BIMaHEAD on the search of a social BIM

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Introduction

Scales...what a fantastic subject for architectural education. In this article, we will assess a specific aspect of innovative teaching using immersive technologies. But we can't jump right into the topic without first discussing architectural research. We believe that teaching innovation necessitates a significant paradigm shift, which will be presented. The BIMaHEAD project will be used to illustrate our proposal. BIMaHEAD is a European project that seeks to develop novel educational and operational methodologies for architectural design. Its primary objective is to streamline arduous processes, freeing up architects to concentrate on their core competencies and areas of expertise.

The BIMaHEAD project is a collaboration between five partners from EU countries including France, Germany, Sweden, Poland, and the Republic of North Macedonia. The National School of Architecture of Nantes (ENSAN) is the main promoter of the project, while the Swedish University HalmStad (HU) is a renowned partner for its research on innovation. The Private Institute for Research in Environment, Civil Engineering, and Energy (IECE) in Skopjé (North Macedonia) was created by a company of engineers and architects, and has a focus on research, training, and consultancy. HafenCity University of Hamburg (HCU) specializes in architecture, urban projects, and civil engineering, with a focus on exploring what cities of the future might look like. The Faculty of Civil Engineering, Architecture, and Environmental Engineering at the Polytechnic University of Lodz (TUL) is very active on an international level, and its excellence is widely recognized.

In simple terms, there are two approaches to the project. The first method involves solving constraints in a sequential manner, where the form, structure, or organization of the flows are addressed first, and then the related problems are iteratively resolved. This approach is often guided by personal experience and aims to isolate constraints and focus on a single solution. On the other hand, the second approach is facilitated by algorithmic, generative, and upcoming AI methods. It involves integrating constraints concurrently, allowing them to interact and generate multiple solutions, which are then refined by revising the input data or through training. We propose the acronym DIM, which stands for Design Innovative Method, to complete the BIM in the BIMaHEAD project.

Scale 1, research in architecture

Is it possible to conduct architecture research that focuses solely on architecture, and can such research also provide knowledge that can benefit other fields? In 2008, a study by Martin Rosvall and Carl T. Bergstrom (2008) found that architecture is not

commonly referenced or self-referential in other disciplines. The question of whether architecture research is feasible and how to define its scope remains a topic of debate, as discussed at the 2014 EPFL colloquium "*What is research in architecture?*" One of the main challenges faced by architecture researchers is how to limit the scope of their research without excluding important aspects or becoming overwhelmed by the complexity of the subject[1]. Research in architecture emerged in the aftermath of the rapid transformation of cities in the late 1960s, with the creation of schools and research initiatives. Objectives of architecture research include:

- creating a community of researchers,
- acquiring and disseminating knowledge and methods,
- establishing a link between practice and research to benefit society.

In France, mathematician and architecture enthusiast André Lichnerowicz, wrote a report in 1970 that helped establish the objectives of research in architecture, leading to the creation of CORDA (Comité de la recherche et du développement en architecture) (Fauquet 2021)[2], in 1972 under the directive of Jacques Duhamel, the Minister of Cultural Affairs. The objectives of the research include the creation *of a community of researchers; the acquisition and dissemination of methods and knowledge, some fundamental, others concerning programming, design and production processes;* but especially *the creation of university workshops of architecture to allow a constant link between practice and research at the service of the community."* (Lichnerowicz 1973)

