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When engineers and quantity surveyors discuss

aesthetics and architects study what cranes do, we

are on the right road.

Ove Arup (1980)

RAAM 8 CONFERENCE: Amsterdam 2010

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Universidad Politécnica de Madrid

Building big is thinking big: conceptual and linguistic networks in architecture and civil engineering

Abstract

During the last decade, the study of metaphor in use (both written and spoken) has received considerable attention in cognitive linguistics research (Cameron and Low 1999, Deignan 2005, Steen 2007, Zanotto et al. 2008). It appears that a good deal of interest has consolidated around figurative language and metaphor use in academic settings (Low 1999, Cortazzi and Jin 1999, Littlemore and Low 2006). Some of the studies aim to show that metaphor use in the classroom may improve and reinforce comprehension and communicative skills in EFL learners. In this paper we focus on part of the mental mappings that some specific learners, namely architecture and civil engineering students, need to activate when matching language and professional knowledge. We will explore some of the conceptual and linguistic networks that students have to operate with in order to assimilate and internalize their discourse community. With this aim, conceptual integration (blending) theory, including meaning compression and decompression (Fauconnier & Turner 2002), has been applied. Also, a selected repertoire of examples taken from architecture and civil engineering domains, e.g. salient journals and books, has been examined to extract information. The findings confirm that non-literal metaphorical language, combined with the occurrence of image schemas, seems systematic and constitutive of both discursive areas. The conclusions suggest that metaphorical conceptual and linguistic structures appear to lend more coherence to these technical domains (for example by creating more word meanings) and, on the other hand, that metaphor fluency is a must for architects and engineers expertise, despite not being actually made explicit. Likewise, the first results of a survey carried out at Madrid Technical University (UPM) are presented. The main aim of the survey was to elucidate to what extent students incorporate learning strategies and discourse community into their knowledge and whether this internalization parallels other types of processing like image perception and description.

Key words: ESP conceptual and linguistic metaphor, conceptual integration in engineering and architecture, academic and professional communication.

Building big is thinking big: conceptual and linguistic mappings in architecture and civil engineering

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Abstract

Various studies on metaphor in use (Cameron and Low 1999; Cortazzi and Jin 1999; Littlemore and Low 2006; Low 1999) claim that metaphor use in the classroom appears to improve and reinforce comprehension and communicative skills in EFL learners. In this paper we focus on the mental mappings that a group of architecture and civil engineering English learners seem to activate in the process to internalize their professional knowledge both in English and Spanish. The theoretical frameworks applied refer both to conceptual and linguistic metaphor (Deignan 2005, Steen 2007) and to conceptual integration (blending) theory (Fauconnier & Turner 2002, Fauconnier & Turner 2008). First, we explore some conceptual and linguistic metaphors encapsulated in the discourse to which students are exposed during their academic training. This is done by perusing linguistic data included in representative architecture and civil engineering academic sources. In addition, we outline and present a comprehensive survey designed to analyze the way these students integrate the specifics of their discourse community into their knowledge. The initial results of this survey show that this internalization parallels other types of processing (like image perception and description verbalizers). The findings also highlight that both conceptual and linguistic metaphors seem systematic and constitutive in architecture and engineering domains. In the conclusions we point out that despite minor variations in frequency use in both disciplines, metaphor proves to be a conceptual and communicative tool for architects and engineers and therefore needs to be acquired by these learners as a key part of their training.

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Introduction

At this point of imminent application of the Common European Framework for Languages (CEF), applied linguists and teachers find an extra motivation to explore the way students' grasp and process knowledge and thus to provide tools to enhance students' learning and self-reflection. In this context, the present paper attempts to explore and to obtain analyzable results about UPM (Madrid Technical University) students' perceptions, learning styles and community discourse processing during their studies. The data obtained are to be crosschecked with data from English students and from engineers and architects (Spanish and English). The resulting data would enable us to offer a fresher and intercultural learning approach and thus to provide language learners with useful information to update and manage their learning capacities once their studies finish as well as fostering mobility. The importance of teamwork building in the current labour market was also considered, and hence one aim of the undertaken survey was to pinpoint divergent but also convergent ways as to how engineering and architecture students look at their professions and might want to develop the present scenario.

Formerly, we hypothesized the following points:

1. Engineering and architecture students' linguistic and conceptual learning process is channeled according to fixed parameters set up by their professions.

2. Engineering and architecture students display discrete learning styles and strategies and therefore separate ways to perceive and process their knowledge.

3. The academic and professional priorities of engineering and architecture students are far from coincidental.

4. The perceptive skills and subsequent competences of engineering students and engineers on the one hand and of architecture students and architects on the other are dissimilar, being the latter group more likely to produce metaphorical examples.

As shown below, these assumptions were challenged in the end-results obtained in the survey.

Aims

The main aims of this work are these:

- To enhance students' academic & professional competences by analysing meaning construction in civil engineering and architecture (CEA).
- To explore the most common conceptual and linguistic structures (frames, metaphors, blends) used in CEA.
- To study to what extent students integrate discourse community into their knowledge.
- To cross-check CEA students' processing, strategies and perceptions.
- To compare CEA students' (academic) results to engineers and architects' (professional) ones.

