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CREATING A FUNCTIONAL AND SPACE PROGRAM FOR NEW BUILDING OF THE FACULTY OF THE BIOMEDICAL ENGINEERING BUILDING, SILESIAN UNIVERSITY OF TECHNOLOGY

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Abstract
The Faculty of Biomedical Engineering was founded two years ago. In the course of the cooperation between the Department of Design Strategies and New Technologies in Architecture, a research project focused on the functional and surface management of the new Faculty was implemented. The main scope of the research was the analysis of the functional needs of particular departments that make up the new Faculty; accordingly, the paper describes the conducted research and the final conclusions.

Streszczenie
Dzięki współpracy naukowej Katedry Strategii Projektowania i Nowych Technologii w Architekturze na Wydziale Architektury Politechniki Śląskiej z Wydziałem Inżynierii Biomedycznej Politechniki Śląskiej, został przeprowadzony projekt badawczy, mający na celu opracowanie programu funkcjonalno-powierzchniowego dla siedziby nowego Wydziału. Głównym elementem badań było poznanie oraz analiza potrzeb organizacyjnych poszczególnych Katedr wchodzących w skład Wydziału. Niniejsze opracowanie zawiera opis przebiegu badań oraz wnioski końcowe. Wydział Inżynierii Biomedycznej jest nowo powstałym Wydziałem Politechniki Śląskiej. Składa się on z czterech Katedr. Tworzenie się Wydziału a wraz z nim nowych kierunków kształcenia studentów w planowanych nowoczesnych laboratoriach i pracowniach, stał się powodem starań władz Wydziału IBM o nowy budynek. Stąd, wyprzedzając plany i decyzje dotyczące siedziby Wydziału IBM, podjęte zostały kroki badawcze mające na celu opracowanie wstępnego programu funkcjonalno-powierzchniowego dla nowego lub adoptowanego budynku. Wstępem było podjecie badań przedprojektowych, które miały na celu rozpoznanie potrzeb użytkowników Wydziału z uwagi na specyfikę i specjalizację poszczególnych Katedr oraz technologię procesów laboratoryjnych. Efektem końcowym jest propozycja programu funkcjonalno-powierzchniowego dla Wydziału.

Keywords: **Functional and space program; Users' needs analysis; "Ideal" ergonomic model for new functions.**

1. INTRODUCTION

The Faculty of Bio-Medical Engineering is newly founded. It consists of four departments: Biomechanics and Rehabilitation Engineering, Computer Science and Medical Equipment, Biomaterials and Medical Products Engineering and Biosensors, Medical Apparatuses and Biomedical Signals Processing. Currently the Faculty is set in several buildings: The Mechanical Engineering, Mining and Geology, Automatic Control, Electronics and Computer Sciences. The creation of the new Faculty offering courses in a new field of engineering, requiring state-of–the-art laboratories and workshops evoked the need for a new separate building. Hence, before definite decisions and plans concerning the seat of the new Faculty were made, studies on the functional and floor area use program were run to construct a new building or adjust one of the existing University facilities. The first steps involved some feasibility and pre-design studies to detect the future users' needs in view of a specific nature of particular departments and laboratory process technologies. The

outcome was a proposal of a functional and floor area use program, resulting from the cooperation between the Department of Design Strategies and New Technologies in Architecture headed by Professor Elżbieta Niezabitowska and the Institute of Engineering and Biomedical Materials at the Department of Biomedical Materials headed by Professor Jan Marciniak and experience in quality analyses and methods of deriving information about users and their specific needs [1], [2], [3].

The studies were conducted based on acknowledged research and world-recognized patterns in programming and quality analyses [4]. The authority in this field is DEWG design office which has been conducting quality analyses and studies on the improvement of the functioning of educational institutions [5], [6]. Programming pre-feasibility studies had the form of case studies and were conducted in two stages, with the participation of 3rd and 4th year students (Students: Aneta Nosal, Sabina Mrowińska, Joanna Kujda, Simon Mrowiec (2008/2009) under the direction of D. Winnicka-Jasłowska). The first stage was accomplished in the academic year of 2008/2009 and concerned devising the functional and surface management program for laboratories and within the framework of concept of the model. The report from this stage was complied as the authors' own work within the framework of the research project: "Users' needs as the main factor of shaping the quality of the built environment" conducted at the Department of Design Strategies and New Technologies in Architecture. Stage II was completed in the academic year of 2009/2010 and concerned the program for other functional zones of the Faculty (Students: Marcin Jamroż, Przemysław Spadło, Michał Szafarczyk, Filip Gołasz, Monika Zygoń (2009/2010) under the direction of D. Winnicka-Jasłowska). Both stages were supervised under the subject of Design Strategies taught by the author of this paper.