We can clearly see the difficulties of developing a research in architecture and then be validated by friendly disciplines. As Thierry Verdier (2018) points out, *"architecture, through the infinity of knowledge and skills that it represents, cannot be circumscribed within the narrow framework of an academic or university discipline. Can we accept that the doctorate in architecture is forced to submit to the great scientific and watertight frameworks distinguishing the university disciplines from each other? Certainly not"* (Verdier 2014). In fact, this is accompanied by a strong scattering of the production of research and therefore the identification of a common root. The corollary is that the researcher-architect, depending on the circuits in which he publishes, may have the impression of abandoning part of his thinking or his competence to enter the disciplinary framework proposed to him. It is, indeed, the legacy of a quarrel between a fundamental architectural research, rather tinged with human sciences against an applicative architectural research, rather colored hard or physical sciences, seeking to free itself from a perception of non-scientific research led by practitioners. Because the "project" is the identity marker of architectural culture, an important nuance must be recorded between knowledge and know-how, between the reflection that one develops on a practice and the practice itself. A strong tendency seeks to reduce knowledge to know-how because, as Mies van der Rohe could say, *"In the term 'architecture' we prefer that of 'building'; and the best results belong to the realm of the "art of building". Many schools get lost in sociology and design,*

[1] http://contour.epfl.ch/fr/what-is-research-in-architecture-2/

[2] https://ensarchi.hypotheses.org/1677

with the result that they forget to build. The art of building begins with the careful joining of two bricks " (Norberg –Schulz 1996). Architecture schools being the place where practice is taught, there is always an ambiguous relationship with research. As if the PHD could not characterize an excellence of practice or be an alteration of knowledge.

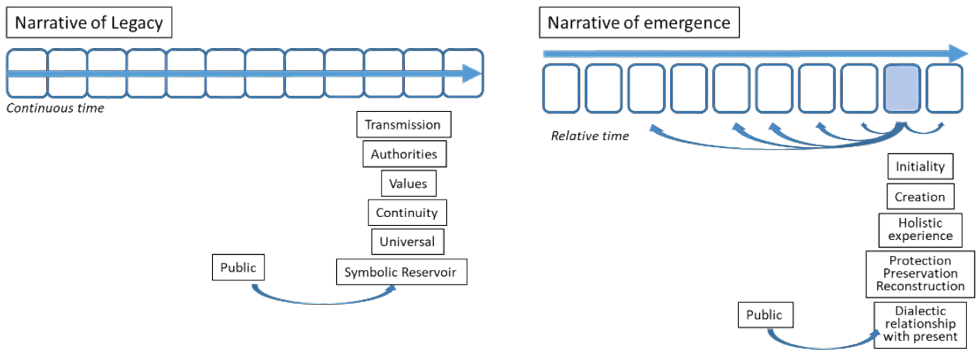

Figure 1 - Concept of Legacy / Emergence
Fig. Lescop

In fact, if we frequently discuss the recognition of the practice as equivalent to a third-cycle level, it would be more consistent with CORDA's goals to acknowledge in "doctors in architecture" the knowledge and skills required to adapt to the social and technological changes in their field, and to identify new practices, potentially leading to a transformation of the architecture profession. This trend is evident in many other fields, such as engineering, where the emergence of themes like "digital city" and "sustainable development" highlights the need for multidisciplinary, specialized, academic, and project-based training for professionals. Essentially, we are now facing two distinct modalities, legacy and emergence, which represent different approaches to the field of architecture. (LESCOP 2018 and Figure 1)

The legacy modality entails the transmission of content and represents continuity. Within the context of architecture, the notion of legacy pertains to the professional, scientific, and technical legacy, which is constructed as a sequence of interdependent periods, each aiming to exhaust a theoretical or technical paradigm. In this field, there are two modes of legacy. The first one is related to the profession, which ensures the transmission of content and a protocol integrating the origin and subsequent organization of the content through practice and education. Interestingly, in the quest to identify proper architectural research, a second mode of legacy has been integrated into the university academic research, which defines and organizes the scientific production of teacher-researchers. This transmission is imbued with certain values, disciplinary and scientific, which justify the exclusion of elements that do not preserve the prior meaning. It is a transmission that upholds and defends legitimacy, which can only be acquired by mastering codes and recognition by peers. Authorities are required to perpetuate and function this modality as a teleology, with the primary objective of preserving and transmitting a status. The Guild of Architects, academic

institutions, training and validation of knowledge are all part of this narrative with the aspiration of achieving a register of universality. This approach has a transcendent quality, involving the creation of symbols and rites that the public will recognize, in order to establish social adherence to professional and scientific authority.[3].

