ENGLSH VERSION

Análisis de la implantación de la metodología BIM en los grados de ingeniería industrial en España bajo la perspectiva de las competencias

Analysis of the implementation of the BIM methodology in the spanish industrial engineering degrees under the competential perspective

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Abstract

Every day, the BIM Methodology (Building Information Modeling) is getting closer to the companies and other members of the AEC sector (Architecture, Engineering and Construction), as well as to educational institutions that are starting to train new professionals on this matter. The roadmap set by the es.BIM Commission establishes the mandatory use of BIM for all public construction tenders as of December 17th, 2018 and for infrastructure tenders as of July 26th, 2019. The purpose of this paper is to make public and share the results of the research work concerning the state of implementation of BIM at different universities and Industrial Engineering Schools in Spain. However, are Spanish universities prepared for the challenge? Are teachers prepared for this? And what about the situation in Latin America? The study undertook a bibliographical review and analysis of publications addressing this topic, and talks given in specialized conferences. Different teaching experiences were analyzed and compared among several Spanish universities, and the problems encountered, the results obtained, future improvements and needs detected in relation to their implementation processes and procedures, have been taken into account.

Keywords: *BIM, Industrial Engineering, University, Competencies, Training*

Resumen

La metodología BIM (Building Information Modelling) está, cada día, acercándose más y más a empresas y otros participantes del sector AEC (Architecture, Engineering and Construction), así como a los centros educativos que empiezan a formar nuevos profesionales en esta materia. La hoja de ruta marcada por la Comisión esBIM establece la obligatoriedad del uso del BIM para toda licitación pública en la Edificación para el 17 de diciembre de 2018 y para el 26 de julio de 2019 en el caso de las Infraestructuras. El objetivo de este artículo es hacer público y compartir los resultados del trabajo de investigación sobre el estado de implantación del BIM en las diferentes universidades y escuelas de Ingeniería Industrial del territorio español. Pero, ¿están las universidades en España preparadas para este reto? ¿Está el profesorado preparado para ello? ¿Y en Latinoamérica? El estudio se realizó a través de la consulta y análisis bibliográfico de publicaciones sobre la materia y comunicaciones en congresos especializados. Se han analizado y comparado diversas experiencias docentes en varias universidades españolas y se han tenido en cuenta las problemáticas encontradas, los resultados obtenidos y las futuras mejoras y necesidades detectadas en sus procesos y procedimientos de implantación.

Palabras clave: BIM, Ingeniería Industrial, Universidad, Competencias, Formación

1. Introduction

The BIM methodology, widely spread in countries of Central Europe and others of the American continent, has started to awaken a real interest in Spain in the past five years. There are many definitions for BIM methodology, which consists in putting into practice a method of collaborative work aimed at the creation, implementation and management of projects concerning a building or infrastructure throughout their entire life cycle. The key to the success of this multidisciplinary collaboration methodology is the involvement and participation, in real time, of all and every one of the stakeholders participating in the process, through a digital model that integrates all the useful information, and was created for that purpose.

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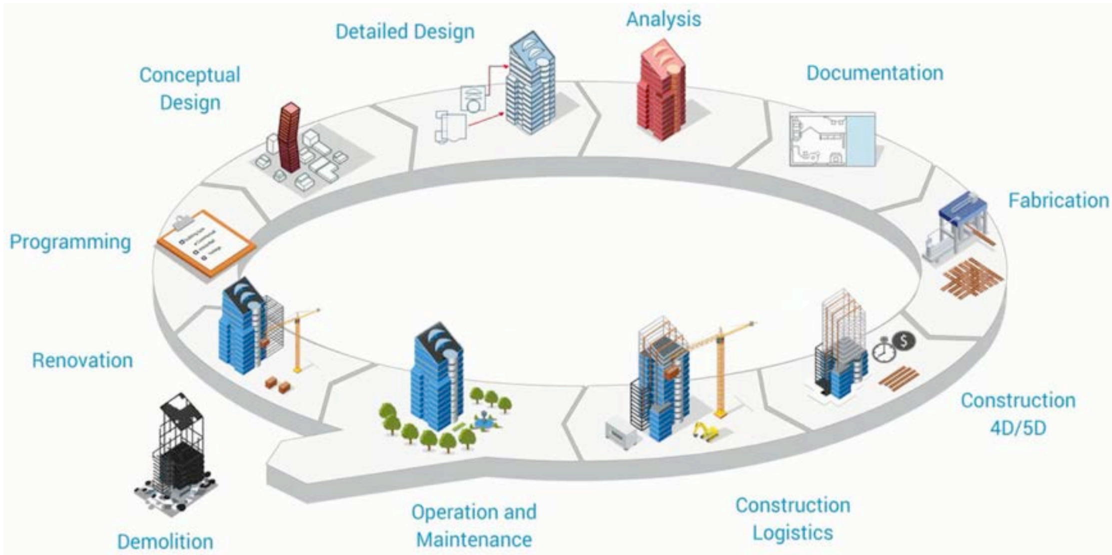

