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RESTRUCTURING PROCESS OF THE ACADEMIC DEPARTMENTS OF UNIMET'S SCHOOL OF ENGINEERING.

RESTRUCTURING PROCESS OF THE ACADEMIC DEPARTMENTS OF THE ENGINEERING FACULTY OF UNIMET.

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Summary

This paper presents the results of an investigation carried out at the Universidad Metropolitana in which the existing structure of the academic departments is reviewed and an improved and forward-looking organizational structure is proposed. It is understood that since these units are the spaces where the university's academic and technical human capital is housed, they are responsible for research, teaching and services. This research was based on two aspects: (a) the state of the art of the future of engineering and the structure of universities in Venezuela and the world; (b) understanding what is expected of engineering in the future in order for Unimet to prepare for these proposals. Areas of interest were identified or disciplines, which were then prioritized using the *Analytic Hierarchy Process (AHP)* according to the relative importance of each one in the School of Engineering and, based on the results, a viable proposal was generated for implementation. The research turned into a project and was successfully implemented a year ago.

Key words: academic departments, engineering, research.

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Abstract

This paper presents the results of an investigation carried out in the Universidad Metropolitana to review of the existing struc- ture and the proposal of a new, improved organizational structure, with a vision of the future of the academic departments, understanding that, being these units where the academic and technical human capital of the university is housed, the responssibility of research, teaching and services rests on them. The research was based on two aspects that included the state of the art of the future of engineering and the structure of universities in Venezuela and the world in order to understand what is expected of engineering in the future and allow Unimet to prepare for those proposals. Areas of interest or disciplines were identified that were later prioritized using Analytic Hierarchy Process (AHP) according to the relative importance that each has in the Faculty of Engineering and, based on the results, the proposal was ge- nerated viable to implant. The research converted into a project was successfully implemented a year ago.

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Background

The operation of the curricula of the Universidad Metropolitana (Unimet) is supported by the schools and departments academic. The school administrations are responsible for maintaining these plans in force for the undergraduate programs in order to guarantee their successful completion by the students. The academic departments ensure that the quarterly execution of the curricula is achieved with the support of the teaching staff, research and services to third parties.

Following the guidelines of continuous revision that have characterized Unimet, it is necessary to study the existing structure of the academic departments of the School of Engineering in order to improve research rates. This can be achieved by promoting the formation of research groups, facilitating the interaction of professors from different areas related to each other and promoting a more harmonious tone in this relationship in terms of services to external entities; all this will contribute to improve the academy and, as a consequence, the operability of the departments.

Unimet has five academic departments: Processes and Systems (PS), Energy (EN), Technology Management (GT), Construction Sciences and Techniques (CTC) and Environmental Studies (EA).

The research will be based on two pillars: the organization of other universities in the area of Engineering, and the projections made by experts on the future of Engineering in the world.

Unimet's School of Engineering in numbers

Unimet's School of Engineering has a total of 2,100 students enrolled in six degree programs: Chemical Engineering, Electrical Engineering, Systems Engineering, Mechanical Engineering, Production Engineering and Civil Engineering, with programs that include a total of 107 undergraduate courses distributed among the five departments mentioned above.

The academic departments coordinate the courses of two master's degree programs and six postgraduate diploma and specialization programs. The graduate programs have a total of 25 courses as shown in Table 1.

Professors may be part-time (PT) or full-time (FT) and each one administratively belongs to a department, although they may assist in subjects of any department of the university.

Table 1. Number of subjects and full-time and part-time professors.
Faculty of Engineering of Unimet.

Current Academic Department	Total undergraduate courses	Total graduate courses	TP Teachers Undergraduate 1617-2	Teachers TC Undergraduate 1617-2	TP Teachers Postgraduate 1617-2
GT	20	11	12	3	5
EN	25	0	13	3	0
SP	29	13	21	3	9
EA	6	1	2	2	1
CTC	27	0	26	2	0
Totals	107	25	74	13	15

Development of the Restructuring Project

The research project to evaluate the current structure of the academic departments of the School of Engineering was developed in five stages based on the following pillars:

1) An investigation into the future of engineering according to publications by experts and organizations that study the field projected into the future.

