International Journal of Engineering Education Vol. 29, No. 3, pp. 740–751, 2013
Printed in Great Britain
0949-149X/91 $3.00+0.00

An Engineering Social Building to Promote Collaborative Learning Practices*

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This paper describes and analyses the perceptions of students of the School of Engineering of Los Andes University (Colombia) regarding the new Mario Laserna (ML) building where an infrastructure of laboratories, halls and spaces has been developed with the purpose of promoting collaborative learning and research practices. The design of this new infrastructure for education in engineering is based on the study of some international examples (which will be succinctly presented) and also on the consideration of the role of space and equipment in teaching and learning practices and upon the desired structure of a modern engineering curriculum. The results presented were obtained through the analysis of a survey of the cohort of students who took courses in the old building (W), built in 1968, as well as in the ML building. The survey especially focused on how the new spaces affected the ways the students work and interact with their peers. In the concluding section, certain hypotheses derived from the results are presented with the intention of promoting further studies.

Keywords: engineering social building; engineering competences; active learning engineering; new learning practices

1. Introduction

In recent decades education has been affected by an increasing trend, not only in engineering, of structuring courses that frequently are specialized, are not very meaningful to the students, and are often unrelated to and disconnected from professional practice. The knowledge, declarative and procedural [1], of experts has influenced the course contents, and it has often been forgotten that the competence for working at a professional level, although based on those course contents, demands other knowledge, skills and thinking processes that are not taught by other course contents. This type of approach has become increasingly inadequate for facing the new and more complex challenges in training engineers [2, 3]. During the last two decades there have been plenty of proposals for remedying this situation through different strategies; these include curricular reforms, launch of transversal projects, project-oriented learning and problem-based learning, new approaches to the laboratories, and new learning spaces [4].

The School of Engineering of Los Andes University, founded in 1948, has consistently set the standard for engineering education in Colombia, especially in regard to new learning methods. Nevertheless, by the late 1990s its training methods were experiencing the aforementioned difficulties. Moreover, the School of Engineering needed to expand the spaces available for its various activities, given the growth in the number of students and staff and the amount of research carried out. By that time there was a geographic dispersal of laboratories and teachers' offices, some of which were several kilometers outside the campus. This prompted an integrated response in 2000, which included development, research, infrastructure, and the provision of extra human resources [5]. The integrated solution was named the Renewal Project for the School of Engineering (PREFI).

The School of Engineering, which by the year 2000 had 5000 students, six departments, and 100 teachers, was located in a building erected in 1968 and intended for 1200 students and 30 teachers distributed in four departments. There were several departments (one floor per department), together with some expanded laboratories in the basements, the larger ones being located in the aforementioned distant locations.

Given this context, and in the framework of a curricular reform that sought to prepare the School of Engineering for the Accreditation Board of Engineering and Technology, ABET, accreditation and to adapt the length of the undergraduate programs to international standards (from a nominal duration of five years to four years), the learning spaces were recognized as an articulating axis for developing professional competences, including students' teamwork [6]. The construction of the new 36 000 m^2 ML building was begun in 2004 and finished in 2007. The intention was to integrate the School's activities, as well as to foster the learning and research processes of the engineering students and teachers, within a collaborative framework. Regarding the courses, the objective was to strengthen project-based learning and hands-on

* Accepted 25 January 2013.

project strategies that intensively used the new spaces, along with formal teaching.

In order to develop the design of the new spaces and its connection to the new teaching and learning processes, different cases presented in the specialized literature were considered, most of them coming from internationally renowned universities: MIT, the University of Colorado at Boulder, Olin College, the École des Mines de Nantes, the Centre of microelectronics Georges Charpak de l'École des Mines de Saint Etienne, and Drexel University [7], as well as the CDIO (Conceive-Design-Implement-Operate) initiative [8], which involves several institutions.

Finally, even though the component related to the new infrastructure was completely developed and fully operational in 2007, the curricular adjustments took the form of modifications to course contents rather than significant changes in teaching methods. This situation enabled the present study to explore the changes perceived by the students in their studying habits resulting from the new learning spaces.

2. Conceptual framework

The School of Engineering mission statement as prepared in the 1990s stated:

> The School of Engineering of Los Andes University exerts leadership in the *formation* given to its undergraduate and graduate students. It carries on *research* of high international visibility that contributes to the development of the country. In order to accomplish this, it has a *faculty* of excellent quality and provides an ideal environment for highly productive work. Its alumni are characterized by the skills they develop to transform society in the technological, economic, social and environmental fields.

Keeping in mind these general guidelines, and based on the aforementioned international examples, in 2000 a group of senior academics started a discussion regarding an integrated reform of the School, taking into consideration the role played by engineers in a globalized world that is increasingly influenced by information and communication technologies.

One of the first stages in this work consisted of an examination of curricular developments that integrated the following factors: flexibility and ease of updating; active learning strategies; laboratories oriented towards the development of abilities on experimentation and design, development of observation and creativity; solid scientific support (including biology); opportunities for international experience for the students; opportunities for teamwork and collaborative work for the students; a focus on the development of skills, attitudes and competences; integrated research; an emphasis on the ethical, social, cultural, economic and environmental dimensions; and articulation with the primary and secondary education (K-12 education) [9].

