Methodology for hospital design in architectural education

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ABSTRACT: The architecture of a hospital should be a response to strong user requirements. Recommendations on how to shape the environment of such facilities are highly complex, integrating guidelines from many fields of science. If contradictions between them exist, the designer is required to set priorities for spatial activities. This issue is particularly important during architectural education. The learning process should include projects with a high level of complexity, thus providing students with the opportunity to prepare works in planning medical facilities. These works should include consideration that medical architecture is a multifaceted task, both in theoretical and practical terms. In this case, the methodology of improvement is a helpful teaching tool. The intent in producing this article was to illustrate the possibility of using process analysis to approximate the performance of medical procedures in the teaching process and their impact on the design of hospital buildings as complex engineering facilities.

INTRODUCTION

The little experience and skills of students at the start of architectural education means teaching exercises involve the solving of simple design problems. In the next stages of education, elements with a higher level of complexity are introduced. Hospital facilities, which require a combination of knowledge from various fields of science, are the most difficult projects to design and implement. The architecture of such facilities is created, among other considerations, under strong pressure of legal, sanitary and hygienic requirements and, above all, functional requirements resulting from the nature of the medical procedures performed.

It is important to equip students with knowledge of the processes, organisation and physical resources required to provide medical services. For example, to reduce medical risks requires knowledge of medical procedures related to hospital infections; design skills in relation to factors affecting safety: environmental conditions (water, air quality, natural lighting, acoustics); the quality of equipment and finishing materials [1]; and materials with relevant certificates [2]. It is also important to use knowledge from the field of management, and the options provided by digital technologies, such as dynamic and simulation modelling [3].

The design process defined in this way is an assumption of the need to analyse a number of conditions beyond the standard skills of architecture. In the case of real projects, decisions should be made based on the consensus developed within interdisciplinary project teams [4].

Preparation of medical facility documentation requires designers to have a unique set of knowledge and skills. Students should be made aware that, when deciding on such a course of professional practice, they must take into account complex technical and functional requirements, building standards and regulations, as well as contact with clients who often use complex medical terminology [5]. The methodology of teaching used is of key importance for obtaining correct design solutions and achieving an educational effect.

EDUCATIONAL ISSUE

The design of objects with complex requirements, e.g. hospital facilities, requires student to learn about the use of such spaces. Even for medical units designed by professionals in multi-person design teams, reservations are raised on the need for changes in the design solutions. This problem occurs in many countries; for example, it is reported in the USA [6] and in Europe [4].

This indicates there are design difficulties, which are a problem even for professionals. Such a complex process is a barrier for students usually with little practical experience in the application of technological processes to architecture.

This means the didactic system should be aimed not only at developing a design solution, but also at understanding the relationships between individual elements of the designed space and acquiring skills in the methodology of shaping such objects.

In search of methods for teaching the architecture of medical facilities, some universities decide on a model consisting of three elements:

Types of model:

- Internship. This model mirrors an internship in a medical facility during which students familiarise themselves with the complex technical and social environment in hospitals or outpatient clinics. After the internship at the medical facility, each student returns to the university to complete a project drawing on the knowledge they have acquired.
- Embedded studio. Architects with experience in the design of medical facilities participate in classes. They familiarise students with ongoing projects. Students observe internal project reviews and other activities.
- Evidence-based research studies. Students are involved in research to improve the architecture of healthcare facilities and its optimisation. Hence, they can interpret current research in the field [5].

Changes in society require the introduction of highly specialised educational programmes in architecture for designs with a high degree of complexity. Modern innovative technologies at universities, both in research and education, are necessary to raise the level of education of students [7].

Modern technologies included in architectural education are vital for an economy based on innovation [8]. Preparing specialists in healthcare architecture requires specialisations at universities, such as Master of architecture and health programmes [9].

PROCESS MANAGEMENT

Where a short time is allocated for teaching complex objects, the task of the teacher is to provide students with tools enabling analysis and critical evaluation of design solutions. One such tool is an analysis team based on process management of the project. This is a concept taken from economics. The process is defined as a set of interrelated actions and activities to produce, receive or deliver a predefined set of products, results or services. It requires the matching and interconnection of all design and product processes [10].

The role and consequences of this approach to shaping space are the subject of publications in architecture. For example, the patient's transport within the operating theatre, taking into account the patient's operation, affects the selection of rooms and space parameters, such as corridor width or the size of the preparation room, and the arrangement of rooms within the operating theatre, in particular the location of the recovery room [11].

This makes it possible to determine quantifiable parameters for the assessment of the designed space. This is based on the present method of designing medical units, which in turn, are based on scientific research - evidence-based design (EBD). Thus, EBD has been present in architectural design for several years. The design is guided by research focused on the needs derived from healthcare architecture [12].