To achieve the main goals included in the Common European Framework for Languages, among the academic and professional needs to be met are the practice of specific communicative skills, and appropriate contextual language use in the types of text that our students will be using. For the present study, we have also taken into consideration the requirements specified in the following academic and professional institutions:

- EUCEET (European Civil Engineering Education and Training) that represents 29 European countries through 101 universities (7 of them are Spanish) and 30 professional and business and research institutions has been producing during eleven years data elaboration and compilation, comparative analyses, criteria and suggestions. These results have been used to adapt civil engineering studies to the Bologna process.
- ASCE (American Society for Civil Engineering) preparation of data about academic requirements to become an engineer and their recommended "Civil Engineering Body of Knowledge for the 21st Century".

- ECCE (European Council of Civil Engineers) published in 2005 and in 2009, includes two surveys and studies on "*The Civil engineering Profession in Europe* and *ECCE Professional Recognition Recommendation*", which describe and analyze the legal conditions to become a chartered civil engineer in European countries.

Amongst the basic competences that engineers need to know are for example the capacities to interpret, to describe and to explain graphical representations, e.g. geometrical and computing design, to different audiences (expert and non-expert). Likewise, the student should be able to develop thinking skills and "to take a holistic approach in solving problems and designing systems" (Imperial College syllabus).

In sum, the student should be able to apply professional judgments to balance risks, costs, benefits, safety, reliability, aesthetics and environmental impact and eventually should be able to give written and spoken verbalization of these jobs. Figure 1 shows the interconnected networks and knowledge web that a future civil engineer should attain and should integrate to prepare their last year final project.

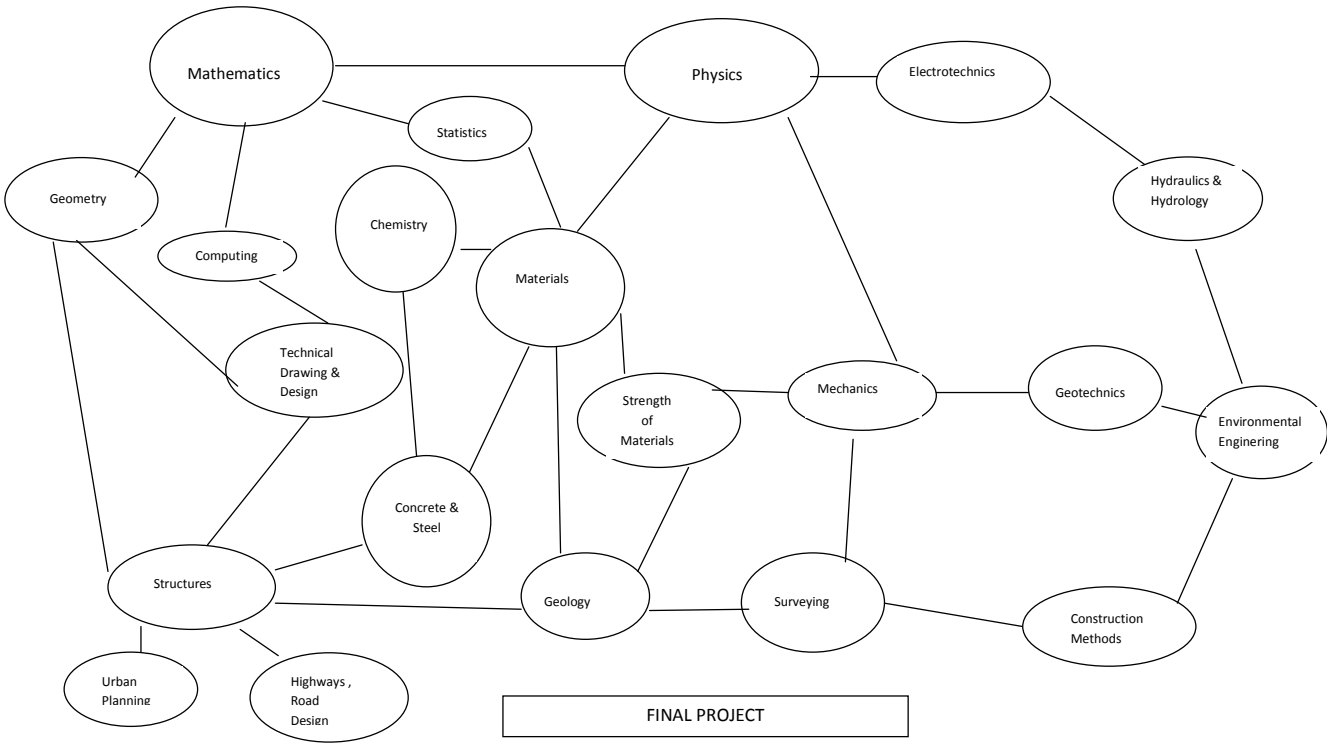

Figure 1

Another important aim of this paper was to focus on the use of therapeutic language as a major input for civil engineering and architecture (CEA) concepts and linguistic elements. Cases

of CEA source domains terms used to convey abstract concepts like in *cementing a friendship*; or in glass *ceiling* (applied to women's careers obstacles) are not considered in this work. Indeed some examples may actually target the medical domain, as in colloquial Spanish: *Estoy para el desguace*, literally meaning: 'I am ready for the scrap yard' though actually meaning: 'I'm feeling shattered/in a terrible condition'. However, our main concern here will be dealing with inputs either from the medical domain or related ones (e.g. psychological, like in *stress, vulnerability, excitability* etc.) onto the engineering field.