2.1 International benchmarking

During this stage, the School of Engineering identified certain elite universities with interesting projects, and focused on four (three from the United States and one in Europe) that seemed to address the questions posed by the reforming team. The four institutions selected were: the School of Engineering of the University of Colorado (Boulder, CO), Massachusetts Institute of Technology (Aerospatiale engineering) (Cambridge, MA) and the Franklin W. Olin College of Engineering (Needham, MA), in the United States, and the Chalmers University of Technology in Europe. The aspects of each of these institutions that served as a basis for the design of the ML building are briefly presented in Table 1.

Table 1. Examples of spaces for engineering learning

University	Description of the analysis
School of Engineering, University of Colorado, Boulder (CO USA)	Two different types of infrastructure in this university were thoroughly analyzed: the Integrated Teaching and Learning Laboratory and the Discovery Learning Center [10]. The first one provides the possibility for students to develop designs, and to develop and test prototypes in the laboratory in an interdisciplinary environment of teamwork. The second one seeks to promote the development of critical thinking, problem resolution, and research skills within a frame of collaborative work [11, 12].
MIT (USA)	The most relevant element concerning this university is related to the initiative CDIO [8, 13, 14] (conceiving, designing, implementing and operating engineering projects). The MIT formation model aims to develop the students' knowledge integration skills. Hence, it is expected that ideas for innovation will arise as a result of the exchange of concepts from science and technology, humanities, arts and social sciences, and the academic interests of each student [9].
Chalmers University of Technology	For this university, which developed a center for microelectronic research in 2000, the emphasis was on the characteristics of the auditoriums that facilitated teamwork and the intensive utilization of IT in the courses.
Olin College of Engineering	Two aspects of this university were studied: the academic center and the technological infrastructure. The first one presents an integration of learning laboratories with research laboratories. It includes teamwork spaces in the form of meeting rooms. The second aspect includes a full supply of last-generation devices for using TICs for learning and teaching. The curriculum is based on the triangle made by a solid formation in sciences and engineering, a formation in entrepreneurship, and a formation in arts and humanities. The curriculum is oriented towards innovation and is supported by hands-on activities, as well as by the development of interdisciplinary transversal projects [15].

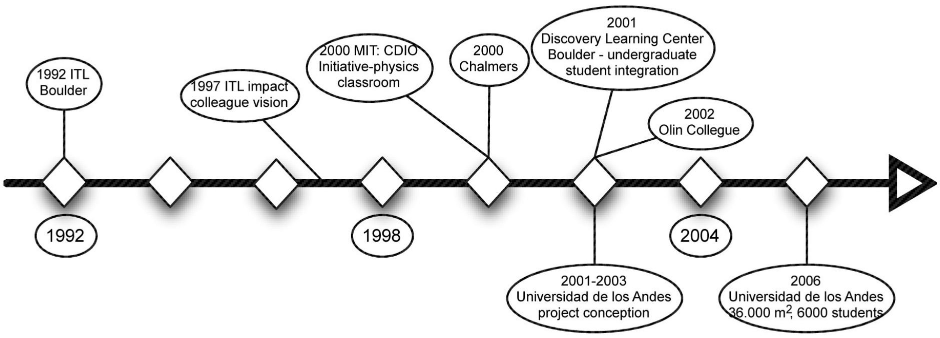

Fig. 1. Chronological path of international references.

Figure 1 presents chronologically the relationship between the projects studied and the reform project for the School of Engineering of Los Andes University.

Table 2 presents the main aspects initially considered in the School of Engineering Reform Project (PREFI).

The teaching of sciences and engineering is increasingly oriented towards the inclusion of active learning strategies [16]. Therefore, engineering departments have made an effort to design and develop more flexible laboratories and classrooms, in which students of every level will have the opportunity to use the technology.

Given the motivations presented in the previous sections, and the learning observed and reviewed in other successful schools of engineering, a group of professors framed their proposal for designing the building on four theoretical pillars in order to create an inclusive building in which the future engineering professionals will develop different competences. These pillars are:

- Active learning and research
- Collaborative learning and research
- Social building
- Building as a learning tool.

These four pillars, which will be described below, seek to develop competences in the professionals, these competences being: the ability to integrate projects in which it is necessary to work with persons from different disciplines; the ability to undertake multidisciplinary research; the ability to work collaboratively to design solutions addressing problems in which the students must design

Fig. 2. ML Building and a computer collaborative facility.

Table 2. Central issues in the reform project (PREFI)

Engineering curriculum	A consideration of the undergraduate and graduate programs, regarding not only the contents but also the search for new competences applicable in an international context, with innovative curricular and methodological approaches.
Research organization	An evolution in the topics of the research, given the context of a country with a medium level of development in a globalized world.
Infrastructure development	A redesign of the physical infrastructure of the laboratories, its supply, and its organization for facilitating the required integration of research, formation, and the increasingly important innovation work in the enterprises.
Human capital management	All of this must be accompanied by an evolution in the management of human resources, in which the formation and incentives policies throughout the professional career must be in line with the purposes of the School in terms of formation, research and transference.