2. SCOPE OF RESEARCH

The scope of the research, first and foremost, was to examine the organizational scheme of the new Faculty. The Faculty's authorities made a detailed description of the organizational structure of four Departments available, including the number of employees at particular organizational units. Next an inventory of currently used rooms and facilities was conducted, as well as inspection of technological aspects of research and teaching activities that utilize specialist equipment.

The next steps of the programming involved the investigation of users' needs by means of interviews, development of ergonomic models, conceptual solutions for specific laboratories, and, successively, administration and office rooms occupied by the teaching and research staff, classrooms, lecture rooms and public zones functions. Also, issues connected with the location of the building were considered and elements of its image determined. The above mentioned tasks were divided into two stages:

Stage I- general examination of the users' needs and preliminary determination of the demand for space, followed by:

- Detection of the users' needs in the course of meetings and interviews;
- Getting acquainted with the fields of science, research processes and laboratory technologies used by particular Departments;
- Devising basic ergonomic patterns of space utilization concerning laboratories, studios and their equipment;
- Focus meetings with the faculty staff to discuss the proposed solutions.

Stage II-construction of the functional and spatial program for the new Faculty, including:

- Determination of functional links between the following spatial zones: public, office, administrative, didactic, laboratory, ancillary and supporting facilities;
- Devising the functional models of public zone, office zone, didactic zone and administrative zone.

3. METHOD OF DATA ACQUISITION AND PROCESSING REQUIRED FOR THE CREATION OF THE FUNCTIONAL AND SPATIAL PROGRAM

This project is experimental and is to be used for research; however, the collected and compiled data render a credible materials constituting an important component of the functional and spatial program for the new Faculty. Programming is an essential step that should precede the design stage. Currently in Poland there are not any specific standards and detailed indices to be used in the design of university buildings. Nevertheless, such standards are commonly applied for example in the USA and Great Britain. Hence, an attempt to formulate a preliminary program for the seat of the new Faculty of Biomedical Engineering, which will certainly provide

valuable experience in the search for best solutions.

The grounds and input for the research is the identification of basic groups of users and their organizational and social needs. The description of the Faculty's organizational structure with division into organizational units and the number of their users provided supportive material. Next, the users and their activity types were depicted , as well as their organizational needs and, what is of special importance nowadays - their social needs. In the past years this factor was not taken into account in the design of university buildings. These days other fields of science, such as sociology and environmental psychology offer better insight into social issues and support architects in their design solutions [8], especially as far as human requirements, such as the needs of privacy and territoriality, isolation and cooperation are concerned. Students constitute the biggest group of university buildings users, with their specific needs that change the image of a modern university facility. An important element in the conducted research work was the consideration of students' organizational and social needs.

In case of any design that will house an institution, it is essential to understand the objectives of its activity, modes of operation and planned or predicted organizational and technical and technological changes. Organizational changes are of great importance and they should translate into the manner in which space is shaped. Forecasts of further development of organizations such as university units, faculties etc. have an impact on design assumptions. Yet, it is spatial solutions that determine the efficiency of current and future functionality of a given organizational structure. It is also vital to assume the number of users of the designed building. The quantity of the users is subject of change in the whole life cycle of the building: it may increase or decrease and change its proportions. Nonetheless, an approximation is important as it enables the formulation of a strategy of efficient space management of the facility, for example, if the number of students declines, some class rooms, lecture rooms or even parts of the building may be leased. On the other hand, if the number of students or teaching staff increases, some space reserves should be available, so that the surplus of space that occurred in some periods of the functional life of the building could be rented or utilized for organizing such events as conferences or exhibitions.

