will work from home most of the time.
Power	**Availability**	There will be no problems with the power supply. However, as some of these buildings where teaching will be relocated have to be refurbished (in a concise time frame), there could potentially be some power issues at the beginning.
Connectivity	**Telephone connection**	There will be no problems with the telephone or mobile phone connection. However, most educators will not use their landlines, as they will be out of offices (only cell phones).
	Internet connection	Overall, there will be no problems with the Internet connection for the computer rooms planned for teaching activities (four rooms – each equipped with 15 computers). However, it may take some time for the Internet connection to be established at the new locations and for the licencing servers to be operative. Also, in some parts of these buildings (at new locations), lecturers and teaching assistants could potentially have issues with WiFi connection.
Institution	**Physical access**	Physical access to all three locations will be allowed to all faculty employees. The current plan is that activities will be split among three locations. Lecture halls and computer

		rooms will be at the first location, offices and open spaces for employees will be at the second one, and laboratories will be at the third location (in several buildings). As physical access will not be possible for students upon their request, educators will definitely substitute some learning resources from the physical environment with online resources. Based on the current stage of the relocation project, we are instructed to organise online activities for the last few semester weeks. During that period, educators and students will be unable to access "old" locations (relocation of equipment and offices will be in progress), and new locations will still not be completely prepared and ready for access.
	Online access	There will be no limitations regarding online access to the faculty services or resources provided by the institution. There are, however, specific risks associated with the online access of licencing servers for the used CAD tools. Moreover, in case of specific issues with online services, our IT department will be preoccupied with many duties, and their support will maybe not be immediately available.
Learning resources	**Physical availability**	All physical learning resources could be substituted with appropriate online resources (if needed). However, we expect that, beside the final transition period, students will have all resources available in the physical environment.
	Online availability	Throughout the COVID-19 era, all educators had to prepare teaching materials and adapt their courses for online delivery (some even before, during the pre-COVID era). Therefore, educators provided not only materials such as presentation slides, reading materials, and useful links but also prepared environments for knowledge exchange between students and educators through forums and chats (e.g. in Moodle or MS Teams). For specific courses, this included a significant reconceptualisation of the way course content needs to be taught and delivered (especially lab tutorials). However, these materials were a helpful backup and add-on content in the post-COVID era. As such, the majority of educators plan to use it this year (with some updates).

		All these online materials will be available for the following semester.
	Physical access	All physical learning resources could be potentially substituted with appropriate online resources (if needed) during the first part of the semester. However, due to the different location of laboratories and new space and time restrictions, we believe that physical access to some facilities will be restricted (e.g. computer rooms).
	Online access	The online (learning) resources will be available - if needed and when needed. Some educators will decide to provide their online materials in advance, while some will be available after the physical delivery of lectures (to improve lecture attendance). Please check *Online availability*.
Personnel	**Availability**	There were no limitations regarding the availability of educators. Many of them will even provide students with, e.g. their private mobile phone numbers to make this transition to the forthcoming situation easier. However, due to the limited physical space at new locations, probably many educators will decide to work from home. In addition, many educators will be recruited as an external associates (for delivery of tutorials). For that reason, this will decrease the possibility of meeting with educators outside of their official consultancy timeslots dedicated to students (less formal communication between educators and students).
Equipment	**Availability**	The response to this crisis condition section is closely related to the availability of laboratory space or, within the context of the Computer-Aided Design course, the computer rooms. The equipment required for educational activities will be available during tutorials. This could cause issues for students who do not possess computers at home or do not satisfy the minimum requirements of the CAD tool they will have to use throughout the semester. In addition to equipment for delivering lectures and tutorials, the institution should also possess servers for the purpose of e.g. conducting several exams for a large number of students in parallel, as well as for the CAD tool licencing purpose.