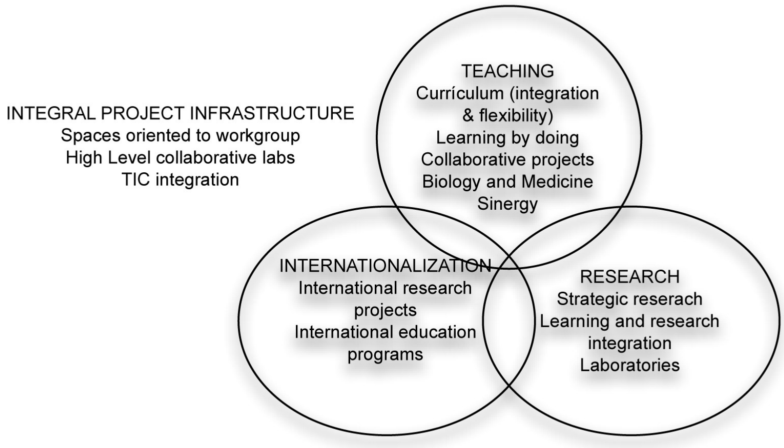

Fig. 3. Conceptual curriculum design.

experiments with multidisciplinary teams, carry out independent research, and learn how to interact with different disciplines and how to communicate effectively [17–20].

2.2 Curriculum structure

Figure 3 illustrates the basic elements that were taken into account in the first conceptual approach to the process of curricular reform.

The undergraduate and graduate programs are oriented towards a greater capability for integration, both transversally (between engineering disciplines) and vertically (between undergraduate and graduate programs, formation and research). The main interests in this project are: the strengthening of teamwork ability; communication; the conception and achievement of projects; an innovative attitude, and international contextualization. To that end, several structural reforms for the curricula were proposed, all of this being within the framework of a significant investment in the physical infrastructure and in laboratories, as well as in the academic formation of the faculty and training for teaching.

Figure 4 shows the major components proposed for the new engineering curricula whose estimated number of credits is 136 (a credit in Colombia corresponds, on average, for undergraduate programs, to 15 hours of work with the professor and 30 hours of independent work). The articulation with the Master's degree and the presence of project activities with research groups is also highly relevant.

2.3 Active and collaborative learning and research

A central concept used in this dimension is that of "collaboratories". This concept was initially proposed in 1989 by Professor William Wulf of the University of Virginia [21].

Active and collaborative learning and research is a form of generating challenges for students and faculty, so as to encourage them to think, analyze,

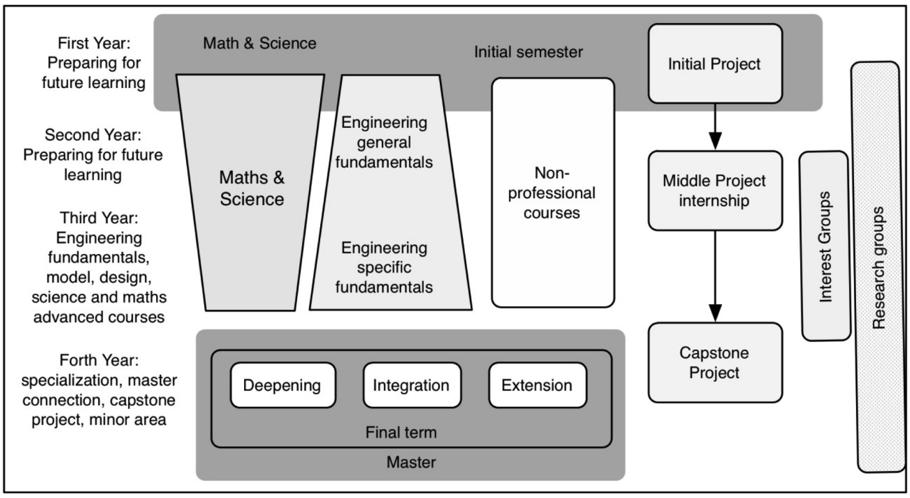

Fig. 4. Curriculum: conceptual structure.

synthesize, and evaluate by means of sufficiently complex activities so that the desired construction of knowledge will be attained [22] and be close to the real context of apprentices and researchers [23]. Active learning activities are directly associated with the solving of real problems in real contexts [24]; based on the work performed in laboratories, simulations and role-playing, all of these put into practice what has been learned [25]. "Conversely to what is sometimes affirmed, active learning is not a methodology, nor a theory or a didactic practice, it is rather a reflexive and critical practice in which the important is not what is done by the teacher, but what the student does for learning" [26]. Active learning is, as a matter of fact, a tautology, as learning implies activity. Thus, it was not a matter of rejecting what had been done up to that moment without further thought, but rather of promoting didactic activities and strategies that fitted the new objectives being pursued.

As for the effectiveness of the "collaboration" in any type of project, it is desirable to develop communication competences among the different members that allow them to use teamwork that leads them to obtain successful results by working on projects [24].

2.4 Social building

A social building is an edifice oriented to teamwork and informal communication. From its architectonic conception, the building must support the development of collaborative and interdisciplinary activities. In practice, this implies research spaces for multidisciplinary groups, workshops that enable cooperative work on projects, group work rooms, informal spaces (broad corridors, lounges, terraces, etc.) that allow and invite interaction between visitors to the building, and the reduction of closed spaces represented by administrative offices [27].

2.5 Building as a learning tool (BLT)

It is intended that the building itself will become a laboratory and an example of engineering. To that end many of its systems must be open for observation and, if possible, to surveillance tasks. The transparency of specialized laboratories and of the spaces destined for research – allowing visibility of the development of the activities that take place there, in the manner of a theatre stage – is compatible with the building being a learning tool. In an edifice with these characteristics the learning and teaching processes surpass the limits of the classroom, or the laboratory, and they take place all the time, everywhere [27].

