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ORIGINAL RESEARCH PAPER

Spaces for contemporary education in engineering: É81 and G56

András Greg[1*], Gabriella Medvegy[2], Gábor Veres[1], Bálint Bachmann[3], Balázs Kokas[4] and Péter Paári[4]

[1] Department of Architecture and Urban Planning, Faculty of Engineering and Information Technology, Institute of Architecture, University of Pécs, Pécs, Hungary

[2] Department of Interior, Applied and Creative Design, Faculty of Engineering and Information Technology, Institute of Architecture, University of Pécs, Pécs, Hungary

[3] Head of Management Board of Breuer Marcel Doctoral School, Faculty of Engineering and Information Technology, University of Pécs, Pécs, Hungary

[4] Department of Building Structures and Energy Design, Faculty of Engineering and Information Technology, Institute of Architecture, University of Pécs, Pécs, Hungary

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ABSTRACT

The article represents a case study of the realization of changing engineering education in two new contemporary educational buildings of the University of Pécs, the impact of these buildings on educational methods, and the impact of community-based education on these buildings. As part of the university development program launched in 2016, the University of Pécs, Faculty of Engineering and Information Technology's campus has been expanded with new architectural education buildings. The task of the new buildings was to adapt to the directions of the new engineering education and the representation of education of its faculty. The engineering education influences the object of architecture and determines its operation and its layout.

KEYWORDS

engineering education, architectural education, creative environments, learning spaces, contemporary architecture, parameterized comfort

1. INTRODUCTION

1.1. The changing engineering education

Even a few decades ago, the environment of the school and the education were considered only as a background for learning. The educational process has previously been interpreted from the point of view of the instructor and has fitted to the teaching manuals. The physical environment was ignored as if teaching were a ubiquitous process. The environment was just a sequence of classrooms that completely ignored the needs of the environment of education in the 21st century.

Because of the rapid changes, technological advances, and innovations in information-based society and industry, the academia of engineering radically changed. Higher education in the built environment is under pressure to change to cope with increasing student numbers in the face of diminishing resources, to meet the demands of an evolving construction industry, and to prepare students more explicitly for their working lives and changes in society, in short, to foster new professionalism [1].

Engineering students need to be prepared for the rapidly changing demands of industry and profession, to become more adaptable, flexible, and versatile in their professional careers [2].

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*Corresponding author.
E-mail: greg.andras@mik.pte.hu

These studies represent that the two well-known methodologies in engineering education, problem-based and project-based learning, are not capable of satisfying the requirements of industry one by one.

The solution is a combination of two different learning methods, where the right method could be selected for developing well-defined skills and transferring the correct knowledge. In each different situation, the competence determines the method. The use of only problem-based or project-based learning can be considered obsolete.

Accordingly, the research questions are as follows:

- The solution is a combination of two different learning methods;
- In each different situation, the competence determines the method;
- The use of only problem-based or project-based learning can be considered obsolete.

1.2. Research objectives

This paper observes the role and interaction between creative environments and community-based student work, learning, and teaching in engineering education to understand the reviewed buildings. It explores the general issues of contemporary education and learning about communities and inspirational spaces. The introduction of the buildings reveals the conclusions of the preliminary research, which are physically displayed.

2. MATERIALS AND METHODS

2.1. Background: Creativity and creative environments

The modern engineering academia is on par with the topics of creativity, innovation, human intelligence, and knowledge creation. Creativity is a key element during the examination of educational spaces and buildings, especially if these must provide creative and inspirational environments.

Creativity is the ability to produce and create a new thing [3]. "Creativity" is an individual's ability to generate original ideas to create something new [3]. Creativity means seeing a relation between new information and a previous experience and developing a fresh combination out of this perspective [4]. Individuals who are successful in making new associations from unrelated elements tend to have unusual access to the potential of new input [5, 6].

Further research has shown that creative behavior is a complex interaction between the individual and environmental characteristics of the results [7–9].

Amabile and his colleagues [9] state, that the first condition for innovation is the creativity of individuals and groups, but all this is not enough to create something new and that three components are needed to increase creativity (in a work environment): expertise, creative thinking skills (problems defining and solving, capacity, multiple tools), and motivation.

The quality of an individual's ability is a significant factor in every professional field, but the process of creation and innovation results in a more successful outcome at the group level with teamwork, community creation creative environment, and coordination. Creativity has been related to notions as varied as cohesiveness, diversity, and tenure [10–12].

"Creative environments" are generally described as organizations that enable the production of knowledge and facilitate learning from experience and from one another; in short, as organizations that provide knowledge sharing [8]. This kind of environment corresponds to a place and space in which knowledge is shared, created, and used, for example: offices, virtual spaces, and mental spaces [13].

Studies have shown that the physical educational environment can stimulate students' imagination and creativity [14, 15].