		During learning activities at home, students will be required to use a computer with an Internet connection. In later course phases, students will use advanced capabilities of CAD tools, which can be very demanding in terms of computer power. Unfortunately, replacement devices were not available for students. In general, the research equipment (which may be used for extracurricular activities) will be primarily available to the staff. However, if required for Bachelor and Master theses, students should ask for official permission from the Faculty Administration.
	Suitability	The available equipment (for this course – computers, CAD tool Solidworks and Moodle learning management system) will be suited for the intended educational activities. If needed, this set of tools could be expanded using cloud storage solutions for easier transfer of files between educators and students. Throughout the course, students will use advanced capabilities of CAD tools, which can be very demanding in terms of computer power (this sometimes causes issues, and educators will have to find an appropriate replacement – e.g., change computer).

After analysing crisis conditions, the following step includes the selection of the digitalisation level. Considering the crisis conditions, the decision is to select blended learning as an approach. The primary rationale for this decision is related to the fact that the final part of the semester will have to be conducted online. Also, we should leave some space for delays and postponements on an organisational level. For that reason, we plan to conduct the majority of lectures and tutorials at the existing Faculty location, while in the rest of the course (last two weeks) the lectures and tutorials will be held online. In addition, online materials could be available to students and educators as additional support during this second part.

Table 2: Level of digitalisation

Name	Description
No technical support	Classic lessons without technical support.
Technology-enhanced learning (< 25% online)	Classic lessons with minor technical support (e.g. PowerPoint). The lesson is not changed at its core, and there is no reduction in the required presence.

Blended learning (25% to 75% online)	Combination of classic lessons with computer-aided learning and teaching (e.g. via the Internet). Presence phases and e-learning phases alternate and complement each other.
Online learning (> 75% online)	Mostly computer-aided learning without physical presence. The online lessons are supported with sporadic physical lessons (e.g. assessment periods).
Fully virtual Classrooms (100% online)	The educators and students are only connected via digital media. The processing of the contents takes place exclusively via electronic means.

Based on the collected information, we can characterise the crisis and understand the conditions for the course to be organised. The following step explores the implications of this emerging situation on the Intended Learning Outcomes. As such, we need to transition to the Content Domain of the proposed framework.

2.2. CONTENT DOMAIN

In regard to the Content Domain, we first had to analyse Intended Learning Outcomes at the levels of the whole programme and individual courses. Please find them below.

Intended Learning Outcomes at the level of the programme to which the course contributes:

- Apply principles and fundamental knowledge of natural and technical sciences to identify and describe simple problems in the field of mechanical engineering.
- Decompose problems into simpler tasks and propose steps to solve them.
- Produce technical documentation using modern computer programs.
- Use modern computer technologies to solve engineering problems.
- Follow global trends in technology development and application in the field of mechanical engineering.

Intended Learning Outcomes at the level of the course:

- List and describe techniques for the creation of the computer representation of the product.
- Describe the difference among available computer model representations.
- List and describe CAD kernels.
- Create a simple 3D CAD computer model of the product.
- Create a technical drawing using a CAD application.
- Describe and explain Feature Based Modelling.
- List and describe feature categories.
- List groups and properties of the features.
- Describe Additive Manufacturing methods and their characteristics.

- Describe how to create a simple script for CAD customisation.

By exploring individual learning outcomes at the programme level, we noticed that we should be able to address all of them, even in the case of a completely virtual environment (what we perceive as the worst-case scenario). Of course, the quality of addressed learning outcomes could be influenced, predominantly related to the student's ability to understand some aspects more profoundly.

By further analysing individual learning outcomes at the level of the course, we believe that all these learning outcomes should not be heavily influenced. However, approaches to teach techniques for creating CAD models need to be carefully considered. This could reflect on how tutorials are carried out throughout the course, and therefore requires a detailed exploration of potential tutorial scenarios.