3. Building conception

3.1 General characteristics of the design

Based on the conceptual guidelines presented in the previous section, the challenge was to design an infrastructure that could comply with the development of new spaces that facilitate the use of new teaching techniques and new ways of approaching the contents of the courses: a higher level of integration between the research and the teaching in the undergraduate and graduate programs; greater interaction between fields of study in the experimental work; an effort in the self-sustainability of the building as part of the students' learning process; a development of the building as an active learning laboratory; and a greater interaction with primary and secondary education.

The new building, designed in accordance with these guidelines, includes the General Library, an auditorium for 700 persons, computer rooms for general purposes, the School of Engineering with its laboratories and offices, as well as public spaces containing fast food stores and car parks. The entrance hall (Fig. 5) is a prominent area with 600 m^2 of space for the staging of exhibitions and events, the function of which, besides the obvious ones of access and reception, is to be a nodal point, a converging point of the horizontal and vertical circulations that take place within the building, a space for discussion and exchange; it is where the daily and the exceptional events of the building are to take place.

Los Andes University intended to introduce into the ML building the latest trends in architecture, learning, teaching, and research. Within the ML building project, the design of the integration of the University General Library became a significant contribution to the production of an integral environment of observation, conception of new propo-

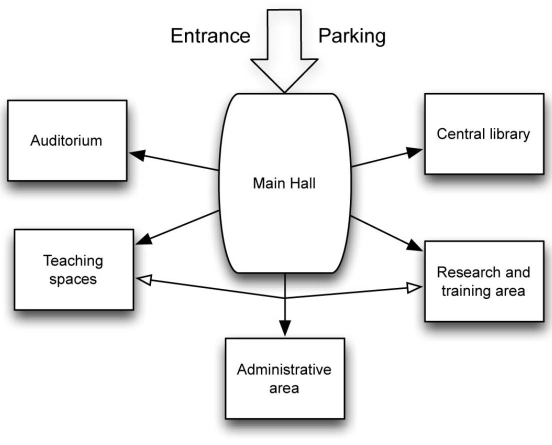

Fig. 5. The ML entrance hall as a connecting point between areas.

sals, and continuous learning. Additionally, through the inclusion of multiple disciplines (art, social science, and humanities), it is intended to promote interdisciplinary activity.

3.2 Teaching spaces

Table 3 summarizes the new spaces of the ML building destined for teaching and learning and the spaces' characteristics.

A main aspect of these spaces is the promotion of encounters and the work of students from different engineering programs by strategically locating the different laboratories.

Additionally, "casual" spaces intertwined with the co-laboratories were proposed. These casual spaces have couches, tables, and "rolling" boards that support communication among the students (these spaces, along with the dining hall and terraces, amount to 600 m^2 of social building space).

3.3 Collaborative laboratory spaces

Apart from the traditional engineering laboratories, which are equipped with the latest technology, spaces were designed with a particular potential for generating collaboration between students from different departments and schools of the University. Below, we describe some of the spaces of the laboratories that represent a competitive advantage in the ML.

The purpose of integrating in the new building all the existing supporting research facilities of the School of Engineering, along with the decision to create a set of seven world-class engineering co-laboratories, posed a highly complex challenge in terms of the design of space, capacity and locations for these facilities, especially because of the requirement that research should be an integral part of the formation of an engineer.

The integration of the collaborative concept into the design had the purpose of explicitly stressing the importance of the collaborative work among the faculty members of different engineering disciplines, and to make it a referent throughout the student formation process. Thus, we have the Fluids collaborative (wind tunnel and instrumented hydraulic channels), the Micro-Nanotechnology collaborative (clean room and microscopy), the COLIVRÍ collaborative (immersive visualization, human–machine interaction and robotics), the Soil-Structure collaborative (vibrating tables, centrifuge, and isolated plate), the Communications collaborative (anechoic chamber and connectivity), and the Biomedical collaborative (cardiovascular dynamics, tissues and electrophysiology).

These co-laboratories, along with the 15 already existing laboratories, the group work wings, and the floor-workshop (microelectronics and mechanics facilities and active work rooms) facilitate the implementation of high performance engineering projects in which the School wishes to focus its research activity. In these locations basic and applied research projects take place, as well as research formation projects with undergraduate and graduate students.

One objective of the spatial location of these co-laboratories is to ensure their visibility for all the residents and the visitors to the engineering building.

4. Methodology and research and results

To investigate and characterize the perceptions of engineering students regarding the way in which the design and spatial disposition of the new ML building influences certain aspects of their learning strategies, particularly group work, a survey was conducted in May and July 2010, three and a half

Table 3. Learning spaces

Type	Characteristics
Classrooms/ laboratories for active and collaborative learning	Ten classrooms that are flexible in terms of disposition and organization. They will have a permanent supply of energy, water, compressed air, and data network for facilitating laboratory work in classes. The aim is to promote hands-on learning, learning by doing, and teamwork activities around engineering projects.
Active learning workshop	Comprising ten hexagonal work points, each with three work spaces for three students with a permanent supply of energy, water, compressed air, and data network, which allow the testing of prototypes designed and developed in other areas, which are placed on each side of the work point. Likewise, it allows the carrying-out of hands-on activities.
Workshop–Halls for construction of light prototypes (mechanics/ electronics)	The main characteristics are the accessibility and the visibility of the facilities for the construction of prototypes, both for their mechanical and their electronic parts and software, as well as for analyzing and testing.
Informatics workshop–Halls for engineering.	The main characteristic is the equipment designed for work groups. An open workshop for machining and stereo lithography printed circuit boards and integrated tests.
Classrooms for teaching programming	Microcomputers are installed in front of a screen controlled by the professor's computer. Students may initially follow the exposition of the professor and, afterwards, carry out their own exercises without leaving their places.