2.2. Community-based educational and learning spaces

Modern, independent schools are present in increasing numbers all over the world. The religious, moral, and political influencing factors were reduced; thus education became scientifically based [16].

Community-Based Learning (CBL) is a pedagogical approach based on experience that is supported by guidance, context-providing, and foundational knowledge. The communities can benefit from the resources of our faculty and students, and these new approaches can be educationally transformative in powerful ways [17].

The interactive learning organizing strategy is based on interaction, interrelationship, and direct communication. The interactive learning organization strategy enables the use of a variety of group-building and interactive methods [18].

Common and special learning spaces naturally have different dimensions and interior design parameters. In addition to the size of the room, the use of interior architectural materials and colors is decisive [19].

These parameters differ significantly for different generations. Even though the x and y generations are close in time, their needs differ in terms of space use and technology. The differentiation of spaces is also important for this reason [20].

In addition to the teaching spaces, the teaching methods have long since changed at Faculty of Engineering and Information Technology, University of Pécs. The Faculty supplemented the traditional front-line teaching style with a workshop/studio type of practical education. In addition to the engineering knowledge of architectural education, the methodology of teaching the elements of artistic creativity was the biggest challenge [21].

2.3. Developments of the faculty

The Faculty of Engineering and Information Technology, University of Pécs has expected to increase the number of international students to 500 in its educational development

program by the end of the Modern Cities Program to achieve this educational program also generated infrastructure investments, asset development, and further territorial and operational organizational improvements. The Faculty set several goals, which developed general education concepts and strategic plans of the faculty concerning the teaching methodology of the domestic and international education portfolio. The development of "É81 and G56" buildings were planned to serve these improvements.

3. RESULTS AND DISCUSSION

3.1. The concept of the project

As discussed in the previous phrases engineering education and architectural education are undergoing fundamental changes, the formation of creative spaces and the consideration of new types of learning methods played a key role in creating the concept of the buildings and educational spaces.

The concept was to create educational buildings and thus built environments where software as education, creativity, community-based student work, co-work, research, designing, and learning at the same time interact with each other through strong cohesion and can respond to the requirements of the engineering profession (Fig. 1). The basis for the creation of the inspirational space was defined by three elements, teaching method, community-based student work, and office-research work:

- Teaching methods;
- Community-based student work;
- Office-research work.

All these explorations and factors led to the creation of a concept in which functions would form a sequence of undivided spaces in one building mass. Reformed, modernized, and rethought teaching, learning, and research methods provided a solid basis for coordinating the dimensions of spaces. By forming a common vertical aspect ratio in the form of a "section", a general "section" was obtained that became applicable to the space requirement of all the functions. Horizontal alignment of the template cross-section provides space for the function.

3.2. Installation of the É81 and G56 buildings

It was an important aspect that new buildings could disclose the system of the campus and integrate it into their surfaces and that these could be easily accessible from other campus buildings.

The É81 and G56 buildings are designed for the same purpose, educational spaces, workshops and studios, which are essentially different in length. This inspired the number in the naming of the buildings, which in value rounded refers to the length of the buildings, 81 m, and 56 m. The abbreviation "É" means the architect in Hungarian language and the abbreviation G means a mechanic. The colors of the cuboids are the inverse of current white university buildings, enclosing the older existing features with an imaginary quotation mark.

3.3. Mass formation, façade design

The guiding principle of mass formation was practicality and simplicity.

The main objective was to find the simplest design and construction form, which allows for a quality appearance in its exterior and interior, while minimizing the use of resources, as financial, substance, and manpower. The concept started with the idea of two lightweight, one-story blocks. The determination of the ideal cross-section was necessary because, in the case of the sequence of the spaces, the mid-support would have impaired the quality of function.

3.4. Function

The two buildings have the same opening and access to the campus side. Behind the long glass wall are the creative spaces of workshops and studios. The spatial structure of the

Fig. 1. É81 building, interior, architectural education building, Campus of Faculty of Engineering and Information Technology, University of Pécs (*Source*: Authors')