The conceptual integration framework proposed by Fauconnier (1987) and developed in Fauconnier and Turner (2002) has been followed as the most appropriate method for our study, because it provides a more complete model than earlier metaphor theories. It is considered more unifying, because conceptual integration theory encompasses conceptual mappings and image metaphor, blends, categorizations, frames, viewpoint shifts, counterfactuals and metonymies. Blends are cognitive operations for combining concepts from different inputs or domains. Examples of medical blends in engineering will be shown as well as examples to illustrate the importance of perception (visual representations) in engineering and architecture, which includes "image blends" in various descriptive examples, subsequently analysed.

Methodological tools

The method followed consisted of:

1st: Gathering linguistic information (written and spoken). This consisted of compiling linguistic corpora (Spanish and English) from engineering and architecture specialized journals, syllabuses, books and oral interviews. At this stage, we realized that the high occurrence of figurative language, e.g. embodied conceptual and linguistic metaphor (e.g. STRUCTURE IS A PATIENT; ENGINEER IS A DOCTOR), metonymy (e.g. Calatrava's torso, namely a building) and multiple domain/mapping images (e.g. the blinking eye, namely a bridge) could only suggest its constitutive rather than an explanatory function (Ungerer & Schmidt 2006: 147) in engineering and architecture communication[1].

2nd: Data were analyzed following Conceptual Metaphor Theory (CMT) and Conceptual Blending Theory (CBT). For reasons dealt with below, it was considered that these linguistic theories were most appropriate. In addition, principles from pragmatic theory and from Languages for Specific Purpose (LSP) research (i.e. genre and discourse analysis) were also taken into account. Most of the journal papers analysed were written in Spanish, although some articles (about 20%) were written in English. They comprised from January 2000 to December 2005. Concordances, frequencies, clusters and keywords were subsequently extracted and analysed by means of AntConc 2006 software and according to the OU CREET

[1] By communication we not only imply written but also pictorial and spoken use of figurative language (Roldán & Úbeda 2006).

(Metaphor Network) suggested method to identify metaphor in discourse. Other corpus approaches to identify metaphor such as the ones carried out by Charteris-Black (2004), Caballero (2003a, and 2003b), and Deignan (2005) also served as references to undertake this work.

3rd: Surveys to be carried out among engineering students, architecture students and engineers and architects. The participants included Spanish (UPM) and English (Imperial College of London) students and professionals. The number was 50 engineering students/ 50 architecture students and 15 engineers/ 15 architects. The first survey contained a practically identical 7 question's questionnaire that was slightly adapted for each group in the perceptual questions. The questionnaire was offered online on the Internet at SurveyMonkey (a software tool for surveys and questionnaires)

Therefore, initially the work undertaken consisted of:

- Corpora compilation (from CEA journals, academic syllabuses, books, etc).
- Application of CMT and CBT to data analysis.

The ongoing study includes:

– Surveys aimed at:

CE & Arch. students (50 Spanish participants).

Engineers & architects (25 Spanish and 25 English).

CE & Arch. students (50 English).

Subsequent forthcoming work will involve more field studies (questionnaires, interviews) to complete information on students' processing, use of learning strategies and discourse community assimilation.

Sequence of stages to follow

1. So far we have explored, and pointed out the embodied metaphorical nature of CEA language. We have done so by drawing examples from written (journals, manuals, academic syllabuses), spoken (conversations, lectures, interviews) and visual communication (engineers and architects like N. Foster, S. Calatrava's artifacts and other architectural/engineering works).
2. The second step entails the articulation of the process of assimilation and internalization of this conceptual universe by students. That is, we will proceed by analyzing responses to perceptual questions, ways of internalizing knowledge, learning strategies, etc. This will allows us to see the process of cognition in acquiring discourse community, etc. One of our main hypotheses is that this mental and linguistic universe includes a considerable number of metaphors and metonymies. Most of them are acquired in an unconscious way, i.e. the learner is not aware of their assimilation

because they form part of the conceptual array of the profession. Therefore, they are administered as such and thus eventually become entrenched.

3. How will this be shown? By the analysis of existing data (ACE syllabuses, manuals, and other linguistic and non-linguistic, i.e. visual, data) Also by direct inquiries (e.g. questionnaires, surveys, interviews)
4. Once we have achieved that, the next step would be to draw together findings (written, spoken and visual) and structure them in a coherent way. In this way, we can manage to articulate the whole picture from both groups.
5. What is the theoretical framework applied in this work? Mainly Fauconnier's and Turner's principles (2002, 2008), namely mental spaces, inputs, emergent structure, blending, conceptual Integration, compression and decompression, inferences, etc.).

Theoretical Framework

The extended use of metaphor in architecture and in civil engineering has been pinpointed in Spanish and English in previous works (Úbeda 2001, Caballero 2003a and 2003b, Roldán 2004). Here, as in many other realms of language, metaphor appears to be pervasive. The conceptual integration framework proposed by Fauconnier 1987 and developed in Fauconnier and Turner 2002, Fauconnier 2008, is followed here as the most appropriate for our purpose, because it provides a more complete model than earlier metaphor theories. It is considered more unifying, because it allows an encompassing analysis of cognitive conceptual and image metaphor, blends, categorizations, frames, counterfactuals and metonymies allowing a . Examples of medical blends in engineering will be shown as well as examples to illustrate the importance of perception (visual representations) in engineering, which includes "image blends" in various descriptive examples, subsequently analysed. Namely, we are interested in the mapping AN ENGINEER IS A (MEDICINE) DOCTOR. As Deignan 2005: 164 explains, it is not always possible to resort to conceptual metaphor to account for the dynamic creation of mappings and corresponding linguistic expressions, in this sense, it is plausible to refer to the concept of blending (Fauconnier & Turner 2002), in particular as seen in Grady et al. 1999 in their study of the conceptual integration network of A SURGEON IS A BUTCHER. Here, starting from a generic space that breaks into two inputs spaces, a blended space emerges showing shared and new characteristics, as we can see below in figure 2. As Deignan 2005:222 argues, the creation of a third mental space by a metaphor goes a step beyond conceptual metaphor theory that only concedes that the structure from the target domain comes from the source domain.