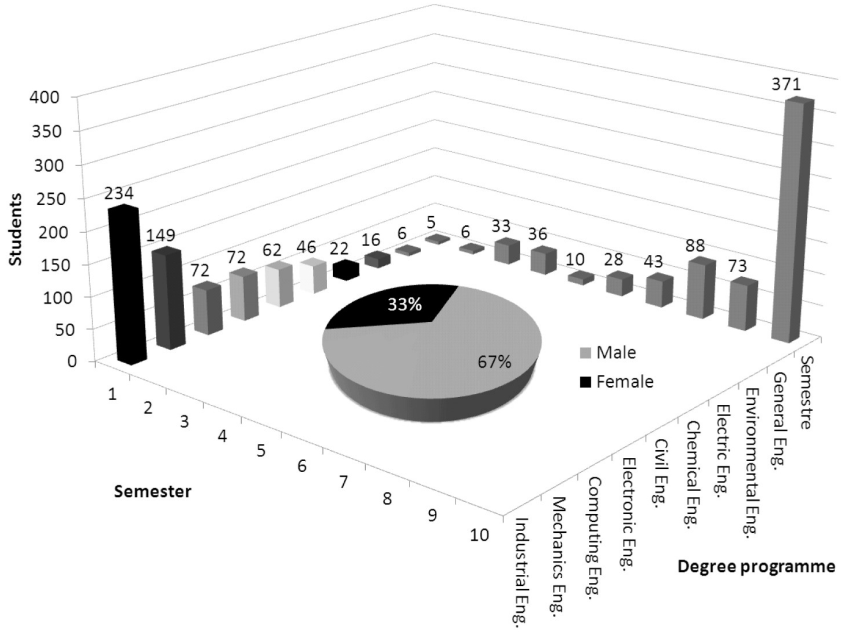

Fig. 6. Distribution of students surveyed by gender, program and semester.

years after the inauguration of the building. For the population sample, we identified the undergraduate and graduate students who had a high probability of having worked both in the old building (named W) and in the ML building. A total of 2860 undergraduate and graduate students were surveyed, but only 1082 answered the survey. From these, only 3% did not use both buildings because they had different study trajectories.

The survey was organized around open and closed questions that attempted to find out whether the ML building promotes and has the resources required for group work. An emphasis was placed on spaces such as the library, the classrooms, the cubicles located in the basement, and the dining hall. Furthermore, it was asked whether the ML building stimulated a greater interaction with students from other disciplines of the School of Engineering and of other Schools as well. An evaluation scale was used for the answers in which A meant "Completely agree", E "Completely disagree", and F "I don't have enough information for answering". This survey was developed through work with focus groups of students.

The main findings of the survey are presented below. Owing to the low rate of answers for the open questions, a special emphasis was given to the closed questions.

4.1 Activities carried out in the W and in the ML

Figure 7 shows the modification in the type of activities carried out by the students in the W building in relation to those they carry out in the ML building. There is evidently a displacement

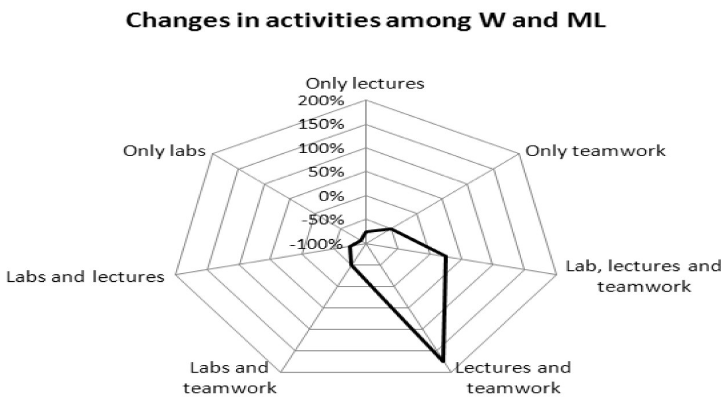

Fig. 7. Percentage change between the activities reported by the students in buildings W and ML.