Another cognitive step in the discussed research is to determine appropriate teaching and learning conditions. The starting point are the curricula and knowledge of the manner in which classes, lectures and workshops for students are conducted. It should be remembered that every university, and even its particular faculties, have specific spatial requirements and functional types of facilities; beside class rooms, lecture rooms or seminars, there are others specific to a given field of study, such as laboratories or studios equipped with devices and aids typical of a given faculty. In the case of the Bio-Medical Engineering Faculty these are laboratories and work rooms used by students during instruction hours and by the research and teaching staff. Each of the four Faculty Departments has its specialist equipment set-up in a specific technology line and having specific dimensions, which is very important in designating the size and proportions of rooms. (Fig. 1). Therefore, it was necessary to conduct the site inspection of the existing specialist facilities. For each of the inspected facilities photographic inventory was carried out as well as general physical measurements taken. The required data included: basic dimensions – length and width, examination of the equipment and technology line, as well as information on the type of activity and manners of equipment use and operation. The information was collected from interviews with the users (both university staff and students) and from the in-situ inspection with participation of all parties concerned. In each room photographic documentation was taken, which was helpful in making records of the equipment and its arrangement. The interviews also involved the assessment of the facilities in terms of size, functionality and equipment, enabling the formulation of conclusions valuable for devising an ergonomic model of an "ideal" new room. The information obtained from university staff also included functional connections among laboratories and the sequence of their use in the teaching process typical of a certain study line, for example: seminars that introduce students to laboratory classes, in order to consider the functional need of their proximity. During the in-situ inspection data on specific requirements and technical conditions that the facilities should fulfil was also collected: micro-climate, lighting conditions (exposure to sunlight or location oriented to the north due to the need of providing lower temperature and elimination of the access of sunlight, or additional lighting of work-stands, etc.), allowable noise emissions levels and vibrations (evoked by some equipment, as well as their potential negative impact on other precise apparatuses, for example on electronic microphones), allowable ambient temperature, ventilation, air-conditioning, etc.

Detailed interviews with the teaching and research staff were conducted to obtain information necessary for designing new laboratories and work rooms, to enable precise determination of the technological aspects of work stands and the space required.

After the analytical and data collection phase, the next step was focused on devising ergonomic models of "ideal" new rooms. On the grounds of information and criticism derived from the staff it was possible to devise best solutions concerning the spatial arrangement and square area of the planned facilities, taking into account the modularity of the facilities to facilitate the transformation of schematically drawn solution to specific design solutions (Figs. 2, 3).

Next, focus meetings were arranged with the university staff to discuss the proposed solutions of laboratory functions. Such meetings are held in small groups consisting of carefully selected people who can contribute to the rectification of the proposed solutions. Staff members representing the four Faculty Departments also actively participated in the process of devising model solutions concerning office space and facilitating the adoption of the most suitable ones in terms of the Faculty's organizational needs. Stage I was finalized by correcting the drawings and schemes and preparing the draft of the program.

Stage II involved the preparation of model solutions for particular zones of the building – see (Fig. 4), in consideration of a specific nature of a given study line and currents spatial needs and requirements for the zones. The outcome was a model functional and spatial scheme for basic zones of the building.

On the bases of the functional and spatial program for the Faculty of bio-Medical Engineering a MSc. thesis and diploma design was completed in the academic year 2010/2011 entitled: "Architectural concept of the Faculty of bio-Medical Engineering, Silesian University of Technology, Gliwice" [9]. The building was planned to be located at the intersection of Akademicka and Skłodowska-Curie Streets. The functional and spatial layout is a response to the conclusions drawn from the programming stage. The concept of the new building provided the creation of common space for three separate functional blocks: didactic, administrative – office and laboratory zones. The public zone is constituted by a modern atrium serving the following functions: representation, resting space, meeting and social contact space in accordance with the DEGW "Learning Landscape" guidelines [5].

The design concept is a response to the current needs of the students and staff of the Faculty of Bio-Medical Engineering, as an effect of studies on the foredesigns of DEGW office [5] and up-to-date trends concerning the programming and design of functions that university facilities fulfil [10]. The view of the ground floor and visualization of the building are shown in Figs. 5 and 6.

4. CONCLUSIONS

4.1. Research and cognitive aspect

The detection of the functioning rules of a future building in consideration of didactic, research and development and social processes that it houses contributes to the formulation of elaborate functional and spatial program for the newly designed building. The complexity of laboratory technologies utilized by particular Departments requires profound predesign analyses, without which it would be practically impossible to design the research and laboratory zones that make up essential parts of the Faculty building. The visits and in-situ inspections in the existing Departments explicated and enabled the understanding of the essence of the processes involved in the teaching and research activities of the Faculty staff. Interviews with the Faculty staff also indicated different modes of student instruction in comparison with, for example, the Faculty of Architecture, specific to the field of study, which, surely, have a definite impact on the shape of the interior space and functional solutions (for example: location of seminar rooms in the vicinity of laboratories). Accordingly, it may be concluded that every type of a university and its particular faculties should fulfill the requirements specific to a given field of study. Thus, design templates cannot be used. This applies to the majority of functional zones and types of rooms in university facilities, as substantiated by all analyses of existing university buildings carried out by the author of this paper, revealing frequently occurring errors in the understanding of specific features, field of study and the associated activities. The predesign analysis discussed in the paper was also made to "try out" data collection and processing methods and to propose and select best solutions.