Thierry Verdier mentioned above recalls that " *there is a great risk of believing that when the architect designs a project, he does research. No, he's just doing his job. Research in architecture is precisely about going beyond the profession to, little by little, question the production of this complex thought* . This entails devising specific research methods that maintain rigor and intellectual ambition. This approach, in contrast to the legacy modality, can be characterized as the emergence modality. Unlike the legacy modality, the emergence modality does not operate on the principle of succession, nor does it follow a linear path. Rather, it is a modality that needs to be activated and performed. Once activated, it can, and above all, must demonstrate the continuity of what is recognized as such. The authority that activates this modality recognizes its origin and therefore validates its authenticity. The emergence modality aims to ensure fidelity to the origin, namely the project's production and academic canons, resulting in the pursuit of a holistic meaning and a total experience. As architectural research involves a dialectical relationship between research in architecture and society, this relationship must be maintained to address contemporary issues, identify the emergence of new practices, and paradoxically, preserve the value of the architect's own practice by pursuing holistic plenitude. This is precisely what is at stake in the BIMaHEAD project.

Scale 2 Education

Education and research are interrelated and mutually reinforcing but operate differently. By recognizing their distinctive roles in the current context, we can strengthen education and foster research. In pedagogy, the relationship to the project is built on three pillars: the notional, referential, and projectual. The notional pillar encompasses major fields of knowledge, identifying current ideas and conceptual tools, while situating them within the context of evolving ideas. Architecture is inherently multidisciplinary, drawing on diverse theoretical and technical sources. The referential pillar identifies trajectories within the architectural discipline, such as historical styles, construction techniques, or ideologies that accompany architectural achievements. Finally, the projectual pillar encompasses the approaches and techniques used to create built spaces.

By following the referential of modalities detailed above, a pedagogy of legacy and a pedagogy of emergence will be found in pedagogy. The license is rather the place of the pedagogy of the legacy and founds the notional, referential and projectual or technical bases which give to the students a range of skills and references which allow them to pass from the execution of a solution by the means given to them for developing original solutions. Over the course of the three years of License, the pedagogy builds this course of emancipation by measuring the theoretical and

[3] Since the covid crisis, there has been a persistent trend among architecture students in France to denounce this legacy as being responsible for the climate crisis and the failure to adapt to new social concerns.

technical acquisitions which respond to each other. In the Masters, we highlight what can be identified as a pedagogy of emergence mainly due to the installation of digital technology in practice, our production capacities and our relationship to the world. Digital tools have moved in twenty years from academic sectors and specialized companies to consumer sectors in which we find the creative, entertainment and cultural industries. This movement was not made without resistance and Antoine Picon (2010) commenting on the field of architecture, recalls that the question was the subject of "an essentially doctrinal or even doctrinaire literature emanating from proselytes, technophiles and other prophets of microscopic neo-avant-gardes. » The advent of the Digital Natives, who were born in the 21st century, has ushered in a new era characterized by the widespread availability and ease of learning technological tools, their mass distribution, and greater acceptance by preceding generations. Heritage mediation, Smart-Cities, the preservation of resources are part of this movement: they are integrated into a global vision of a palimpsest city (Cormerais 2015), a smart and connected city . We are only at the beginning of this change, the stakes of which will be above all democratic before being technological.

Scale 3 Institutions

The connection between pedagogy and research is integral to the functioning of an educational institution and must align with the overall mission and objectives of the school. This involves addressing internal concerns such as recognizing and evaluating the time dedicated to research, and developing innovative educational content. Additionally, establishing international networks is crucial, which includes supporting students to study abroad, welcoming foreign students, and offering international courses. Attending scientific and educational conferences globally can also be valuable in fostering cross-cultural exchange and promoting specific research initiatives in architecture.