2) A study of the organizational structure in areas associated with engineering in at least 15 universities in Venezuela and in the rest of the world, as well as theworld. In this phase, organizational charts and information contained in official websites were reviewed and universities in Peru and Colombia were visited. In addition, organizations, institutions and research areas associated with engineering at the universities consulted were also evaluated during this stage.

3) Selection of areas of interest obtained in the previous stages relevant to Unimet. In work sessions with the participation of professors from each career, the list of areas of interest detected in stages 1 and 2 was evaluated and, with the use of a decision tool, the opinion of experts was integrated, the relative importance of each discipline was determined and ranked by importance.

4) Elaboration of a new restructuring proposal based on the fundamental axes of the results obtained: the characteristics of the structure of the Faculty of Engineering in other universities of the world and the outstanding aspects highlighted by the experts on the future of the subject; all this to achieve the improvement of the efficiency of the academic departments of the Faculty of Engineering of Unimet in the aspects of teaching, research and services to third parties.

5) Evaluation of the effect that the relocation of professors, subjects and lines of research would have on the proposed academic departments.

The guiding guidelines for the departmental restructuring project and its results, which should be reflected in the departmental reorganization proposals, are as follows:

- The new concepts of the Engineering of the future that should open the doors to promote the Engineering of the future from Unimet in Venezuela and the world.
- The new structure must:
    - Be in accordance with Unimet's mission, vision and core values.
    - Promote the formation of multidisciplinary teams.
    - To allow new engineering concepts to permeate within the lines of research, the existing subject programs and the academic staff of the School of Engineering.
    - Improve the operation of the activities of the academic departments.
    - Optimize the location of subjects, professors and research lines in order to improve the operability of the academic departments.

The future of engineering

A review was made of documents published by experts, organizations and associations proposing discussions on what the future holds for engineering.

In the review of publications on the future of the area and of engineering education projected towards 2020, 2025 and 2030, the aim is to detect the future that experts foresee and for which it is necessary to prepare, as well as the ideas that stand out in this vision of the future. Then, based on the analysis of the environment of Unimet and the community, the lines of research, careers and academic programs, we propose the modifications that may be discovered to refocus, if necessary, the current structure of the academic departments.

This review will make it possible to identify weaknesses and strengths of Unimet's current situation, based on the need to prepare students so that when they enter the job market they are able to adapt to an increasingly globalized environment, with clear differences between developed and developing countries, which also have important differential nuances by location, diosyncrasy, geopolitical situations and many other aspects, which is not an easy task. It is even more difficult to imagine that Unimet graduates must prepare themselves for labor demands that are much greater than those seen in the environment, but there are countless

publications that help to understand what people and organizations think about that future in order to find ways to face it successfully.

What should be the structure of the academic departments, which are responsible for preparing the graduates of the future, and how can the impact on the organization of academic departments have an impact on research and, consequently, on teaching? The answer is that it is not only the academic departments that guarantee the success of the graduates, but the university as a whole: the Faculty of Engineering with its professors, trainers, department heads, school directors, assistants and technicians; it is with all this potential that Unimet graduates are valued as professionals of the highest quality, both in Venezuela and abroad. As the academic departments house professors, technicians, laboratories and with them, research and services, to the extent that intellectual production improves, teaching is kept up to date and therefore optimized. From the organizational point of view, the structure of the academic departments should serve as a promoter to match the interests of the university and those of the professors in order to favor research.

According to Rossen (2012), engineering is constantly changing, and therefore, engineering education must also remain in a continuous transformation.

According to a 2010 Unesco report, engineering "is the field or discipline, practice, profession and art concerned with the development, acquisition and application of mathematical, technical or scientific knowledge to understand, design, develop, invent, innovate and use materials, machines, structures, systems and processes for a specific purpose".

The authors presented below emphasize the importance of the subject in solving problems that, according to the new approach, are no longer exclusively technical, but have an important humanistic component. Rugarcia *et al.* (2000) state that engineers will face great challenges in the future, because they have a very high responsibility for the development and satisfaction of the needs of human beings and society in general.