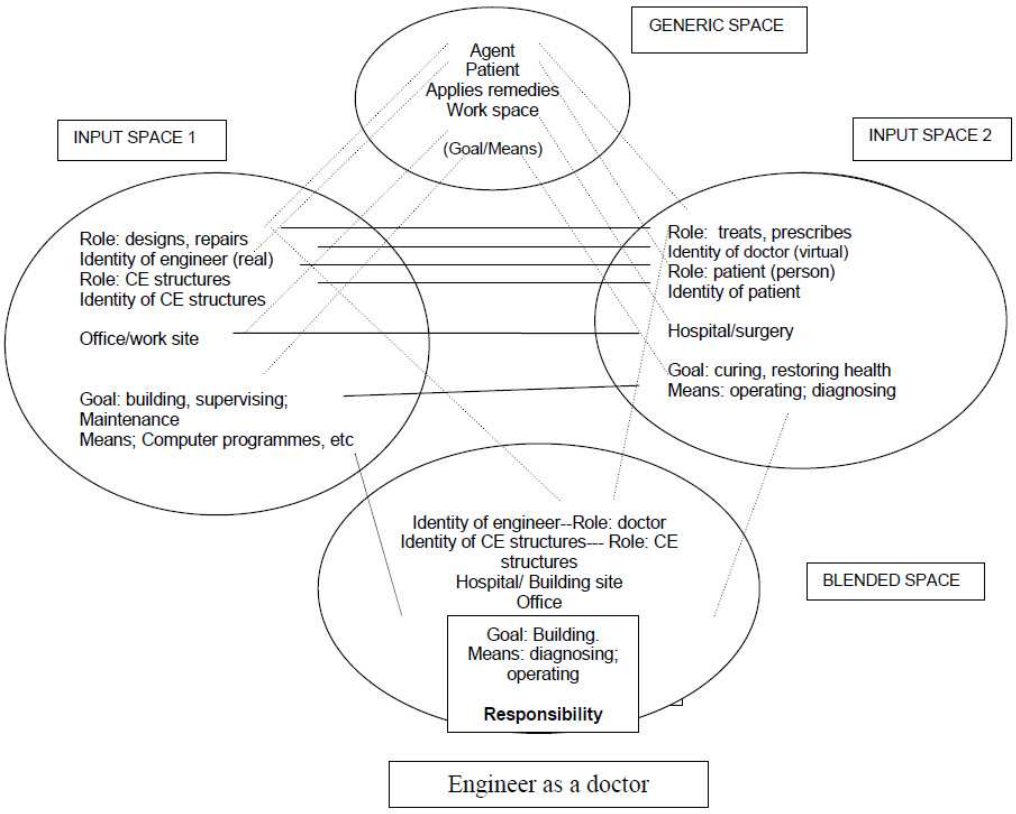

Figure 2

Among the major factors that the engineer and the architect have to consider is the effect that the structure will have upon people. As seen above in the engineer as a doctor blend, the emergent structure compressed in the blend entailed the metaphor of the structure as being human, i.e. the "humanization" of the structure, and therefore deserving to be looked after. But going one step further, there are links connecting the welfare of people in bodies which is sought after (responsible: doctors) and the welfare of the people in the structure (responsible: engineers) as shown in figure 3. From this emergent structure, the degree of satisfaction of the people using the structure follows, not only physical, but also aesthetic (figure 4). This represents a double-scope network (Fauconnier and Turner 2002:132) because the different organizing frames of the inputs contribute to the blend in an innovative way. For example, the welfare of people in a building is about people feeling comfortable in it, including the right quantity of light, not too bright or too dim and a pleasing visual environment through the design of windows and lighting systems; the absence of distracting noise; the right temperature and ventilation.

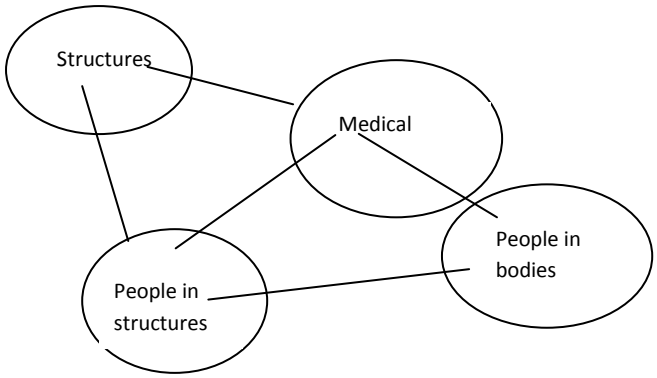

Figure 3. Interrelated medical-engineering networks

Likewise, when the external appearance of the building is aesthetically pleasant, this facilitates the internal well-being of people in the building (better health) as well as their enjoyment. Actually, if this aim is achieved in building structures, and care is taken of respecting earth resources and controlling pollution, it would produce the desired effect of living in a healthy planet. In figure 4 we see the links connecting the networks between the external look of the structure and the internal wellbeing of the people who use the structure and between the aesthetic appearance of the structure and the enjoyment of people.