As discussed in the first part, schools and research laboratories training doctoral students in architecture face the challenge of convincing the society that a thesis in architecture is a valuable addition to the operational field. It enhances technical and conceptual skills, enabling graduates to tackle contemporary challenges of construction and sustainable development. Third-cycle training does not replace practical knowledge, but rather adds applied knowledge. Students engage in research dissertations and laboratory internships to move back and forth between the academic and operational worlds, identifying opportunities to develop a specialization that will set them apart in the job market.

To achieve this, it is important to create opportunities for students to find internships and work, and offer specificities in their range of skills, which will place the School at the forefront of societal and technical issues. This has a strong impact on the students' course, as they identify movements in society that will organize their specialization. The course and follow-up of graduate students are major concerns, and their production is valued by the choice of projects carried out and the notoriety they can acquire, as well as communication about their work.

To facilitate publication and visibility of their work, formatting constraints must be integrated early on in the pedagogical process. The pedagogy/research articulation is a part of the school's overall system and must participate in the general policy of the establishment, consolidating its general project. Internal issues, such as teacher evaluation of time devoted to research and development of renewed educational content, must be addressed, as well as the development and maintenance of international networks through encouraging students to study abroad, welcoming foreign students, and participating in international meetings at the scientific or educational level, to recognize specific research in architecture.

Scale 4 Proposals

Reflective thinking is a component of the BIMaHEAD program, which is a collaboration between five European countries - France, Germany, Poland, Sweden, and Macedonia - aimed at developing innovative educational material. The new courses are required to use distinct methods and themes while offering students topics that will equip them with the necessary skills to tackle new design challenges. The program began with a comparative analysis of educational programs in ten European countries, to assess the extent to which BIM concepts are incorporated into the curriculum. Overall, the analysis indicates a comparable approach that does not go much beyond the use of 3D models with IFCs.

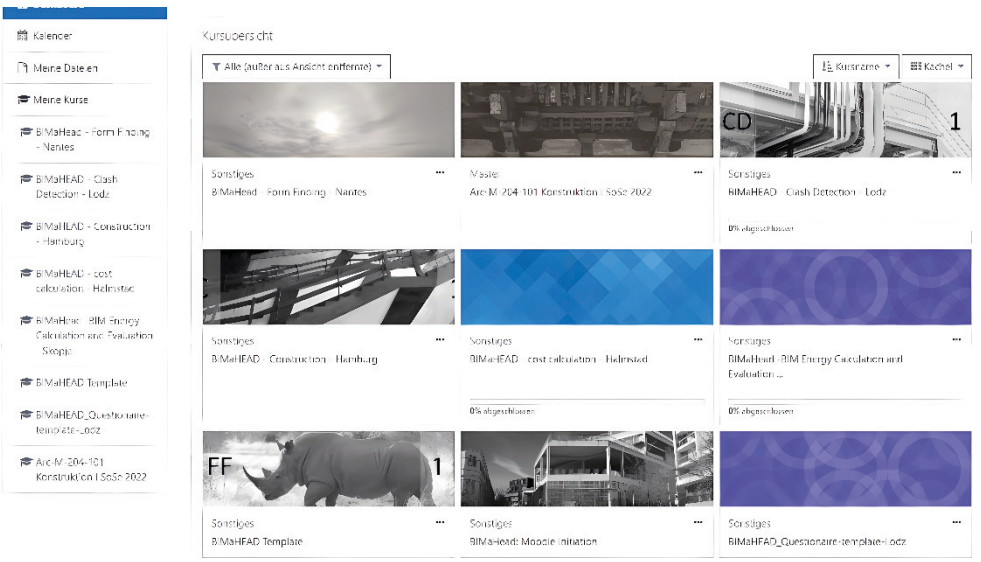

Figure 2 - The temporry BIMaHEAD Moodle page

During the process of creating the content, we observed two changes in the concept of emergence that require our attention. The first pertains to immersion and our ability to design, examine, and present projects at a 1:1 scale. Virtual reality and metaverses are the tools that enable us to achieve this level of immersion, which opens up numerous possibilities and issues that we must carefully consider. The

second paradigm shift is brought about by generative design, which is experiencing a resurgence thanks to algorithmic software and the rapid advancement of Artificial Intelligence. This approach redefines the very notion of design principles, allowing us to explore thousands of solutions based on predefined criteria. While these techniques might suggest that anyone can design, they also highlight the importance of expertise and the potential for increased complexity in projects.