After the analysis of ILOs on both programme and course level, student learning profiles need to be assessed and determined. Using the learning styles proposed by Honey and Mumford (see Figure 3), we can differentiate between them and be more aware of conditions that influence the acquisition of knowledge and the achievement of learning outcomes. According to the proposed list, we characterised our students as mostly *Activist learners*, who *"mostly acquire knowledge and skills through a learning by doing approach, with an active engagement in new activities and experiences, despite they get bored with implementation and longer-term consolidation"*. In general, we may also claim that our students show behavioural similarities with *Pragmatist learners*, as they want to experimentally check the applicability and usefulness of knowledge and skills through direct practice. However, as the literature suggests, we need to consider individual differences between students and plan our teaching activities to be suitable for all four learning styles (Activist learner, Reflector learner, Theorist learner and Pragmatist learner). Based on the course syllabus, we believe that our course introduces content for all four types of learners and in their preferred format (to a certain level). However, the virtual delivery of this course could mainly influence Activists' and Pragmatists' learning styles, which again emphasises tutorials and exploration of potential tutorial scenarios.

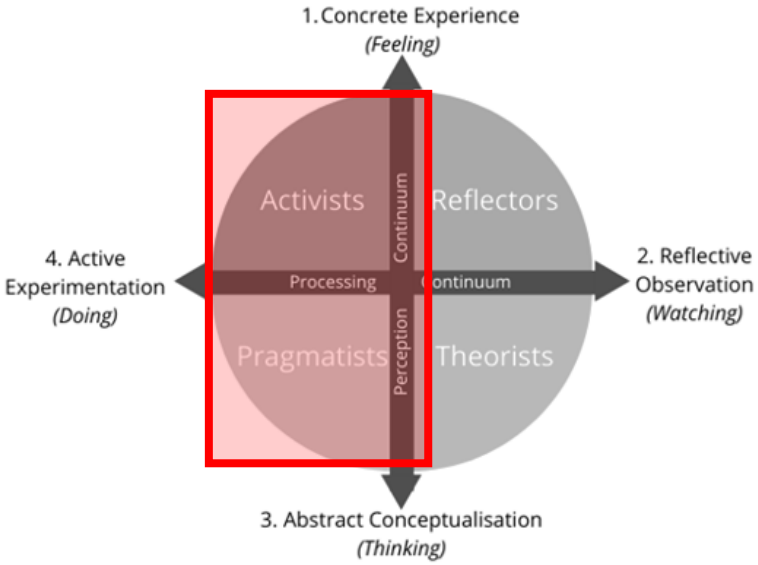

Figure 3: Characterisation of dominant learning styles using the Honey and Mumford's framework

From these two steps, we could easily come up with the necessity to plan significantly in advance delivery of tutorials. Our teaching approach corresponds to the *Instructions* coupled with elements of *Kolb's Cycle* (predominantly *Concrete Experience* and *Active Experimentation*) from the list provided at https://cresdet.eu/framework-old/educational-methodologies-and-tools/. In this way, the theory-heavy lectures are complemented and students are provided with applicable skills.

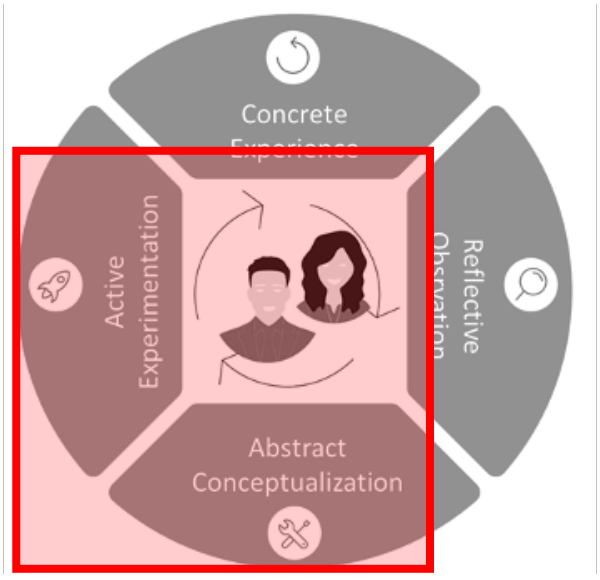

Figure 4: Characterisation of the teaching approach using Kolb's Cycle

Also, we are able to balance teacher-centred and student-centred approaches and requirements of a low-tech and high-tech environments. Of course, the course is related to CAD and requires

continuous usage of computers; it is "high-tech" by default. However, a considerable part of course content can be delivered and adopted via computer (not very high requirements).