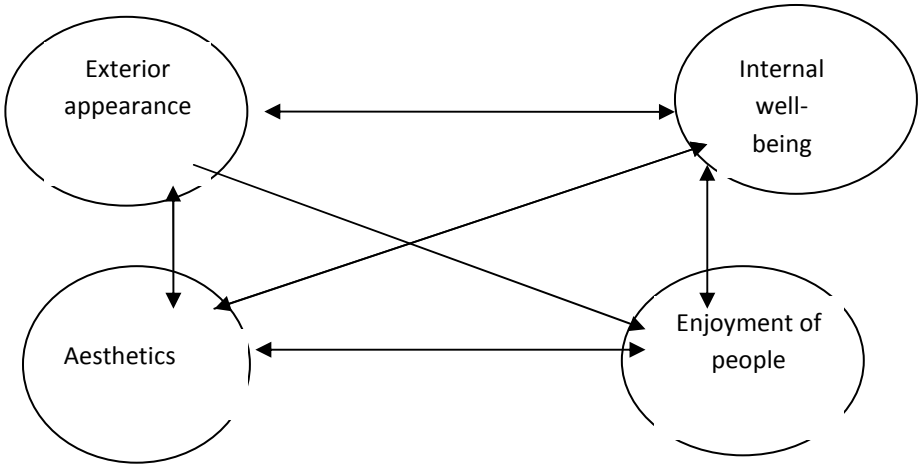

Figure 4. Further networks on the medical-engineering blend

As shown in previous research (Caballero 2003a, 2003b; Roldán and Úbeda 2006), there are a considerable number of terms in architecture and engineering construction that evoke a visual origin and description. To portray their designs and creations, engineers and architects prefer to use drawings and figures that are mostly images and that may trigger visual interpretation in the spectator. Hence, when having to describe their work in words, they choose pictographic ones, like *the jagged fan of five overscaled concrete fins* (Caballero 2003b:150). At face value, engineers and architects seem to share visual representations as a key competence in their jobs.

In a way, an important and seemingly hard skill that both architects and engineers must acquire during their training is verbalising, putting into spoken and written words their mental images, which probably explains why metaphor or metonymy is so common. Caballero (2003a, 2003b) has examined the occurrence of conceptual metaphor and, particularly of image metaphor in architecture. Many of the examples that she presents from her collected corpus have a visual origin and nature. Equally, she points out that it is not often so easy to differentiate conceptual from image metaphor in architecture texts, claiming that there is often interplay between both types because of "the visual and aesthetic constraints of the discipline" (2003b:150). Adding to that, we also underline the key role of the visual component in engineering, as well as the aesthetic element, frequently underestimated. In fact, this issue can be proved in many historic examples, such as Segovia Aqueduct or the Chinese wall. In Roldán and Úbeda (2006: 538) additional evidence indicates a considerable use of metonymic images in descriptive engineering construction texts.

Another common feature for architects and engineers is the frequent presence of embodiment in their conceptual mappings and, as we will show in the examples below, in image blending. This was also reflected in the use of the medical metaphor. This way of reasoning explains the ubiquity of the human figure in engineering metaphorical mappings and blends, part of it was explained above in the STRUCTURES AS PATIENTS and ENGINEERS AS DOCTORS mappings. This feature arises from considering structures as fragile as human beings and therefore requiring medical attention. Let us look at how these blends operate together in images. We can see in figure 5 an example of how the moving shape of the human body inspired Calatrava in the "Turning Torso" high-rise building in Malmö (Sweden).

Figure 5. Turning Torso building (Malmö) and its analogy with the human body

Survey Results

The first results of the survey suggest that even though remarkable differences between engineering and architecture were found in the way students face their respective studies at a primary stage, i.e., when designing and projecting, (figures 6 and 7) these differences get blurred when using more socially oriented skills such as reading and speaking (figures 8 and 9). Coincidences between both groups are even more relevant when asked both about their opinion of the profession and of their personal opinion (figures 10 and 11).