According to Coates (2015), the study of expert proposals on the future of engineering highlights the role of the field in the development of third world countries, which face even greater challenges than those that arose before the industrial revolution and which, to be able to achieve them, need to strengthen multidisciplinary capabilities.

In this perspective, the concept of sustainability, which appears in most of the documents reviewed, also stands out. Rosen (2016), Coates (2015), Jacobs in an interview with Kanani (2015), and NAE (2015), among others, understand it as the massification of solutions to human needs without destroying the environment; these needs are: decent housing, continuous drinking water, clothing, communications in different dimensions (public transportation, roads, digital communications) and balanced and affordable food.

In this review of the state of the art, the importance that the authors attach to multidisciplinary work as an important tool to face the challenges of the future was detected with much satisfaction. The development of activities of this nature is part of the guiding values of Unimet.

Organizational structure of Venezuelan and international engineering schools

During the research process, a document review was carried out, complemented with visits to higher education institutions, to learn about the organizational structure of the Faculty of Engineering at those sites in the country and abroad. We worked on the basis of the topic in three Venezuelan universities, five South American universities, four in the United States, one in Australia and one in Spain, in order to identify opportunities for improvement that could be replicated at Unimet.

All the information was obtained from the official websites of each of the universities, except for two, one in Colombia and one in Peru, which were visited and whose structural characteristics were obtained from interviews with deans and assistants at those institutions.

The study highlights that in 35.71% of the cases, the academic departments are attached to the undergraduate programs or careers and there are no academic departments that attend to several careers. In 42.86% of the cases studied, there is an academic department per school or engineering program, but in addition, there are multidisciplinary academic departments by areas of interest and research centers associated with the degree programs. The rest of the cases only contemplate academic departments by areas of interest or development that provide services to different careers. The latter is the case of the Universidad Metropolitana, where the academic departments provide multidisciplinary services to the undergraduate programs (careers).

It should also be noted that in more than 80% of the universities surveyed, the academic departments of basic sciences are attached to the Faculty of Engineering.

This review has been useful in identifying areas of interest of the main universities, particularly in terms of centers and research departments. Of course, each institution of higher learning demonstrates institutional interest in developing certain areas. The authors' interest has been to identify those common areas that were detected in several institutions.

Selection of development areas

Given the interesting findings in the publications analyzed previously and in the organizational structures of other universities and, understanding that it is necessary to identify the areas of development or common disciplines that stand out in both sources of information, which could become the basis for internal discussion for the definition of the scope of the academic departments that will form the new structure, the list of the identified areas of interest was discussed in group sessions and submitted for discussion among the academic managers and professors of the School of Engineering.

The working sessions consisted of multidisciplinary face-to-face meetings of professors, researchers and academic managers of the School of Engineering, from which a preliminary list of 23 disciplines or areas of development was drawn up, as shown below:

1. Technology
2. Systems
3. Food
4. Manufacturing
5. Engineering Projects
6. Energy and Alternative Energies
7. Environment / Sustainability
8. Processes
9. Construction
10. Materials
11. Industrial production
12. Robotics
13. Control and automation
14. Biomedical
15. Structures
16. Oil and Gas
17. Communications
18. 3D World
19. Technology management
20. Energetics
21. Environmental studies
Processes and Systems
23. Construction sciences and techniques

Once the preliminary list of 23 disciplines as the predominant areas of development was constructed, work sessions were held to filter, group, evaluate and establish those subjects that could be used for the proposed restructuring of the academic departments.

Development of the proposals of restructuring of the departments

Based on the list of 23 preliminary disciplines, which served as a starting point for the discussion, concepts, dimensions of the disciplines were studied, the environment and capabilities of Unimet were assessed, grouped by similarity and the list was reduced to 10 groups of areas of interest or development. Namely:

1. Energy + Gas + Oil
2. Industrial Production + Manufacturing + Design + Design + 3D Printing + Materials
3. Environment + sustainability
4. Project Management + Innovation and Development
5. Information systems
6. Maintenance

7. Food
8. Processes
9. Habitat + Construction + Structures
10. Control + Automation + Robotics + Telecommunications

Once the definition stage has been completed and it is understood that the In order to determine the relative importance of areas of interest in the future development of the Faculty of Engineering, the *AHP* tool was used as a decision technique to determine the relative importance of areas of interest in the future development of the Faculty of Engineering.