The content is accessible with Moddle, other platforms are tested. (Fig 2)

Form Finding Nantes

This module is focused on using environmental elements as inspiration for designing shapes, and it starts with the software Grasshopper. Grasshopper is a plugin for Rhinoceros, a 3D modelling software, that allows designers to create complex shapes and structures through visual programming. The module then moves on to using Unity and metaverses to create a virtual experience of the design proposals. Unity is a game engine that enables designers to create interactive and immersive experiences. By using Unity, students can create a virtual environment where users can experience the design proposals at a 1:1 scale. This allows users to experience the proposed design in a more realistic and interactive way, making it easier to visualize the final product. (fig.3)

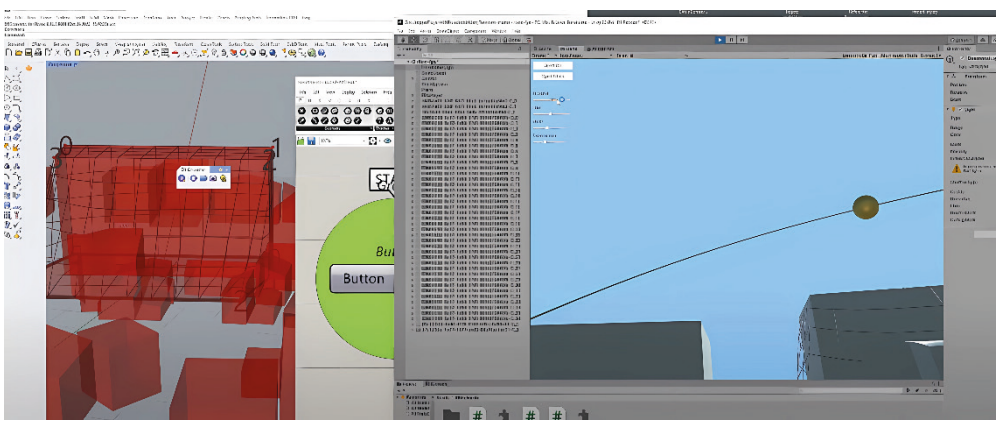

Figure 3 - Solar study in real time using Grasshopper inside Unity

Construction Hamburg

This module utilizes virtual reality technology to help students better understand how to assemble complex building structures. By using virtual reality, students can interact with 3D models of the building structure and get a sense of its size, shape, and overall design. SimLab is the software used in this module to create virtual reality experiences. SimLab is a software that is created specifically for virtual reality applications. It allows designers to create 3D models of buildings and other structures, and then simulate the assembly process in a virtual environment. By using SimLab, students can see how different building materials interact with one another, and test out different construction methods and techniques. One of the

key features of SimLab is its ability to dynamically adjust materials based on the virtual environment. Overall, this module provides a unique approach to designing and assembling complex building structures. By using virtual reality technology and SimLab, students can gain a better understanding of how different building materials interact with one another, and test out different construction methods in a virtual environment. This can help save time and resources in the actual construction process while also improving the overall quality and performance of the final structure. (Fig. 4)