In the case of medical facilities, process management can be based, *inter alia*, on analysing the activity of space users, i.e. patients, visitors and staff. From the point of view of achieving the learning effect, it is essential for the student to acquire the skill of process mapping and workflow. Modern research indicates that flow process analysis is a task that should be performed by specialists of design:

> *Instructing how to see the process may seem absurd, but tasks that are well known to us are often treated as one operation, without noticing that they often consist of complex tasks necessary to complete the process* [13].

To optimise solutions, this activity should be based on a previous process of observation and process research. In the case of studies prepared by students, acquiring knowledge about processes can be done by analysing documents of a medical unit, literature on the subject, observations of a medical unit during work or the guidelines and consultations provided by the teacher. The conclusion of such activities should be a comparative analysis of the process. It provides the parameters for the activities for the users of the space, and facilitates the analysis and comparison of design solutions.

PERFORMING A MEDICAL PROCEDURE: EXAMPLES OF ANALYSIS

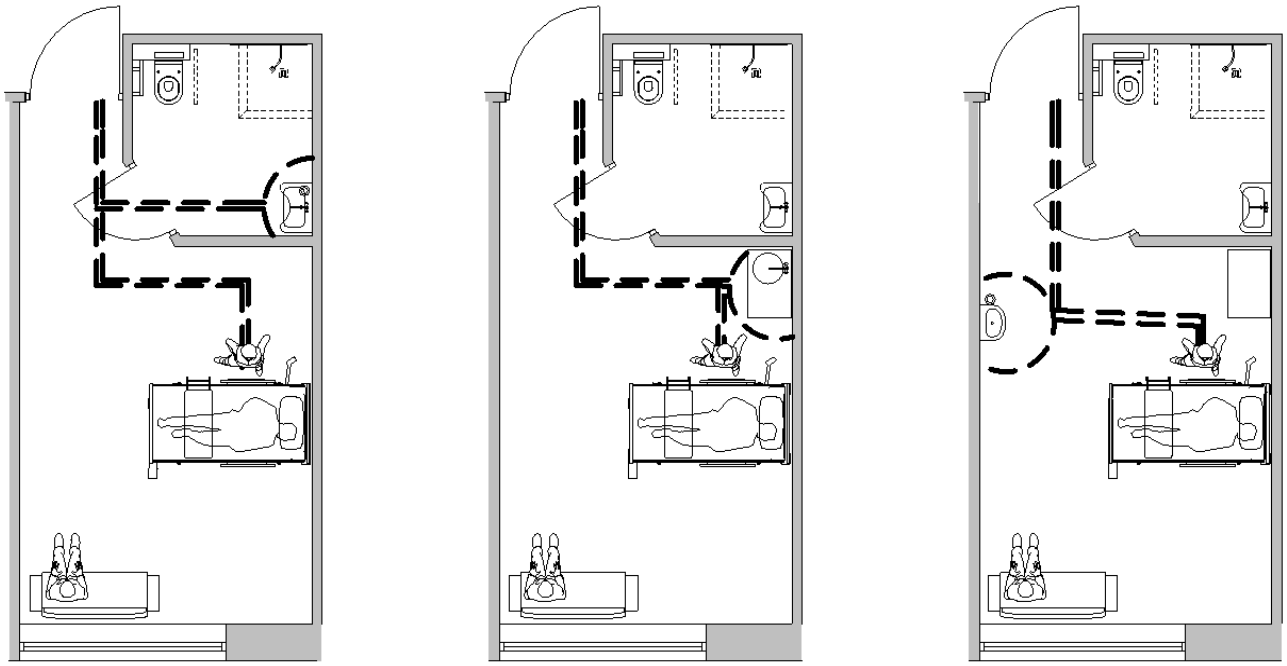
Process analysis makes it possible to conduct analyses related to medical procedures and also allows for the development of architectural solutions. Appropriate shaping of space helps not only to take into account the relationships between individual elements, but also significantly affects the amount of work needed to properly

perform medical procedures. At microscale, architectural solutions can be compared in terms of the amount of work needed to perform a procedure; for example, in relation to a basic activity, such as washing and disinfecting hands before and after contact with a patient.

As recommended by the World Health Organization (WHO), in therapeutic facilities, space users should follow the principle regarding five moments for hand hygiene. The hands should be washed and disinfected each time in the following situations [14][15]:

- Before seeing the patient.
- Before a clean aseptic procedure.
- After exposure to body fluids.
- After seeing the patient.
- After contact with the patient's environment.

Through such recommendations, the route of staff during a procedure can be traced and the impact of the architectural solution on the amount of work performed by the staff can be compared for different designs (see Figure 1).