4.2. Educational aspect

Some students are deeply interested in research the methodologies, quality analyses of buildings and predesign analyses. Due to participation in research projects students of architecture could get better insight

into the essence of the architectural profession and develop useful analytical skills. Undoubtedly, their knowledge about users' needs improved and they found it easier to comprehend users' needs and requirements. The discussed studies included focus meetings and interviews which presented opportunities for learning about users' preferences. The presentation of design options and discussions offer useful training preparing students for future negotiations with investors. In the course of the discussions certain aspects of crucial importance to the planning and investment design processes are revealed. Students' involvement in research projects makes them sensitive and alert to many design problems and often expose errors that could have been avoided. Thanks to pre-design analyses future architects realize the complexity of the design process.

Figure 1.
Strength test laboratory. Inventory photograph. Author: Nosal A.

Figure 2.
General mechanics and materials strength laboratory. Exemplary elaboration – the current state, ergonomic "ideal" models and explanatory remarks to the design. Aneta Nosal, Sabina Mrowińska, Joanna Kujda, Szymon Mrowiec – fourth year students supervised by D. Winnicka-Jasłowska in the academic year of 2009/2010

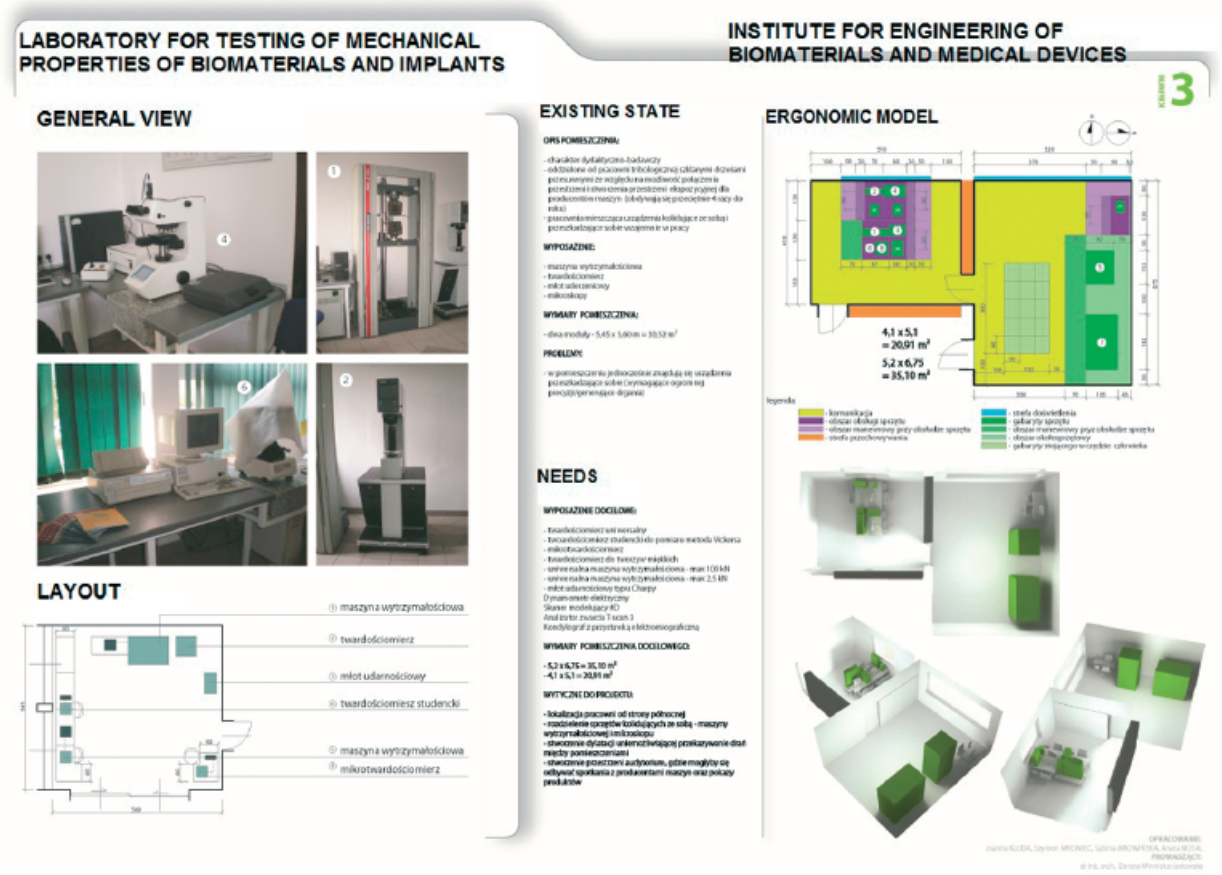

Figure 3.
Strength test work room. Exemplary elaboration – the current state, ergonomic "ideal" models and explanatory remarks to the design. Aneta Nosal, Sabina Mrowińska, Joanna Kujda, Szymon Mrowiec – fourth year students supervised by D. Winnicka-Jasłowska in the academic year of 2009/2010

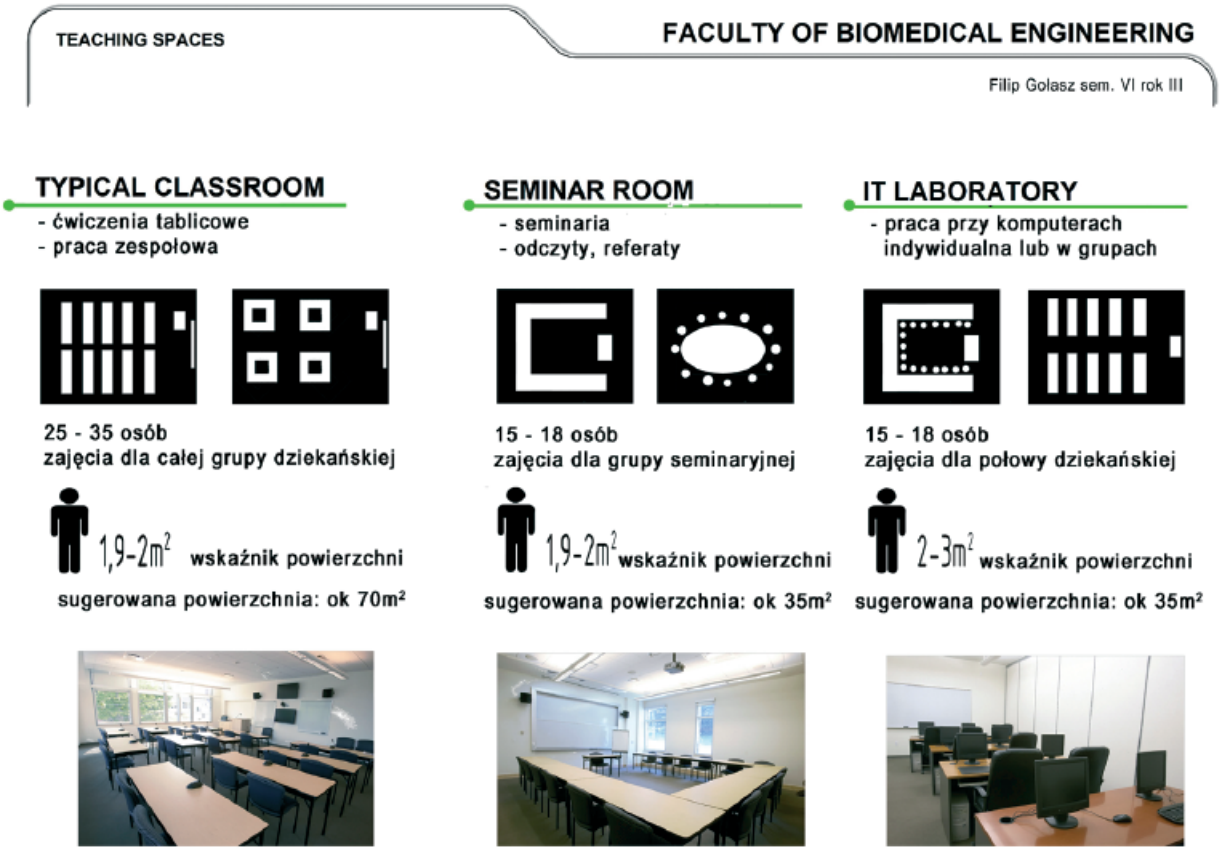

Figure 4.
Analyses of the arrangements of selected types of didactic rooms. Elaborated by Filip Gołasz – third year student supervised by D. Winnicka-Jasłowska in the academic year of 2009/2010