Figure 1. *BIM model life cycle*
Source: www.advenser.ae

The life cycle (Figure 1) is understood as the accomplishment of all and each one of the phases of a building project, from the generation of the first designs to the completion of the building, to which post-project activities are incorporated, such as maintenance, rehabilitation and possible demolition of the construction.

The benefits of the BIM methodology that are most named in the scientific literature, are related to cost reduction and the possibility of having a better control of the construction along the project's entire life cycle; additionally, the time-saving documented records are also quite significant. Furthermore, the negative aspects of its implementation are concentrated on the use of BIM software (Bryde et al. 2013). BIM has contributed to a very important transformation within the building industry and its benefits for different participants can be classified according to the phase or stage of the process: pre-construction, design, construction and post-construction. The most characteristics are referred to how to make fewer mistakes, thereby obtaining higher efficiency, accuracy, rapidity, productivity, coordination coherence, communication and cost reduction in the project. Due to the scope and varied nature of the benefits derived from using the BIM methodology in the projects, it is recognized and agreed that it contributes with countless benefits to the AEC industry and the FM sector (Facilities Management). However, the actual problem to date, and which deserves careful consideration, is whether the professionals are ready to fully adopt BIM (Mandhar et al. 2013).

Ever since, work has been carried out to deal with the standardization needs, among other relevant aspects (Figure 2). This normalizing current was originated in the 90's, in the United States, by a private organization whose main goal was to develop and standardize BIM systems by fostering the use of open interoperability standards, the Industry Alliance for Interoperability (IAI), which would later become the buildingSMART International Alliance for Interoperability. It is a non-profit organization, which aims at developing and maintaining international, open and neutral BIM standards (Open BIM), in order to accelerate the interoperability in the construction sector through successful cases, specifications, documentation and reference guides, and to identify and solve the problems preventing the information exchange, so that it is possible to expand the use of this technology and the processes associated to the building's entire life cycle, by including all stakeholders.

Technical Principles: Basic Standard

What it does	Name	Normative
Describes Processes	IDM IDM Information Delivery Manual	ISO 29481-1 ISO 29481-2
Transports informaation / Data	IFC IFC Industry Foundation Class	ISO 16739
Change coordination	BCF BCF BIM Colaboration Format	buildingSmart BCF
Maping of Terms	IFD International Framework for Dictionaries	ISO 12006-3 buildingSmart Data Dictionary
Translates processes into technical requirements	MVD Model View Definitions	buildingSmart MVD

Figure 2. *BIM Regulation*
Source: buildingSMART

Moreover, the BIM maturity and development levels (Figure 3) have been widely discussed by different authors (Barlish et al., 2012) (Succar, 2010) (Sebastian et al., 2010), although the Bew-Richards BIM Maturity Model is the most used in the industry and the organizations, and it is the model adopted by the United Kingdom (Martin Dorta et al., 2014). The concept of BIM levels is accepted, and they are defined with a range from 0 to 3, based on the criterion to comply with the adoption of this methodology according to the status that the organization has thereon. This model identifies "Level 0" as the simplest model, with 2D representation using CAD as a substitute for traditional paper drawings, where there is no collaboration whatsoever. "Level 1" starts introducing practices regarding the production, distribution and building information quality management, including data generated by CAD systems and a normalized collaboration process. In "Level 2" we already see a collaborative process requiring data exchange procedures among different project stakeholders, which implies 3D environment management with BIM tools and associated data of the different disciplines of the project. There is still not a single work model. Finally, "Level 3" involves, among others, the creation of a cooperation culture that allows project members to "learn and share", which enables a frame of reference for data integration, ensures the information consistency, empowers the collaboration and provides complete interoperability.