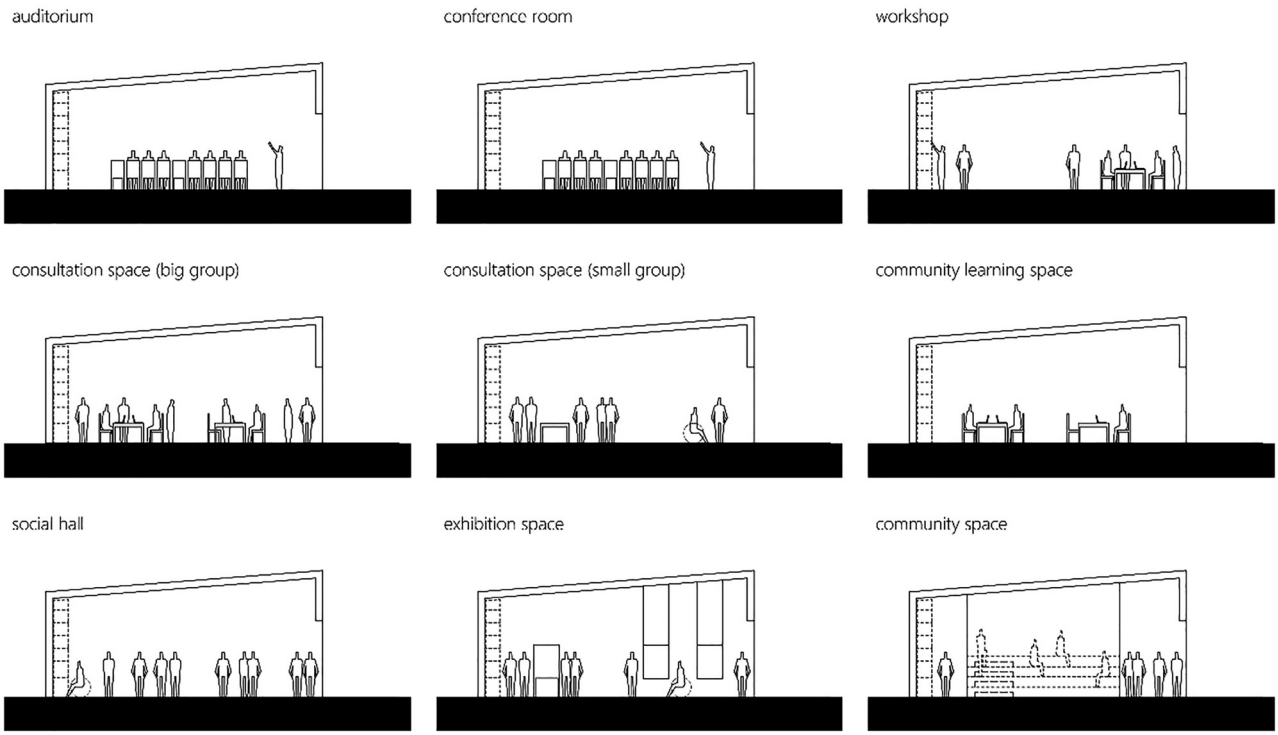

Fig. 2. Different types of use of the cross-sectional space (*Source*: Authors')