Figure 5.
MSc. thesis – diploma work. Projection of the second floor. Author: Gmytrasz K. Supervised by D. Winnicka-Jasłowska. Silesian University of Technology, Gliwice 2011

Figure 6.
MSc. thesis – diploma work. View of the atrium. Author: Gmytrasz K. Supervised by D. Winnicka-Jasłowska. Silesian University of Technology, Gliwice 2011

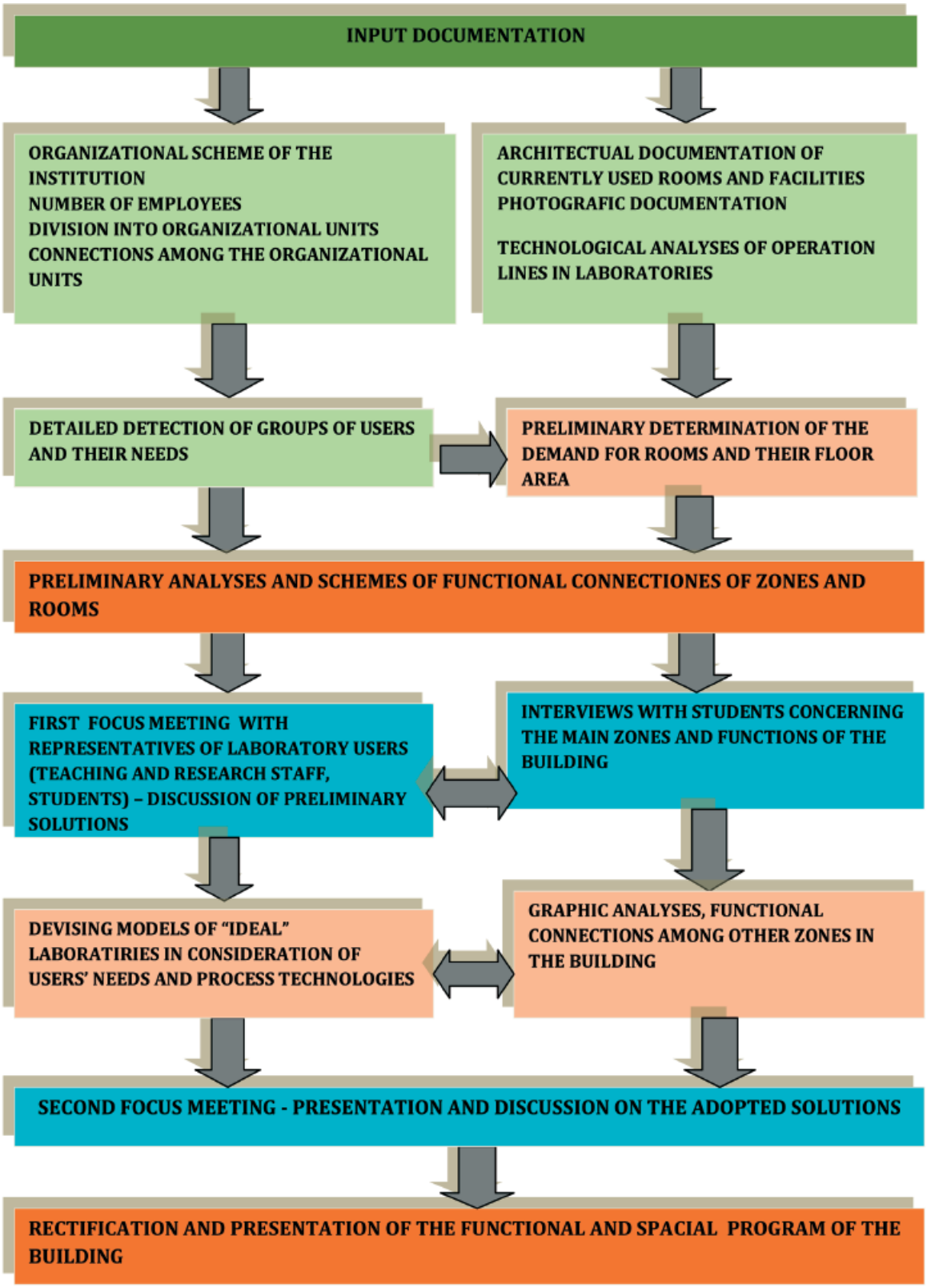

Figure 7
Conceptual diagram of the pre-design analysis. Author: D. Winnicka-Jasłowska

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