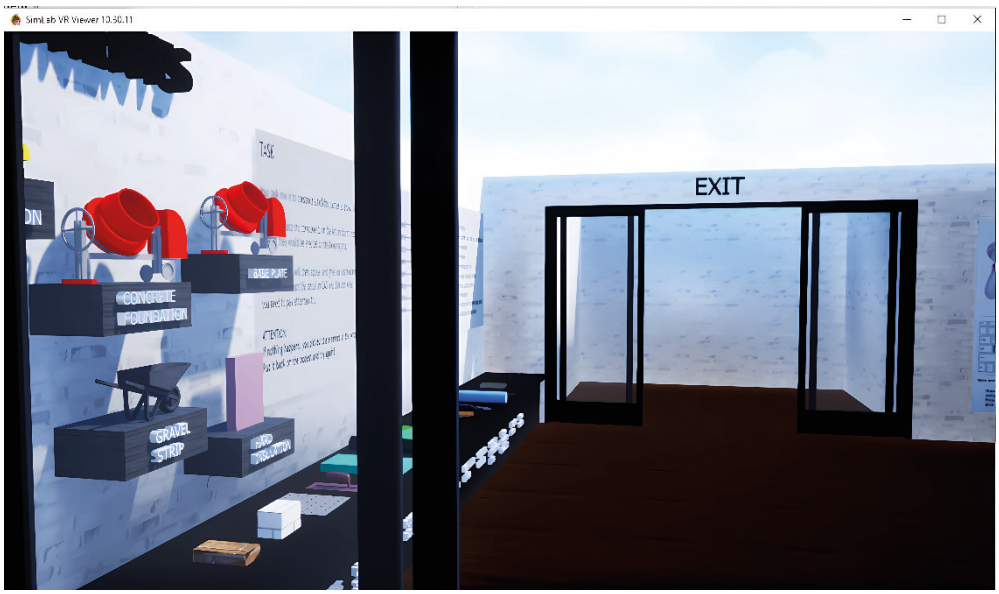

Figure 4 - Construction module with Simlab

Cost calculation - Halmstad

The objective of the course is to help students understand the process of digital calculation and the differences between this process and more traditional manual methods. To achieve this objective, the course is divided into two parts. In the first part of the course, students will review digital construction processes and their characteristics. They will also review software applications and practical examples in digital environments. This part of the course will conclude with a quiz or test to assess students' understanding of the material covered. The second part of the course will focus on software applications. Students will review various software applications and examples of their use. They will also review a digital calculation presented in a PDF file that contains amounts and figures. This part of the course will conclude with questions related to the PDF file. Overall, the course aims to provide students with a comprehensive understanding of digital construction processes and software applications. Through the quizzes and tests, students will be able to demonstrate their understanding of the material and their ability to apply it in practical situations. (Fig 5)

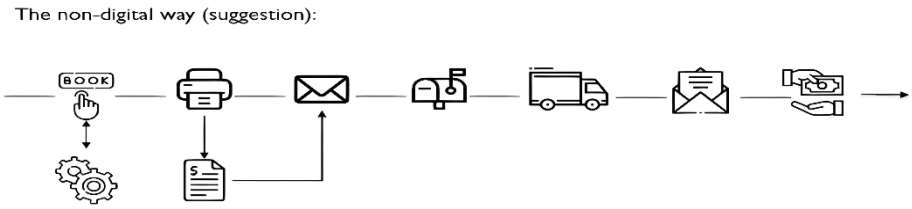

Figure 5 - Cost calculation

Clash Detection Łódź

The Clash Detection Module is an integral part of the BIMaHEAD Course, which aims to equip students with advanced knowledge and skills in Building Information Modelling (BIM) and help them detect clashes and collisions in AEC (Architecture, Engineering, and Construction) projects. By identifying errors and inconsistencies in projects at an early stage of design, engineers and architects can save resources, materials, costs, and time, thereby contributing to a more sustainable built environment.