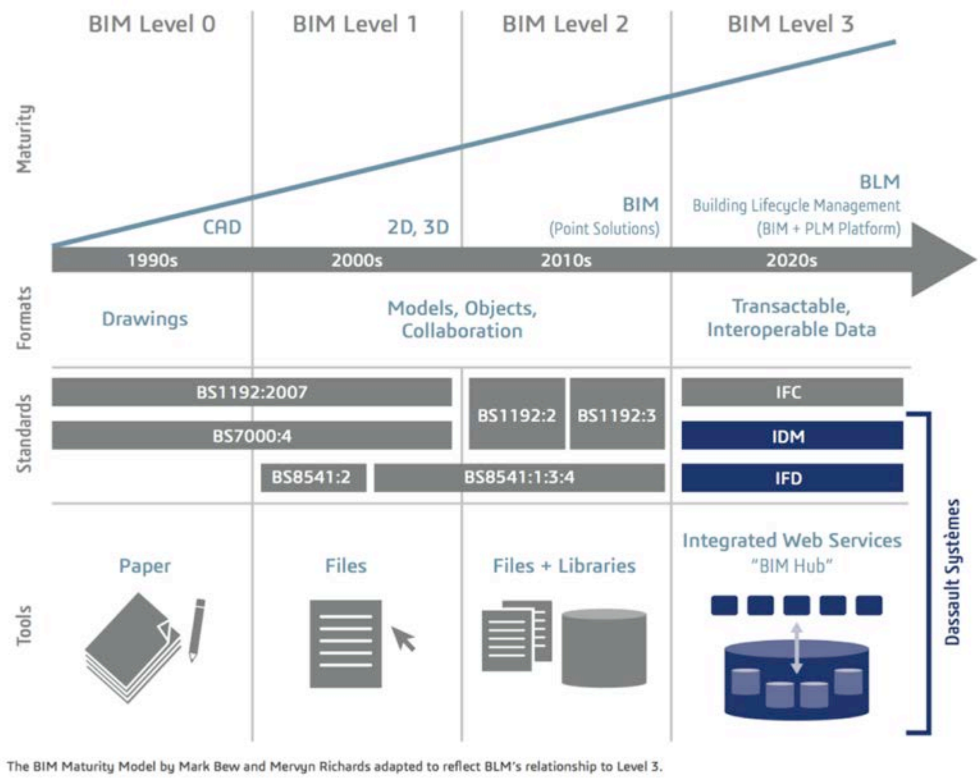

Figure 3. *BIM maturity levels defined by Mark Bew and Mervyn Richards*
Source: www.medium.com

2. Originality

In the literature we can find different papers and reports (Liébana et al., 2013) (Piedecausa et al., 2015) (Maldonado, 2016) concerning the implementation of BIM methodology in several university schools and faculties in Spain. Its inclusion in the various curricula has taken place from different platforms, in such a way that the approach to this matter has been made through cross curricular workshops, as in the University of Alicante (Piedecausa et al., 2017), integrating workshops in the University of Seville (Nieto et al., 2017), intensive teacher training programs in the Polytechnic, School of Cuenca (Cañizares et al., 2017), inclusion of the BIM methodology fundamentals in higher education courses (Gallego et al., 2015)(Valverde et al., 2016), inclusion of BIM methodology in building master degrees (Cos-Gayon, 2016), specific master degrees on BIM (Polytechnic University of Madrid, International University of La Rioja, University of Granada,…), development of own degrees (University of Oviedo, University of Seville,…), etc. All of them have a common denominator, which is the technical and technological aspect of the implementation of the BIM methodology.

It is evident that BIM integration in the past years has been chaotic and asymmetrical (Mokhtar-Noriega et al., 2018), where the technical aspect is playing the key role without considering the cultural dimension of this methodology. Therefore, there is not enough evidence about the importance of considering cultural and emotional aspects in the implementation of the BIM methodology in the education of present and future professionals. Why should engineering students know the BIM methodology? And why should it be taught from the perspective of the people rather than the perspective of the applications? Could this change of paradigm enhance the benefits of implementing a BIM methodology in the organizations? Is it really meaningful to teach future graduates the BIM methodology and BIM tools, without preparing them first to work in a collaborative environment? Should the curriculum of Industrial Engineering include training on learning tools such as cooperation? If companies have to prepare and train themselves for *managing organizational changes, shouldn't faculties in general, and those of Industrial Engineering in particular, be anticipating and implementing their own change management to adapt their educational model to the professional needs of collaborative models?.*

As far as we know, there is no clear and defined approach that actually responds to the above questions. Therefore, this paper aims at analyzing and proposing ways to go in the direction of improving the cultural and organizational bases supporting the technical knowledge of the BIM methodology.