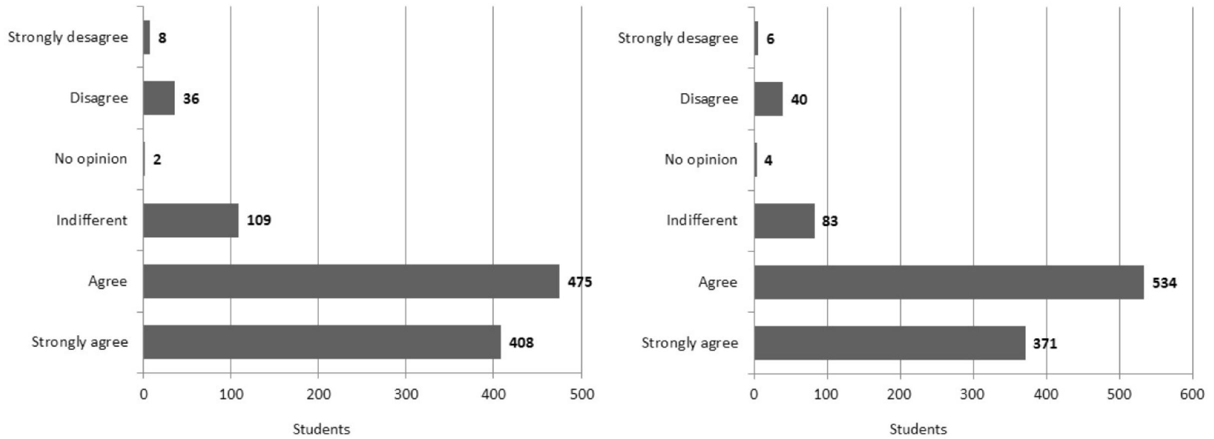

Fig. 8. (Left) The ML building (new) promotes the implementation of group work activities. (Right) The ML building provides the facilities required for group work.

from activities that lacked group work to activities that include group work; this verifies the premise's suitability in relation to the increase in group work.

In general, students mention teamwork when they describe what changed between the old and new building.

4.2 Group work

When asked whether they considered that "the Mario Laserna building promotes the development of groupwork activities", 81.6% of the students replied that they partly agreed or completely agreed with this statement. This means not only that the activities undertaken are more oriented to group work, but also that the building itself promotes these activities (Fig. 7).

Moreover, when asked whether "the Mario Laserna building has provided the resources necessary for group work", 83.8% of the students partly agreed or completely agreed with this statement (Fig. 8). It can therefore be inferred that the facilities and spaces of the ML building are favorable for groupwork. 195 students are indifferent to the changes in the building with regard to promoting groupwork.

4.3 Use of specific spaces

In general, the spaces are used, but their rate of use varies according to the type of students. A detailed examination of the use of the specific locations for group work shows that they are also disparities in their frequency of use (Fig. 9).

Evidently, spaces such as the library rooms, the dining hall, and the tables in the circulation spaces are clearly identified by most students as being work spaces. In contrast, the places that imply the need to do more structured work, and that need to be reserved several weeks ahead, are less often identified by the students as work spaces. It is important to notice that there are only a few project rooms and they are destined for the projects for which this facility is requested, being assigned for the whole semester to a few students (Fig. 9).

4.4 Interaction between the engineering students and students from other disciplines

This section explores whether the ML building actually accomplishes its objective of promoting the interaction among students from different branches of engineering. Figure 10 shows a clear tendency for a positive answer, even though it is not a conclusive result. A possible explanation is that this interaction must also be promoted by the work demanded by the professors, and given that there have not been significant changes, particularly regarding the promotion of this type of work, these results appear to be logical.

If the question asked is in regard to students from programs outside of the School of Engineering, the number of positive answers decreases when compared with the previous question. Nevertheless, there is still an increase of interaction when com-

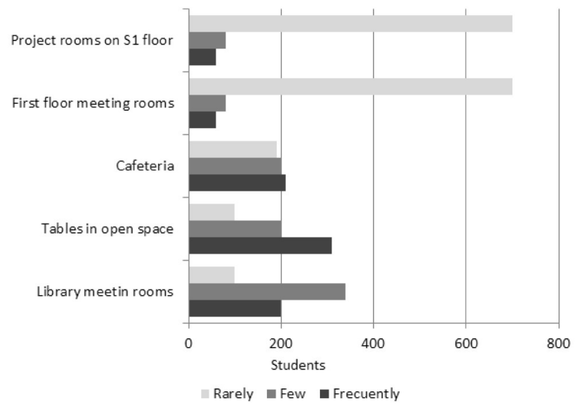

Fig. 9. Frequency of utilization of the spaces of the ML building for group work and study activities.

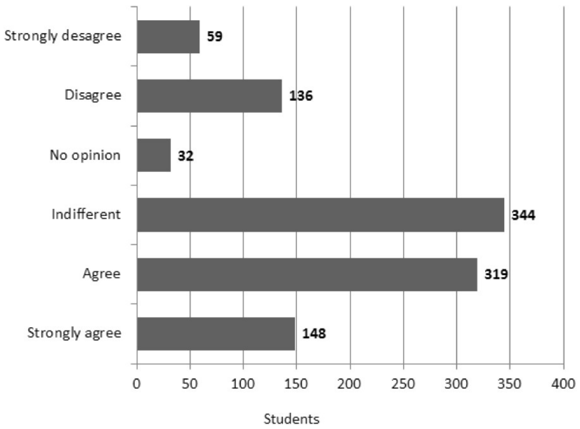

Fig. 10. With regard to the academic activities that take place outside the classroom, the ML building promotes the development of activities/projects/practices with students from other engineering programs.

pared with the interaction in the W building (Fig. 10). Regardless of the lower interaction level with students from other Schools, the students acknowledge the importance of this relation; therefore, it is not possible to ascribe this fact to ignorance or indifference. This finding reinforces the hypothesis that the interaction with students from other disciplines might have a strong causal relation with what is proposed in the curriculum (Fig. 11(right)).

4.5 The building as a study object

Among the design premises was the intention that the building itself should serve as a laboratory. Two questions in the survey addressed this subject. The results displayed in Fig. 12 shows that a significant number of students (43%) believe that the building has indeed been used for this purpose. A possible explanation of the fact that most students have not used the building as a laboratory could be that many courses have not proposed activities that promote this approach.