Definition of the relative importance of the disciplines to each other in order to project Engineering at Unimet into the future

The use of multi-criteria multi-expert decision making techniques in real problems in which it is desired to identify, based on the appropriate criteria, the relevance of each alternative to achieve a given objective is well documented in the literature. In the present research work, during this stage it is necessary to determine the relative importance of each area of development or discipline pre-established in the list of 10, in order to identify whether, according to the experts participating in the decision process, it is necessary to eliminate any group because they consider it to be irrelevant.

The *AHP* technique allows structuring the decision problem as an objective to be achieved, decision criteria and alternatives, which in the case of this work are the 10 groups pre-established as development areas. The objective of the decision problem is: "To determine whether the topics to be developed (areas of interest or disciplines) will consolidate the Faculty of Engineering to project itself into the future".

The decision bases to be defined are:

- Promotes academic development
- Facilitates services to third parties
- It is multidisciplinary
- Promotes Unimet with recognized academic activity
- Promotes research
- Promotes the insertion of subjects and professors
- Promotes the strengthening of the university as a vanguard university
- Operational balance

Once the 10 disciplines or areas of development and the eight decision bases were established, a hierarchical model for the decision was established which, applying the *AHP* technique, will determine the relevance that each group of disciplines has for the Faculty of Engineering of Unimet.

The eight decision bases were grouped into three decision criteria that comprise the entire basis for the *AHP* model, for simplicity and to ensure consistency in the results. Once the decision model was established and tested, each participant in the decision was consulted in several face-to-face sessions, one on one.

Work sessions

The *AHP Ratings* decision model was defined using the application *Expert Choice*®.

The advantages of *AHP Ratings were* used to evaluate the disciplines for each criterion and appropriate ranges were also defined for each criterion.

Figure 1 shows the objective and criteria of the *Expert Choice*® decision model, while Figure 2 details the list of disciplines or model alternatives developed according to *AHP Ratings*.

Figure 1. Objective function and criteria of the AHP Ratings decision model for the definition of the base disciplines for the Faculty of Engineering.

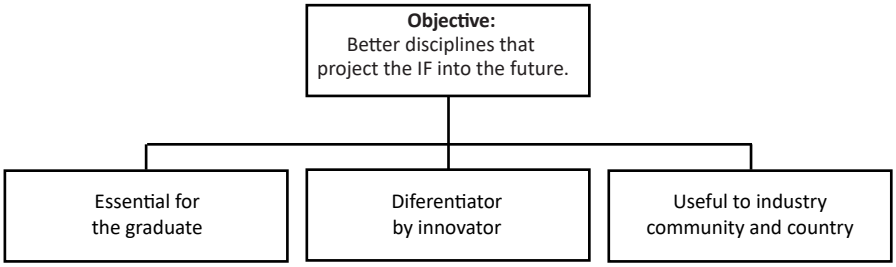

Figure 2. Disciplines as alternatives to the model presented in Figure 2.
for the AHP Ratings, with example values.

The ranges chosen for each criterion are listed below.

Criterion 1: Differentiator by innovator

- Essential to differentiate ourselves
- Some universities have it
- There are recognized universities in this discipline
- It is not in our best interest

Criterion 2: Essential for the graduate

- Essential for the graduate
- Needed in the programs
- It is not necessary to

Criterion 3: Useful to industry, community and country

- Very useful to the industry
- Can be used
- It does not serve the industry or the community.0

Once the *AHP* decision model was created with the objective, alternative and criteria with their ranges, we proceeded to carry out the interviews with the professors of the School of Engineering, who were defined as the participants, individually. The survey was conducted in two parts: the first to give weight to the criteria and the second to assign the relative importance of each discipline with respect to the others. The objective: to project Unimet's Faculty of Engineering into the future.