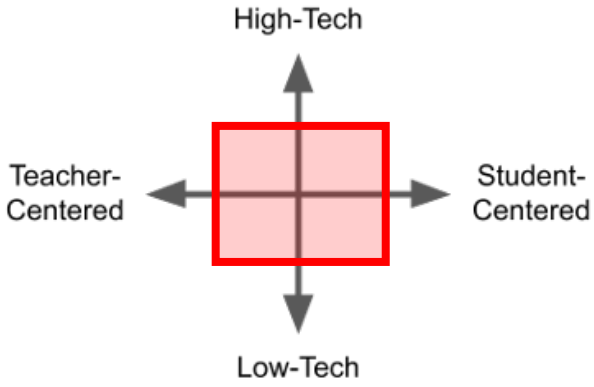

Figure 5: The proposed course aims to the balance between student- and teacher-centred approaches as well as between low-tech and high-tech envinronments

Due to the relatively narrow focus of this course, many educational items are perceived as irrelevant to this course. On the other hand, some of them have already been elements of our teaching practices for years. From the group of *Design specific tools and methodologies*, we may list virtual prototypes, technical drawings, standards, and hands-on activities, while from *the generic list of educational* items – lecturing, classroom discussion, and quizzes. From the existing list (we may expect that Knowledge Hub will be extended in the following period), we should consider implementing AR- and VR-visualisation tools (these devices are available at our institution).

However, the course size and the number of involved participants (more than 600 students) causes many difficulties. More specifically, the traditional way of delivering these tutorials is in two-hour timeslots for 15 weeks (30 hours overall) by an instructor. Instructors are either teaching/research assistants employed by the institution or recruited from our alumni (industrial practitioners). Therefore, we can ensure high-quality teaching, as they can transfer contextual knowledge and provide students with insights from the industrial practice. This was perceived as a successful practice in previous years, and student feedback was very positive. Hence, we would like to continue with the same way of teaching this practical aspect of the course.

For that reason, the course leaders invested significant efforts to explore and analyse current teaching trends related to CAD courses to search for the most convenient way to deliver high-quality teaching of courses, despite the potential "crisis" issues that are about to start. The current trends in teaching CAD are related to the introduction of cloud-based tools such as Onshape (PTC, see Figure 6), Fusion 360 (Autodesk) or the 3DEXPERIENCE platform (Dassault Systèmes). These tools offer several benefits on the administration and basic user level, which are relevant for the course delivery. Moreover, these tools are generally easy to use and accessible via Internet browsers. Compared to the traditional CAD tools that must be locally installed on a desktop computer or laptop, these tools can be accessed through Web (or

even Mobile) browsing apps. This accessibility from different devices could be beneficial, although students are expected to predominantly use their computers for CAD tools. In addition, these digital tools require less processing power of students' computers. Students thus don't need to own powerful devices (especially considering the continuous increase in minimum computer requirements for CAD tools over the years). Of course, the applicability and usability of these tools rely heavily on the quality of the Internet connection (reliability and speed) and latency related to the used servers. In some crises, these could be "deal-breakers"; still, for us, these are not expected to be the main problems.

From the perspective of communication between students, but also student-teacher and teacher-students interaction, these cloud-based tools offer many collaboration features which can then support exchange, revision and submission of created documents. This can also allow students to communicate easily and teachers (instructors) to continuously track students' progress and insert comments/annotations to their work. This type of communication replaces cumbersome e-mail threads and associated issues. In addition, usage of this type of CAD systems could enable a centralised overview of student activities (for course lecturers) and less demanding administrative activities.