Figure 13 shows that indeed there is an important relationship between the activities proposed in the courses and the effective utilization of the building as a study resource; 32% of the students acknowledge that the subject has been considered in class.

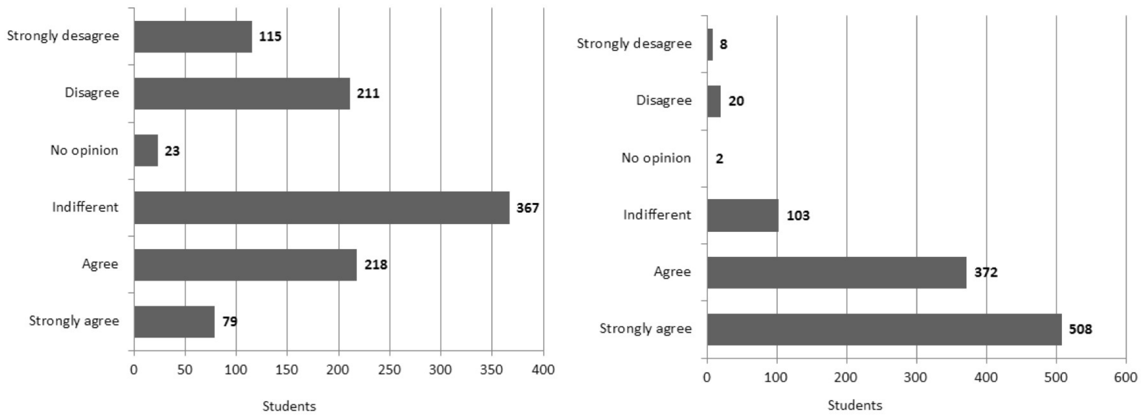

Fig. 11. (Left) Since the inauguration of the ML building, I interact more than before with students from careers outside the School of Engineering. (Right) For my development as an engineer it is important to keep in contact with students from other disciplines.

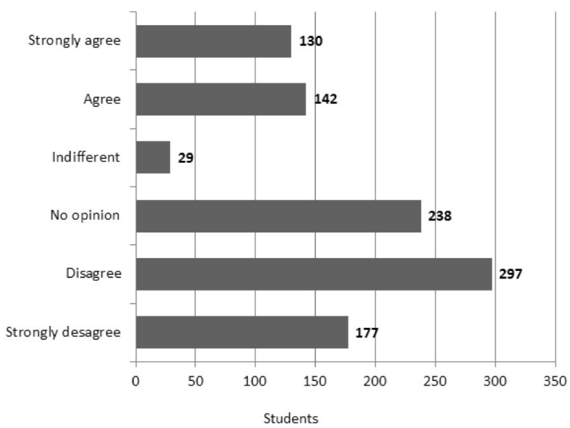

Fig. 12. As an engineering student I have used the structure and design of the ML building for approaching specific concepts or subjects of my field of study.

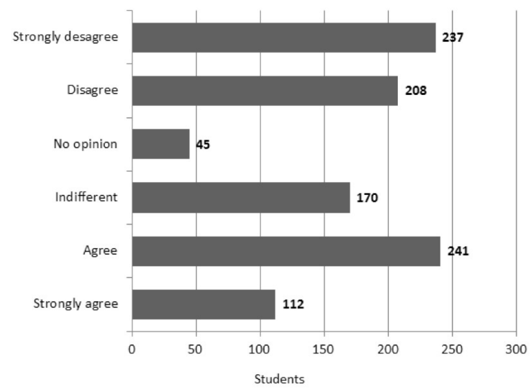

Fig. 13. I have participated in classes where the structure and design of the building have been used to approach a specific concept or subject of my field of study.

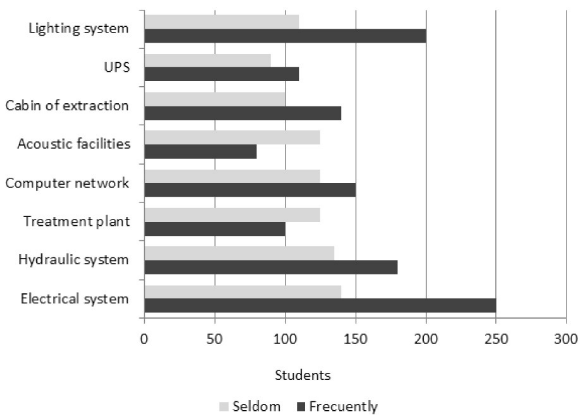

Fig. 14. Which of the following systems in the ML building have been used as learning tools in your engineering formation?

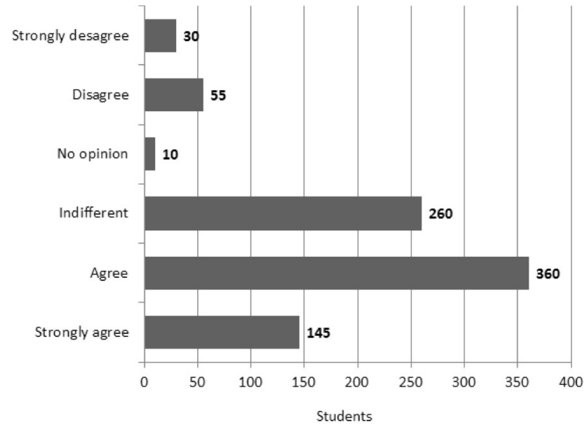

Fig. 16. The ML building has changed significantly the manner in which I learn engineering.