Results of weights on criteria and priorities for the disciplines were obtained for each participant, which are shown in the following section.

Decision model results

The averaged results of the model presented in the previous chapter are shown in Tables 2 and 3. Table 2 shows the weight obtained in the criteria of the model, according to the opinion of the participants, while Table 3 shows the averaged relative priorities of the disciplines, ordered from highest to lowest.

Table 2. Averaged weights of the model criteria.

Average criteria	
Differentiator by innovator	44.41 %
Required in the programs	29.26 %
Useful to industry, community and country	26.33 %

Table 3. Averaged relative priorities of the disciplines evaluated.

Average priorities of the disciplines	
Industrial Production, Manufacturing, Design, Design, Materials, 3D Printing	12.60 %
Environment and Sustainability	10.96 %
Energy, Oil & Gas	10.92 %
Project Management, Innovation and Development	10.57 %
Habitat, Construction and Structures	10.41 %
Processes	9.83 %
Control, Automation, Robotics and Telecommunications	9.82 %
Information Systems	9.35 %
Food	8.10 %
Maintenance	7.45 %

According to the results of the average weights of the criteria in Table 2, the criterion with the greatest importance for the participants in the decision process is the one related to research, followed by the other two, with very similar weights, with a little less than three percentage points difference.

On the other hand, according to the analysis of the results obtained, it is observed that all the disciplines evaluated are important areas in the field of Engineering and should be considered in the different curricula assigned to the School of Engineering. These values show that none of the mentioned disciplines should be discarded in the reorganization process.

Once the results have been evaluated in work meetings, it is decided not to discard any discipline and to look for strategies to group them together so that all are included and groups of disciplines are formed that are uniform for their operability.

It was decided, at this stage only, to incorporate the area of Maintenance, which showed the lowest valuation value, to the discipline of Industrial Production, since the field of maintenance is a fac- tor closely associated with the world of industry and production.

Likewise, it was decided to incorporate the Food sector, seen from the point of view of the generation of new products, into the Processes discipline. This leads to the definitive definition of 10 groups of disciplines or areas to be considered.

These disciplines and their relative weights will make it possible to establish the guidelines for the development and strengthening of the Faculty for the future. They will also serve as a guide for the establishment of new lines of research and the reinforcement of current ones, define possible services to third parties and provide for future new transversal academic axes in the different curricula of the engineering careers.

Seven possible proposals for groups of disciplines were analyzed, and t h e one considered most convenient for the School of Engineering was unanimously chosen.

Proposed grouping of disciplines and new departments for the Faculty of Engineering of Unimet

The chosen proposal groups the disciplines into four academic departments, which can be seen in Table 4. Once the structure is defined, each course or subject of the School of Engineering is assigned its possible location in each discipline in order to test the chosen model of organization of the departments and the relative size in terms of subjects of each area. Table 4 shows the number of undergraduate and graduate courses that each discipline would group together.

Table 4. Proposed grouping of subjects to define the new departments of the School of Engineering.

Grouped disciplines	Number of subjects of undergraduate	Number of undergraduate sections opened in 2016-2017.
EN + PR + AU	35	70
PI	22	90
YES + GP	23	101
HC + DS	22	54

The list of the different areas of knowledge that would comprise each discipline and/or grouping of the same was detailed. Doubts about the scope of these areas were clarified to avoid confusion, and the redistribution of full-time and part-time professors, administrative and laboratory personnel for this departmental project was evaluated, as shown in Table 5.

Table 5. Distribution of laboratories and professors assigned to the proposed departments.

Department name proposed	Laboratories	Detailed list of disciplines
Energy and Automation (EN)	Electronics, Electrical Machines, Automatons, Simulation, Transfer Phenomena, Separation Process Laboratories, Food, Tribology (Oils and Lubricants)	Energy, gas, petroleum, automation, control, robotics, telecommunications, electronics, food as new product generation, chemical processes
Industrial production (IP)	Materials, Mechanical Engineering, Fluid Mechanics, Fluid Mechanics	Industrial Production: Manufacturing, Design + Materials, 3D Printing, Maintenance, Production Management
Projects and systems (SP)	Innovation	Information systems, Operations Research, Project Management, Innovation and Development
Construction and Sustainable Development (CDS)	Soils, Concrete, Materials and Testing, Topography, Environmental Quality	Habitat, Construction, Structures, Roadways, Hydrology; Sustainable development: Waste treatment, Environmental impact, Biome, Biotope

The impact of this new distribution in terms of subject name changes, relocation of professors on the payroll and reassignment of codes is reviewed and sized below.