Figure 6: Example of a cloud-based CAD Tool (Onshape)

In addition to CAD education trends, we discussed potential CAD tool selection with our potential instructors and industrial practitioners. We asked them to comment on the pros and cons of the two alternatives – Solidworks vs. Onshape – and their readiness to learn how to use a new tool (if needed). Generally speaking, this step was necessary to examine their perception of the relevancy and usability of cloud-based tools and their willingness to expand their knowledge and learn new cloud-based CAD tools. As our instructors followed recent CAD technology development trends, some were familiar with novelties and showed interest in learning new tools. Also, some of them stated that they had previously used Onshape.

However, some instructors were/are sceptical about the applicability of cloud-based tools in an industrial context. To be more specific, two instructors commented that students equipped with Solidworks would be more competitive in the market (based on the current situation). Also, one instructor raised concerns that if we introduce students to the tool which is currently not used broadly in the industry, it *"will be hard to make them learn another one"*. It is necessary to consider that some instructors are reluctant to learn a new tool, as they all have daily jobs and are already overloaded with duties and responsibilities. In addition, to cover tutorials in smaller groups (up to 18 students), course requires a significant number of external associates (instructors) which causes some additional functionalities.

Given that the course is characterised with a large number of instructors, their feedback was very important for course leaders, and all efforts were invested in the direction of supporting and facilitating the successful delivery of tutorials. Therefore, based on the received feedback and discussions with CAD providers, we decided to keep using Solidworks for the forthcoming semester. Furthermore, since we used Solidworks in previous years, educators didn't have to transition to another tool for 3D CAD modelling. In addition, many e-learning materials were previously prepared and could be reused for this course edition. However, this decision resulted in changing the tutorial assessment (see below).Considering the previous CAD tutorial experiences and lessons learned reported after the COVID-19 period, the plan was to support communication between students and instructors. For that reason, the decision was to introduce some modules from the 3DExperience platform (more details will be added later) based on the CAD provider's suggestions. Course leaders have to test and evaluate the provided solutions and explore their applicability within the course context.

2.2.1. COURSE IMPLEMENTATION PLAN

After planning and revising the course design, several steps have to be taken related to implementing the proposed plan. First, the plan needs to cover both physical and virtual aspects of the course in order to introduce a selected level of digitalisation (blended learning - 25% to 75% online).

The crisis conditions must be revisited and analysed to plan the implementation carefully.

In general, lectures will remain the same and, as in previous years, students will be able to attend lectures in a physical environment. In addition, by using the e-learning Moodle system, the students will be able to retrieve lecture materials and check pre-recorded lecture videos (available on Youtube). Tutorials will be held with the support of Solidworks, which was perceived as very beneficial for course leaders and external associates. The selection of this software tool required less effort in terms of tutorial preparation and delivery of learning materials (which have already been prepared for Solidworks) since external associates are already experienced and well-versed in 3D solid-based modelling using that particular tool. Also, there will be no difficulties with examining the modelling part of the course.

However, to facilitate the work of external associates and help them communicating with the students, we decided to try out the 3DExperience platform to improve traditional ways of

exchanging CAD documents. As it possesses more functionalities than the conventional cloud-based file-sharing tools (e.g. OneDrive, Google Drive) or e-mail communication means, this platform should better support the exchange of documents.

In the end, the Faculty administration decided to condense lecturing within a shorter number of weeks so that all courses could be conducted in a physical form (to a large extent) and under current Faculty conditions. This also required moving the semester start one week in advance. In this way, educators and students will experience fewer difficulties transitioning to a different location. Such a decision allowed some external associates to continue their teaching activities, as they would be forced to stop due to the other location (at least within the given time frame – afternoon hours from 4:15 pm to 7:45 pm). The current plan entails only a few weeks of online teaching at the end of April and early May. For that reason, the course leaders scheduled specific lectures, which are subjectively perceived as less interactive, later in the semester (during the online period).