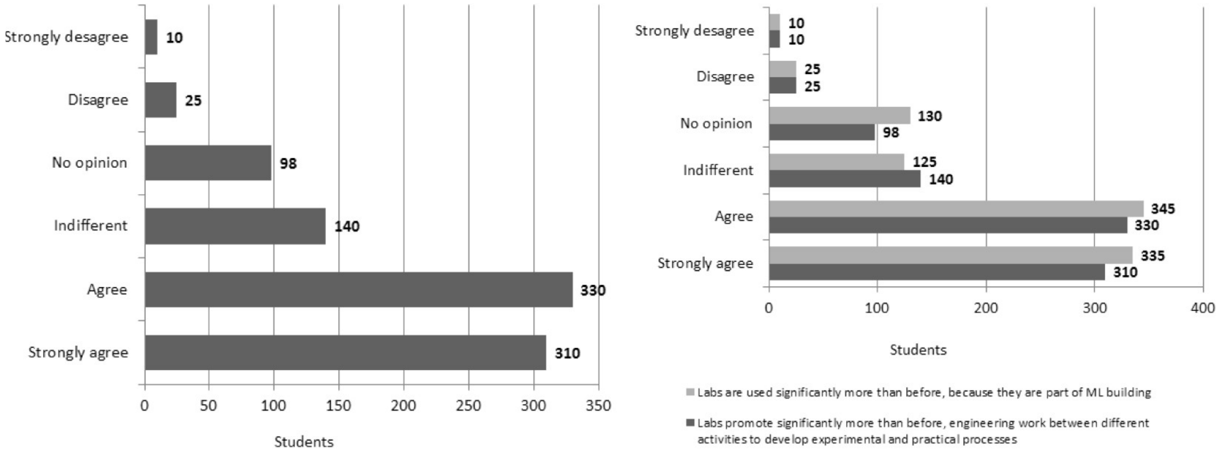

Fig. 15. (Left) The laboratories promote, significantly more than before, work between different branches of engineering undertaking experimental and practical activities and processes. (Right) The laboratories are being used in the ML building significantly more than those in the W building were used.

For those who answered that they use the building as a study resource, Figure 14 shows the elements that were taken into account:

4.6 Laboratories

Another objective of the conceptual design of the building focused on the engineering laboratories. The above graphs illustrate the perception of the students in this regard. In general, it is perceived to be a greater use of the laboratories. Some questions, the responses to which are not reported in this paper, confirm the greater use of the laboratories. Overall, the change in infrastructure and equipment between the W and the ML buildings is undoubtedly vast; this should promote more laboratory practices, and this indeed seems to be the case.

4.7 Engineering learning

The survey included two questions about perceptions of change related to the manner in which engineering is learned. Figure 16 illustrates the answer to one of the questions, showing that the students do perceive a change in the way they learn engineering. However, the survey results do not allow us to identify this change in detail. The new building changed the way students learned engineering: the principal reason is that now they know that they can work in activities with other engineering students and with other university students.

5. Discussions

There has been a major reform regarding the spaces dedicated to the processes of engineering teaching, learning, and research (36 000 m^2 in which 600 students and 150 faculty members carry out their activities, within a university campus of 90 000 m^2). The principal objective was to promote collaborative learning practice. Some of the data perception in Table 4 is an approximation of evidence of that.

The objectives that drove the design were assessed through the perception of the students by using tools such as surveys on the cohort of students

Table 4. Relationship between key question and perception results

The new building promotes group work activities.	81,6% of students agree and strongly agree.
The new building promotes activities with students of other programs.	78% of students not are disagree with this affirmation.
The engineering students interact more with students from careers outside of the Engineering School.	65% of the students not are disagree with this affirmation.

who experienced the change of locations. Based on the analysis of their perceptions, we conclude that:

1. The new spaces and facilities contribute to modifying the way in which the students work in activities not directly related to the intended development of a curriculum.
2. As could be expected, there is a significant increase in the activities that involve group work and a decrease in the activities that do not include this type of work. From this perspective, it is possible to establish that the students consider that the group work has increased, as well as the need and potential for working together with students from other branches of engineering.
3. In the aspects in which it is expected that the curriculum has a strong impact, the effect is considerably reduced. This conclusion may be approached from a different perspective: in order to make the most out of the new spaces and resources with a pedagogic intention, it is necessary to harmonize the curriculum with the general intention of reforming it.

Also, there were some limitations that should be seen as opportunities for a further research, such as:

- Detailed research was done with students. It would be very valuable to extend it to faculty members, researchers, and other general users of the facilities of the building (companies, government, other universities).
- It would be enlightening to analyze other impact factors related to the level of the students in the building (compared with historic indicators).

6. Conclusions

The greatest design challenge of this project was to create a close relationship between an academic project of the University and the functional and physical characteristics of a building. The main lessons learned and challenges are related to key factors, such as detailed investigation of similar projects abroad and how these have influenced the performance of the students, professors and researchers. It is important to point out that another lessons learned were that the creativity and the innovation in the integration of a curriculum are pertinent to the national reality with a physical location. In this kind of project it is relevant to integrate the creativity and the innovation with a curriculum with opportunities for co-creation with other engineering schools.

To sum up, this project continues to be a possibility for permanently re-thinking and re-evaluating the actions of the students and professors who can develop high impact projects for society.

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