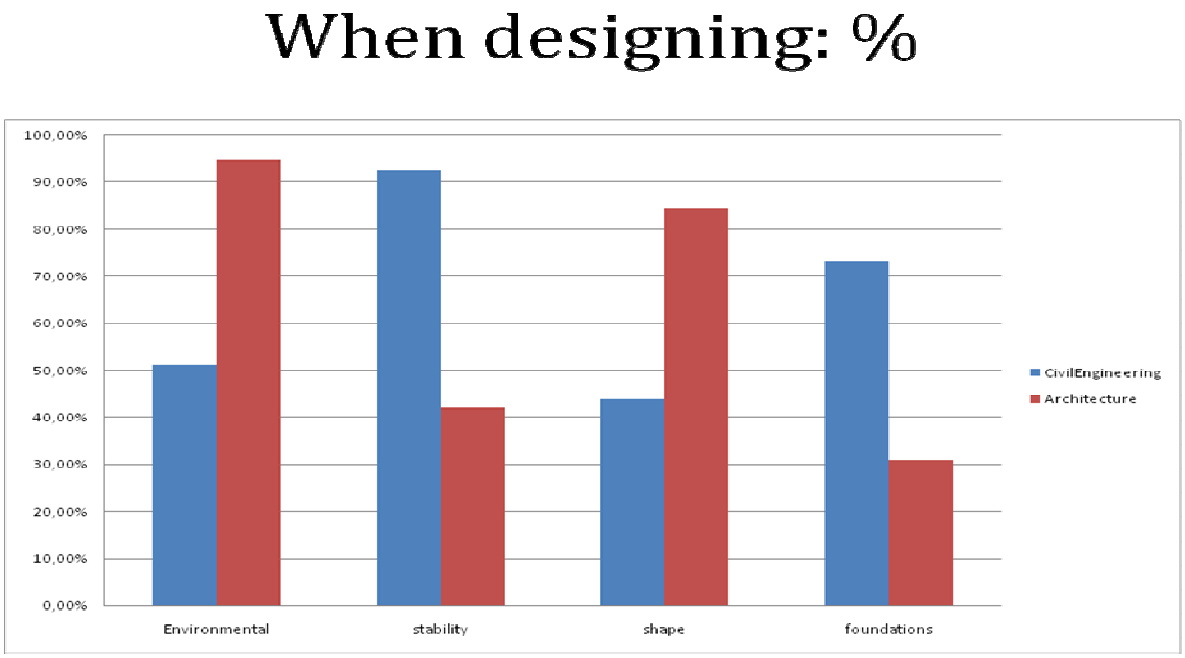

Figure 6

When projecting: %

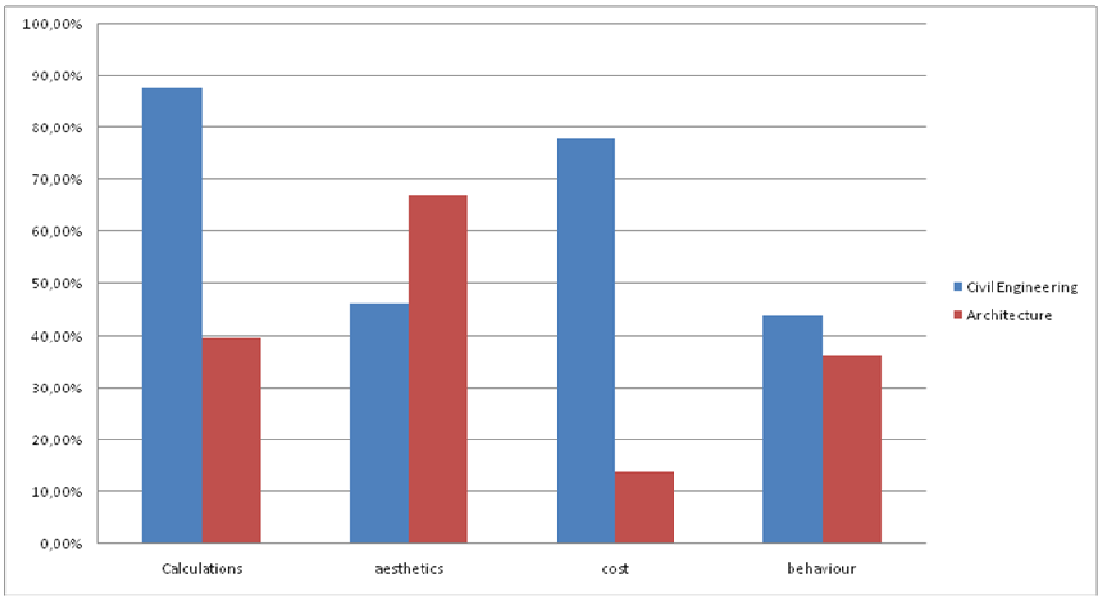

Figure 7

When speaking: %

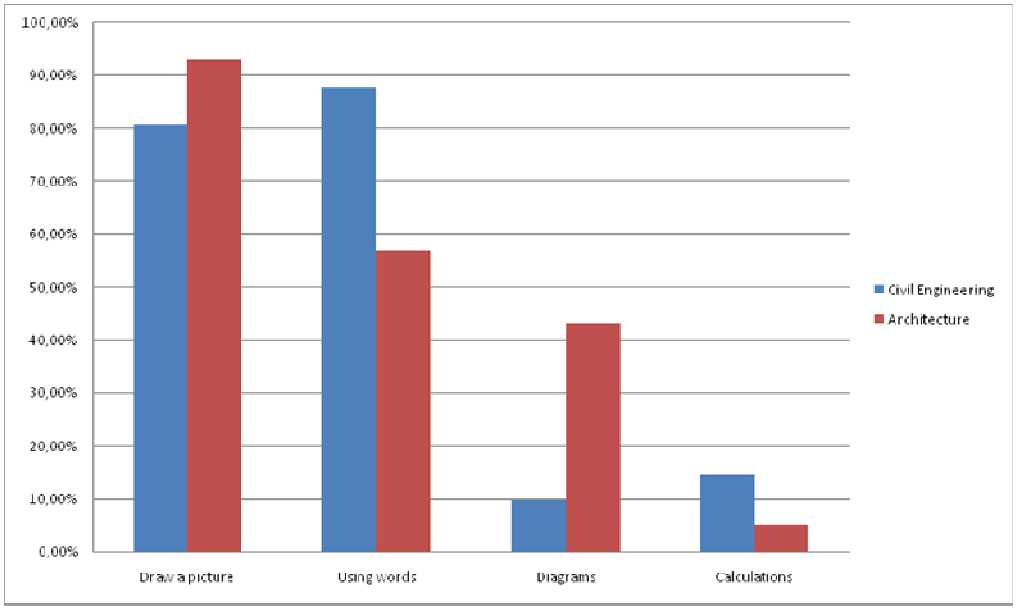

Figure 8

When reading: %

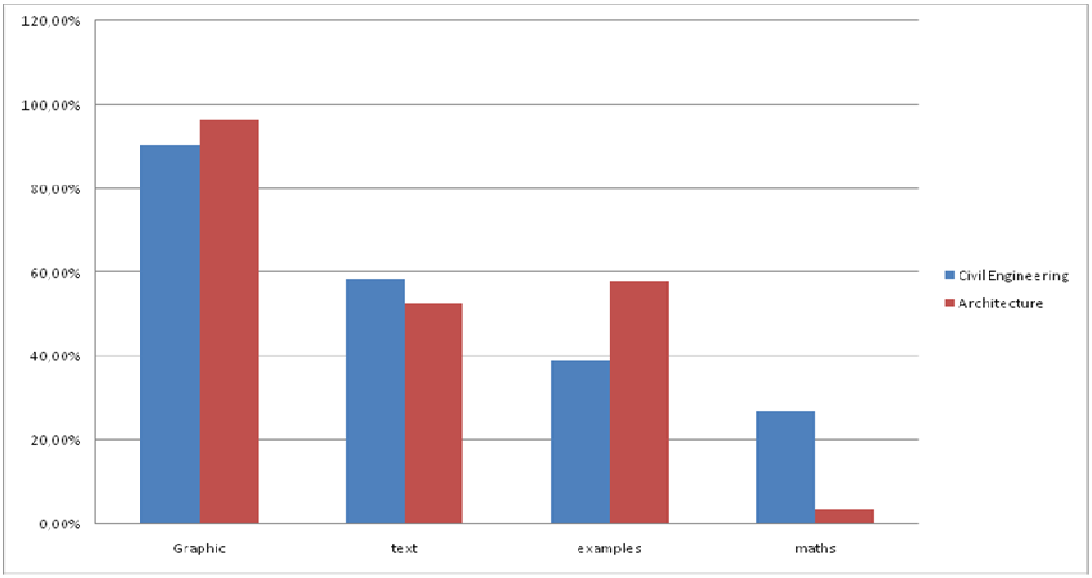

Figure 9

Professional relevance: %

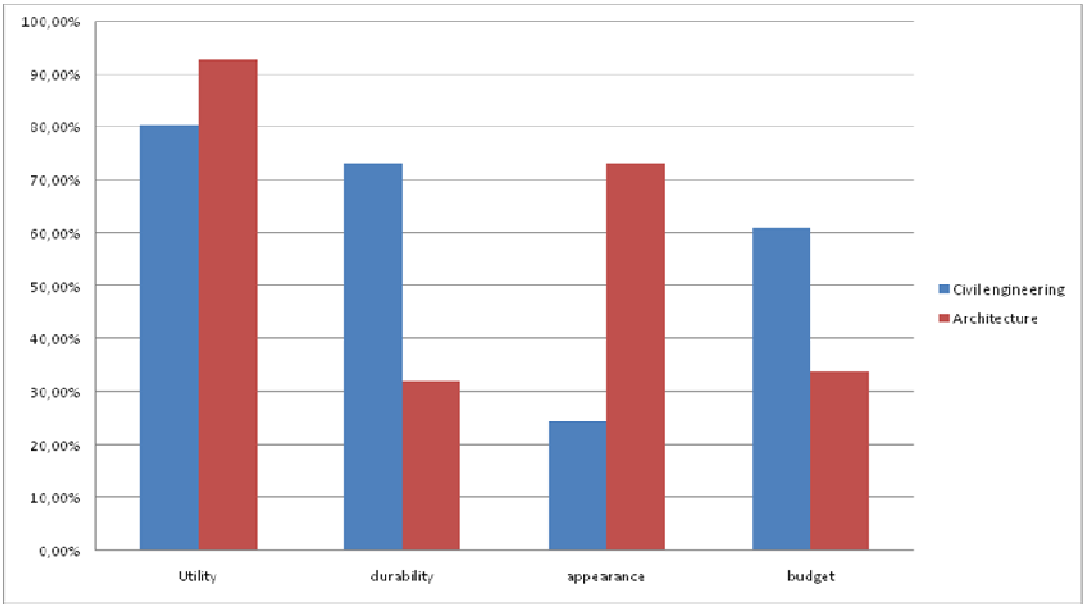

Figure 10

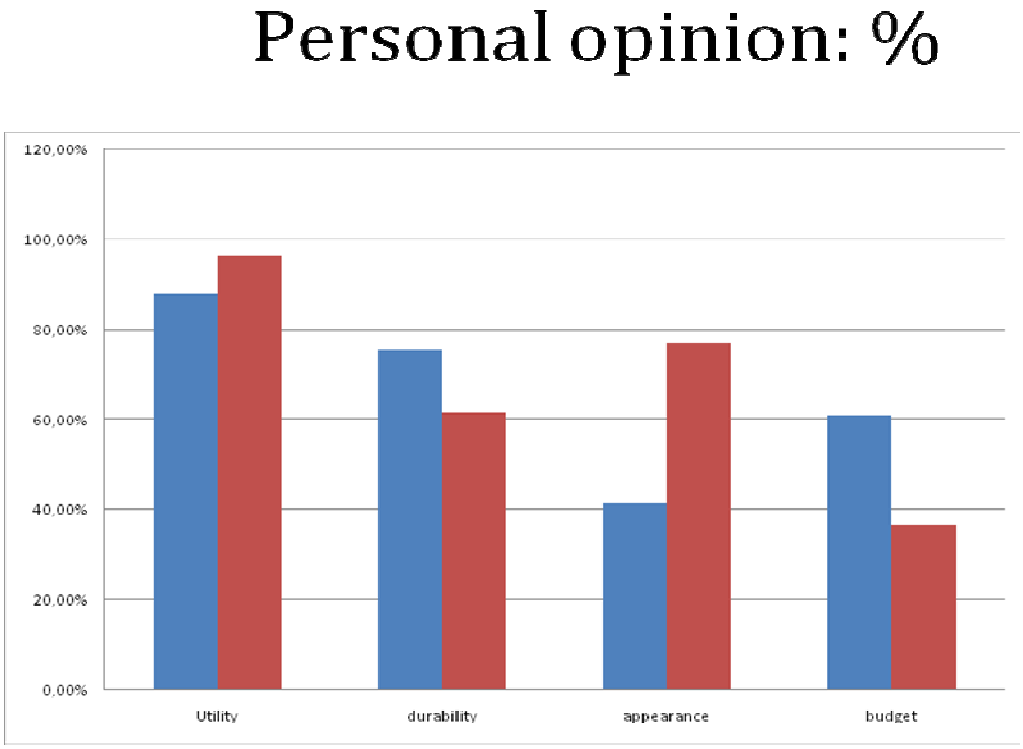

Figure 11

Perceptually speaking, engineering and architecture students show significant differences. Contrary to what was hypothesized above, metaphor use is equally important in both groups. The most striking difference noted however is the high use of professionally typical nouns i.e. “Objective Nouns” (ON), in this particular case by architecture students, which seems to reflect the trickling down learning effects from belonging to this community discourse. Instead, adjectives (evocative or impressionistic) are considerably preferred by engineering students (figure 12).