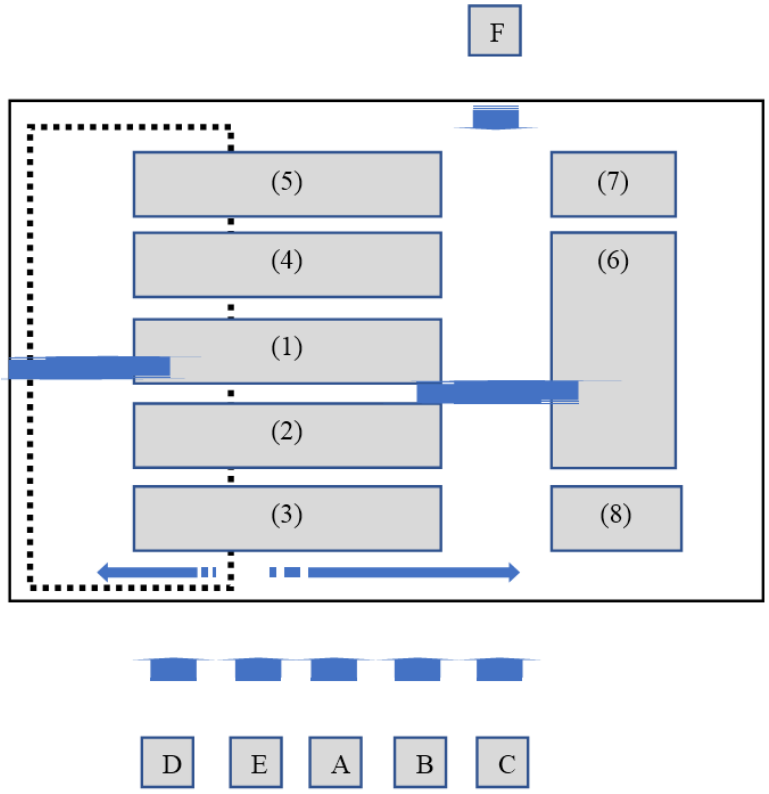
a) b) c)

Figure 1: Analysis of the personnel route needed to perform the procedure of cleaning and disinfecting hands depending on the design solution. A proper solution reduces the length of the route necessary to travel during the procedure (Source: Author).

By carrying out such calculations, a student can perform critical design analysis relatively quickly in relation to a simple and easy to understand medical procedure. Such an approach allows the introduction of increasingly complex architectural problems into the didactic process. Shown in Figure 2 is the process of passing different groups of user through the areas of an hospital emergency ward. In this case, the analysis of the process leads to the verification of the solution in wider scope and makes it possible to bypass the study of individual activities, analysing the passage of individual groups of patients through the unit. In the case of professional teams, it is recommended that such mapping be performed based on complex methodology by an interdisciplinary team of specialists [3].

With studies prepared by students, it is possible to apply simplifications by using architectural plans developed by a group of students, and it is possible to perform analyses and compare solutions based on quantifiable data, e.g. regarding the amount of surface contaminated by potentially infectious patients, the number of potential contacts with other users, or useful information, such as the length of the route that must be taken by personnel during medical procedures, or the patient from entering the unit until assistance is provided.

This type of comparative analysis allows a group of students to perform reliable quantifiable assessment of design solutions. This provides a better understanding of the work process of space users and processes occurring within the building, as well as the impact of architectural solutions on the comfort of users' work and threats occurring in the hospital. It also prepares students for working in multi-person project teams whose task it is to integrate knowledge from many fields and to use various optimisation tools, which can be exemplified by the Lean Six Sigma system to improve the efficiency of the emergency ward [3].



Legend:

1. Resuscitation and treatment area
2. Immediate therapy area
3. The area of medical segregation of registration and admissions
4. Initial intensive care area
5. Observation area
6. Consultation area/Auxiliary areas
7. The area of detailed diagnostics (imaging and laboratory)
8. The area of medical emergency teams

The patient's route of analysis resulting from the implementation of the medical segregation system and the division of patients into groups:

A. Patients requiring urgent intervention
B. Patients who require quick help
C. Patients whose life and health are not in immediate danger
D. Route of an infectious patient
E. Route of a patient in need of decontamination
F. Route of personnel within the unit

Figure 2: General visualisation of processes taking place in the area of an hospital emergency ward. The processes facilitate both the analysis of the route of the patient and staff, as well as the management of potential conflicts, such as contact between a potentially infectious patient and other space users, the accumulation of activity in a limited space, the area of medical segregation of registration and admission (Source: Author).

CONCLUSIONS

In the didactic process, the design process should be enriched with analytical elements allowing students to independently quantify their proposed solutions. In many cases, the correct solution for a system requires the integration of knowledge from many fields of science, in relation to which students are not prepared as part of their specialisation. Studies in architecture contain only the basic elements to identify problems in the field of medicine, hospital infections or medical facility management requiring optimal spatial and functional systems.

The process method requires the analysis of the activities of space users, which is the basis for visualising the problems of space recipients in the teaching process. Such activities particularly are important in medical facilities because the ability to design the optimal space affects the safety of use of the facility and the quality of the medical procedures performed.

The ability to solve multi-faceted problems has positive effects both in theoretical and practical terms. There is a dynamic development of knowledge in regards to shaping medical facilities, as well as technical capabilities, e.g. diagnostic and surgical. The progress of modern technology contributes to the need for constant updating of knowledge and the formal transformation of medical facilities, so the teaching process should prepare architecture students for active participation in this process.

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