Figure 6 - The Immersive part of clash detection where knowledge is tested

The Module introduces theory and practices through a sequence of tasks, enabling learners to acquire the skills needed for future architects and engineers in the AEC sector. It is designed to take learners through a game-like experience with different levels to be achieved and scores to be collected. Successful completion of the Module may result in the award of a certificate. The Clash Detection Module is an essential component of BIM education, as it emphasizes the significance of early identification of issues in the design process. By utilizing the tools and techniques introduced in this Module, students can develop the critical skills needed to detect and resolve clashes and collisions in AEC projects, leading to more efficient and sustainable construction practices. The Module's approach of combining theoretical knowledge with practical applications makes it an effective learning tool for students in the AEC sector. (Fig 6)

Energy Calculation and Evaluation

This course is designed to teach students how to use BIM (Building Information Modeling) as a digital tool to enhance the energy efficiency of buildings throughout their life cycle. The course covers various topics, including the concepts of energy consumption in buildings, energy and cost life cycle assessment, and the basic definitions associated with energy values and variables. Additionally, students will learn about the classification of energy-efficient buildings based on commonly used European codes and the methodology of energy balance based on BIM models. Furthermore, the course emphasizes the advantages of BIM over traditional methods of project delivery. The goal is to provide learners with advanced knowledge and skills that can help them improve energy efficiency in their work as professionals in the AEC (Architecture, Engineering, and Construction) sector. Therefore, the course is suitable for all professional profiles in the AEC sector who wish to enhance their knowledge of BIM and energy-efficient building design.

Conclusion

It is important to distinguish between technical advancements resulting from improved tools and the evolution of paradigms related to the representation and communication of knowledge. As new technologies replace old paradigms, it is crucial to pay close attention to emerging paradigms. Conversely, when paradigms are being reformulated, it is important to trace the continuities from past preoccupations to present tensions. In our pedagogy of emergence, we propose projects to students that establish a strong dialectic with the business world and institutions, probing the evolutions of architectural practice. (Fig. 7)

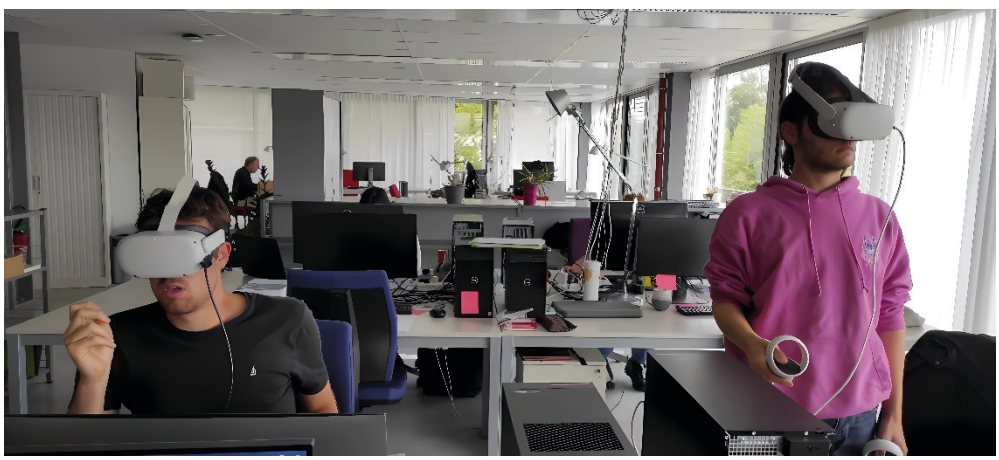

Figure 7 - BIMaHEAD being tested by PDH students

We prioritize real, involved projects, often built in the form of full-scale prototypes. Students develop their own skills, which they acquire through their specialization and education rather than solely identifying themselves as architects. We are committed to linking these projects to the creation of new positions in companies or research labs. Over the past few years, we have witnessed the emergence of new professions

in fields such as arts, traditional and playful scenography, tourism, light, and digital, alongside the careers of operational architects

Undoubtedly, the challenges and demands for pursuing a PhD in architecture are influenced by the economic context of a given country. In some places, like France, there is significant pressure and challenges for architects to find work, whereas in Germany there may be more opportunities available. However, the need to reinvent the world of construction in response to climate change requires a significant shift in pedagogy for architecture, which may include the pursuit of a PhD. Despite the difficulties, it is important for the field of architecture to continue to invest in research and specialized knowledge, in order to develop solutions and approaches that are better equipped to meet the contemporary challenges of sustainable development.

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