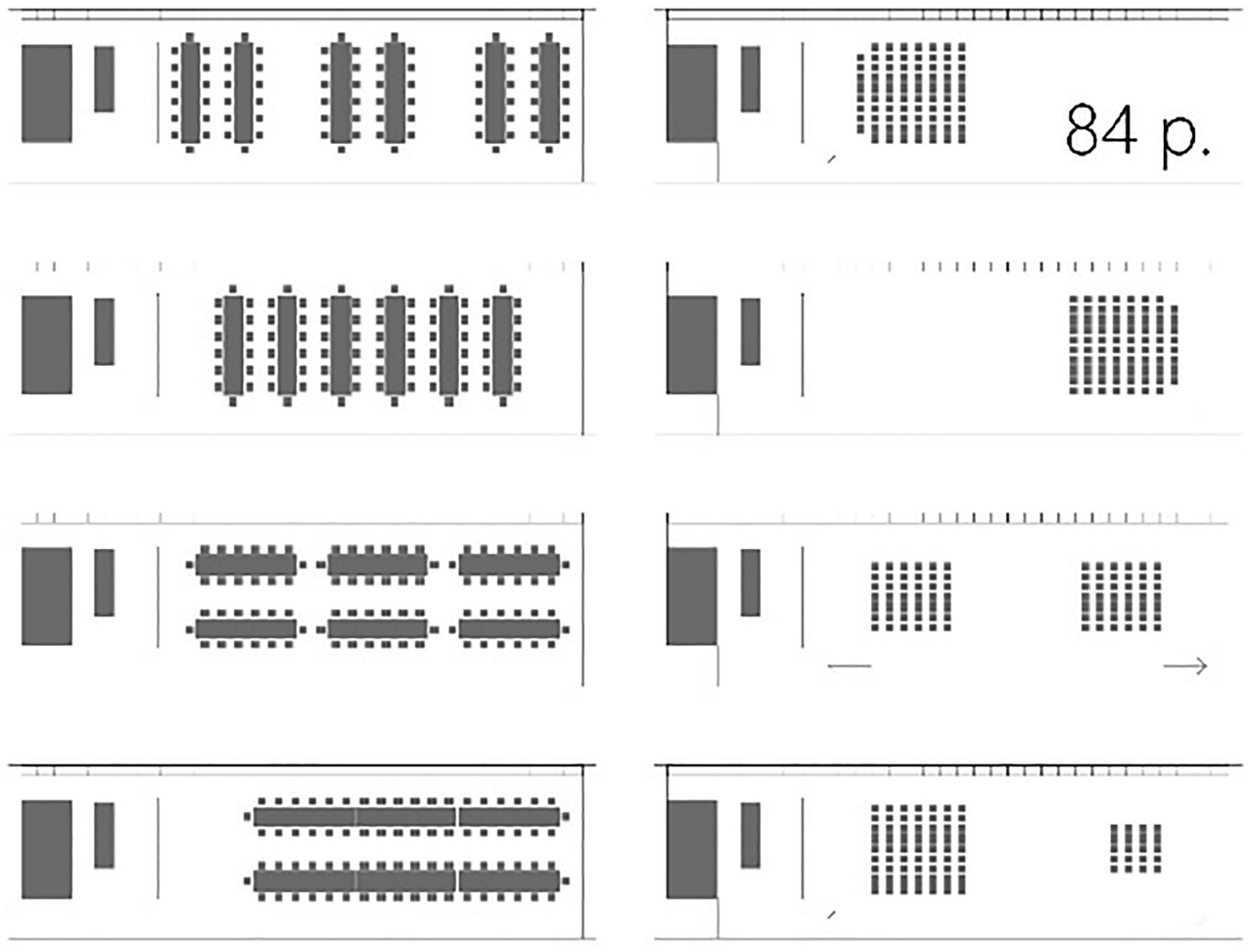

Fig. 3. Different types of use of floor plan in case of 36 people (*Source*: Authors')

transparent, contemporary educational arenas of the É81 building is less differentiated and therefore suitable for large numbers of people.

The open space spatial structure was the guiding principle when designing the educational surface. Depending on the size of the large contiguous space, a multifunctional space can be created. Functions that satisfy the space requirements of education the lecture room; the consultation space; the presentation space; the learning space; the conference room; the workshop space; the exhibition space; event space; student community space (Fig. 1).

The design of the space makes it possible to organize presentations, exhibitions, and large-scale scientific activities.

By changing the furnishing of large contiguous spaces, it is possible to organize various functions (Fig. 2).

3.5. Spatial arrangements: Furnished variations

The multi-functionality of space lies in mobility. In the case of undivided space, different equipment schemes may represent mobility. Ad hoc installations can be provided by furniture that is easy to move, stack into each other, and requires little space during storage (Fig. 3).

On the other side of the wet blocks are the open offices of the students at the Doctoral School of Architecture and the young lecturers of the Architectural Institution. The open office promotes the activity of academic, professional, research, and public communication.

3.6. Interior

In the sterile white interior, the structural raster, mechanical equipment, and the play of natural and artificial light serve as tools for interior design. The homogeneous use of materials was achieved by showing the raw and coherent surfaces.

The aim was to connect inspirational spaces and connect them.

Student community space is a dedicated presentation space, but it also serves as a community space. This multifunctionality characterizes the whole building.

The rhythm of larger and smaller spaces creates spaces at different levels of socialization. The use of materials in the spaces is disposable and recyclable, there is also simplicity, and practicality was the main criteria.

Community-based education requires the development of optimized and measurable, parameterized spaces with a comfortable feel which must have purposeful and measurable engineering dimensions. Each space must satisfy multiple functional requirements to avoid duplication of functions with nearly the same dimensions.

4. CONCLUSION

Engineering education is undergoing fundamental changes. Thanks to the rapid development of the industry and the changing skills expected of engineering generation in terms of practical and theoretical knowledge. The industry is constantly developing itself to satisfy new needs from the world, and these require the preparedness of a new generation of engineers who need to acquire entirely new skills. These three participants are in a constant and coherent relationship with each other, reacting to each other's vibrations. Defining and designing the form of education determines the success of engineering training and the spatial design of the training.

The type of education, in this case, engineering education, influences the object of architecture and determines its operation and layout. The organization of the spaces follows the function and educational needs.

In the case of the É81 and G56 educational buildings, the functional and technical requirements determined the dimensions of the building. The new engineering education buildings must meet the new needs of industry; the classroom design is changed from traditional education spaces to student-centered spaces where the students' engagement and collaboration are enabled through project and problem-based tasks.

These versatile spaces enable students to develop the skills (computer, social, learning, collaboration) and attitudes needed for professional practice that the industry requires nowadays. The minimum depth and height of the tract of spaces were determined to satisfy the various functions, this standardized framework helped to create clean spaces suitable for many functions by modifying only the furnishing. Before and after classes the students have started to rearrange the spaces and form the space for their needs as collaborations and individual works. By monitoring these transformations, the professors could learn from these and, even leaving the equipment the same, adapt to the students' behavioral culture during the lessons.

In conclusion, the student's skills required by industry are constantly improving thanks to the creation of architectural spaces adapted to their learning and social habits.

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