From the subsequent forthcoming stages more data that will complete these results are expected. Thus, in the survey aimed at engineers and architects, the professional findings on processing will be compared to the academic ones. In addition, the information found from the questions about perceptions will contribute to the academic data bank so far obtained, hence making possible a comparative study between both.

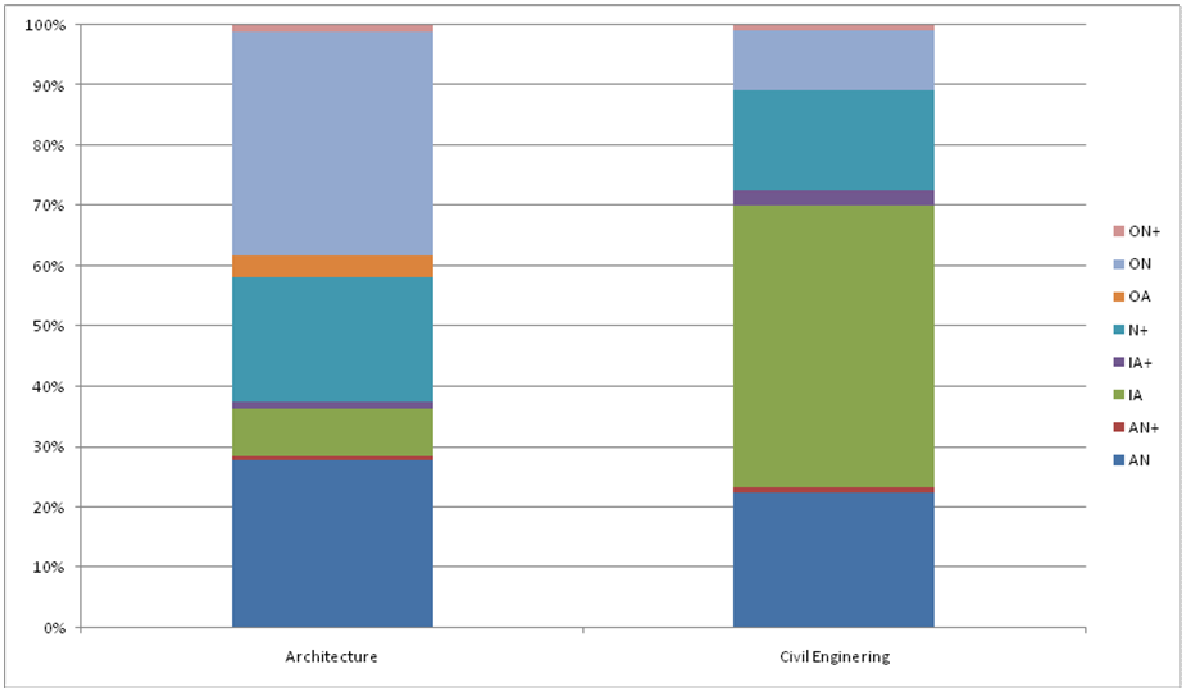

Figure 12

Conclusions

In this paper we have tried to focus on the conceptual and linguistic dimensions of engineering and architecture both academic and professionally. Our main interest was to investigate engineering and architecture students' processing by exploring the relationship between their perceptions and ways of learning and whether their knowledge internalization is characterized by their respective professional communities. We also analyzed how this process was manifested in language as a feature of membership to discourse community.

Another point we presented is how relevant is for engineering and architecture communication the extensive use of images (pictures, sketches, diagrams, graphs) and also when thinking and reasoning. The visual representations and perceptions of images appear to be more direct, immediate, holistic and eye-catching than the use of words, hence the use of iconic designs, projects and creations. It is suggested here that within the civil engineering and the architecture groups not only images appear as complement of words, but also words' main function seems to be the description of images. Further research on this interrelation promises to produce important insights into the fascinating worlds of building and technology.

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