The proposal described above was submitted to the consideration of the councils of the different departments of the Faculty of Engineering and the authorities and was accepted.

The project was successfully implemented as of academic period 1718-3, once all the required administrative changes were achieved: reassignment of codes in the subjects that were relocated to academic departments with new identifiers; relocation of academic, technical and administrative personnel; relocation of laboratory assignments; creation of accounting accounts in the cases of the new departments, among other changes. Many units of the Universidad Metropolitana participated and were guarantors of the successful implementation of the project: Human Capital, Finance, Control of Studies and all the personnel of the School of Engineering, who were proactive with the changes that took place.

Conclusions

The research and development methodology of the project to restructure the academic departments of the Faculty of Engineering of Unimet made it possible to define four solid academic departments, with defined and clear scopes, with a distribution of academic areas of development and research that do not overlap and with an equitable and transparent distribution of subjects.

A review of the organizational structures of some universities whose information was published on the web made it possible to understand the need to move forward with the restructuring project.

The use of *AHP* in the grouping of areas of interest made it possible to follow the most objective form of this grouping, but it also involved professors and researchers in the decision of the structure.

Bibliographic references

AMERICAN SOCIETY OF CIVIL ENGINEERS (2009). "Achieving The Vision For Civil Engineering in 2025. A Roadmap for the Profession*. American So- ciety of Civil Engineers, Reston, Virginia*. Retrieved from https://www. asce.org.

COATES, J. (2008), "Engineering and the Future of Technology", *The Bridge, Vol. 27,* Issue 3. Retrieved from https://www.nae.edu/.

MURPHY, C. F., ALLEN, D., ALLENBY, B., CRITTENDEN, J., DAVIDSON C. I., HENDRICKSON C. and MATTHEWS H. S. (2009), "Sustainability in Enginee- ring Education and Research at U. S. Universities," *Environmental Scien- ce Technology*, *Vol. 43,* Issue 15, pp. 5,558-5,564.

NATIONAL ACADEMY OF ENGINEERING (2006)*,* "Engineering for the Deve- loping World"*. The Bridge, Vol. 34*, Number 2, summer 2004. Retrieved from http://www.engineeringchallenges.org/

NATIONAL ACADEMY OF ENGINEERING (2005). "Educating the Engineer of 2020. Adapting Engineering Education To The New Century*." National Academy Press,* ISBN 0-309-09649-9, DOI: 10.17226/11338. Accessed on October 15, 2018. Retrieved from https://www.nae.edu/.

ROSSEN, M. A. (2012), "Engineering Sustainability: A Technical Approach to Sustainability", *Sustainability, Vol. 4*, Issue 9, 2270-2292, DOI: 10.3390/ su4092270.

RUGARCIA, A., FELDER, R. M., WOODS, D. R. and STICE, J. E. (2000). "The Fu- ture of Engineering Education. I. A Vision for a new Century. *Chemical Engineering Education*, *34*(1), 16-25.

SAATY, T. L. (1994). *Fundamentals of Decision Making and Priority Theory with the AHP*. Pittsburgh: RWS Publication.

SAATY, T. L. and KEARNS, K. P. (1985). *Analytical Planning. The Organization of Systems. The Analytic Hierarchy Process Series. Vol. IV, Decision Making using the AHP*. Pittsburgh: RWS Publication.

UNITED NATIONS EDUCATIONAL, SCIENTIFIC, AND CULTURAL ORGANIZATION (Unesco) (2010). *"Engineering: Issues Challenges and Opportuni- ties for Development", Unesco Report* ISBN *978-92-3-104156-3*. Recu- perated from http://unesdoc.unesco.org.