This year, the assessment has to be changed, organised around two theoretical exams from the lectures, six small CAD modelling exams (about 20-30 minutes each), and one overall CAD modelling exam (about 1.5h). The theoretical aspect of the course will be examined through two quizzes (via Moodle platform). In previous years, these quizzes were held in computer rooms (physical environment). However, the relocation of Faculty facilities caused significant modifications to their planning and scheduling. To be more precise, their timing is slightly postponed (two weeks later compared to previous course schedules) and will be distributed between two locations. The first one will be conducted at the same place as the last year (computer rooms at the Faculty) but in a slightly different format due to the availability of only four computer rooms (15-20 seats) in a physical setup. As stated above, the modelling aspect of the course will be examined at the current Faculty location through a series of smaller exams at the beginning of every tutorial (one per tutorial, starting from the second week) and the final exam. The number of small CAD modelling exams has been reduced to enable their execution during the physical part of the course (initial ten weeks). Yet, they will still cover the learning outcomes from the course. Reducing the number of small exams also enables the execution of the overall CAD modelling exam while the physical environment will still be available for teaching. The rest of the tutorials (after the overall CAD modelling exams) were organised to cover other CAD features that are typically not examined (e.g., Sheet metal).

2.3. VALIDATION DOMAIN

As we plan to conduct the course the following semester, we will collect feedback on course design and implementation. Furthermore, students will be asked to assess to what extent the ILOs and SLPs are addressed with the revised course for the given "crisis" situation.

3. REFLECTION ON THE APPLICABILITY OF THE PROPOSED FRAMEWORK

The proposed framework was validated through the presented case study to analyse the advantages and disadvantages of individual framework elements. To start with, the proposed list of crisis conditions and the associated templated appropriately supported the characterisation of the crisis situation. By going through the template, different criteria for characterising crises had to be addressed, and they provided a clear structure for the process. Despite the comprehensiveness of the list of generic crisis conditions, a minor issue is the lack of possibility to address the dynamics of underlying conditions easily. Very often the conditions and, to be more specific, limitations change during the semester, and the framework does not include these dynamics explicitly in the crisis characterisation. As such, this could be addressed by indicating different time points throughout the course. Characterisation of crisis situations should serve as the foundation for estimating the potential level of digitalisation implemented in the given course. However, this framework step is a bit detached from the previous criteria. Although the selected level could help us better understand the aim and available options for tailoring or reconceptualising courses within the context of crisis, the framework should better facilitate the transition. Still, we believe that the Crisis Domain is supported adequately with additional guidelines and documents (even though the Knowledge Hub is still under development).

In the Content Domain, framework steps indicate the overall strategy on what needs to be assessed and in what way. However, more explicit guidelines could be given related to different groups of implications. Unfortunately, many educators are not entirely familiar with ILO and SLP concepts, and providing them with more theoretical background for these steps is suggested. Throughout later steps in this Domain, the users of this framework could clearly benefit from *Design specific tools and methodologies* and *a generic list of educational items.* Further work on Knowledge Hub should extend the list of the tools and methods within and outside engineering and design education fields. Finally, the last domain steps should also incorporate straightforward suggestions on how to revise the course (considering class size as one of the main drivers of significant execution issues) and implement the course modifications. Within our context, we realised that the selection of particular types of CAD tools could influence many aspects of the course. Although this was not identified using the proposed Knowledge Hub lists of methods and tools, crisis characterisation, digitalisation estimation step and ILO implication assessment pointed to this course aspect and emphasised the need to articulate all forthcoming issues in that regard. In addition, student-student and teacher-student communication should not be neglected in the framework (maybe it deserves explicit mention).

As a final remark, thoughtful course revision and overall course plan must be followed by a clear implementation plan. This step should serve to revisit all crisis scenario conditions and allow users to reflect on individual course segments (lectures, tutorials, available resources, *etc.*).

Based on these suggestions, the following version of the framework should address some of these minor limitations in terms of its usability and user-friendliness.