3.Methodology

With regard to the data collection and accurate information that allowed doing the research, the starting point was the study carried out by the Subgroup 2.2 of the Work Group 2 (People), which defined the Technical Committee of the es.BIM Commission. The Spanish Ministry of Development (MFOM) created this Commission on July 14th, 2015 for the implementation of the BIM methodology in the country, with the aim of driving forward the implementation in the construction sector, thereby giving continuity to the European Guideline 2014/24/EU (European Parliament 2014) on public hiring, undergoing the Draft Bill stage for its incorporation into the national legislation. Specifically, article 22 makes reference to electronic and data modeling of buildings or similar by opening the possibility for member states to establish the requirement of using specific tools for electronic data modeling of buildings in construction processes.

The analysis of the BIM Training Map in Spanish universities (Commission es.BIM 2017) has allowed to delve deeper into the education of those universities where Industrial Engineering Schools are somehow teaching BIM-related courses. Based on data of this national map, which includes Undergraduate and Master Degrees university levels with BIM-related courses, the analysis is focused on the fields including training (subject matters, workshops…) within Industrial Engineering Undergraduate or Postgraduate Degrees, expanding on their teaching guidelines, in order to analyze the subjects included, the goals pursued and the competencies addressed in the context of the BIM methodology.

In the same line, the analysis has also considered the courses taught in Spanish universities by teachers belonging to the Spanish Graphic Engineering Association (INGEGRAF), a non-profit organization focused on promoting the field of Graphic Expression in Engineering, which either include BIM contents in the official teaching, or have an interest in including them.

Likewise, the implementation situation has been analyzed based on various talks and communications as of 2012, in the frame of the BIM International Congress – EUBIM (BIM users Meeting). Since the first conference, it has become one of the main sources of information regarding the knowledge of BIM implementation in Spain. In fact, a reference space within the congress has been considered for specifically addressing BIM at the universities, because they are considered one of the change agents of dissemination, training and research of new building project management methodologies. In this case, the analysis has focused on the communications resulting from real experiences over the years with regard to programming and implementing BIM tools in the curricula of regulated subjects of undergraduate and postgraduate degrees. The purpose was to see to what point the goals, possibilities, training methodology and outcome are aimed at or are capable of creating a collaborative policy for all building process stakeholders, thereby encouraging not only the knowledge but also the necessary competencies and skills to produce this cultural change.

Finally, as a result of the study, the conclusions summarize the state of implementation of the BIM methodology in Industrial Engineering Schools, and propose roadmaps or ways that will help bypassing the gaps discovered in the competency-based education of future graduates from these schools, in relation to the BIM methodology.

4.Analysis of the Information

According to recent data collected in Spain by the site www.universia.es, there is currently a total of 84 universities, public and private, which provide a total of 2,856 degrees. From these, only 699 are focused in knowledge fields that, theoretically, could include BIM teaching: Engineering, Technology, Industry, Architecture and Construction, with a ratio of 4.7:1 among public and private universities. The baseline data of the survey carried out by the es.BIM Commission, in order to know the current state of inclusion of the BIM methodology in the curricula, are supported by the responses sent by 28 of 119 schools with engineering and architecture degrees, which were asked to collaborate and whose public-private distribution ratio is 23:5. In this respect, it is important to highlight that only five universities (Cantabria, Extremadura, Jaén, Oviedo and Valladolid) with Industrial Engineering degrees participated in the survey, which represents 11.63% of the total (Architecture: 11, Engineering: 11, Building/Technical Architecture: 16, Industrial Engineering: 5), which clearly reflects the scarce implementation of BIM methodology in general and the little involvement of Industrial Engineering in particular.

On the other hand, nine universities (Almería, Córdoba, Jaén, Polytechnic of Cartagena, Oviedo, Polytechnic of Madrid, Polytechnic of Catalonia, Polytechnic of Valencia and La Rioja) were found to rely on teachers ascribed to the Spanish Graphic Engineering Association, INGEGRAF; and although all of them declared their interest to include BIM in the official teaching program, only six of them already offer courses including BIM content, but solely in the context of industrial engineering degree studies in the universities of Oviedo, Jaén and the Polytechnic of Cartagena.

Furthermore, a review was undertaken, throughout different editions of the EUBIM International Congress, regarding different communications and talks addressing the BIM subject in the university and, among them, those dealing with matters specifically related to university education (Chart 1). From the total of 25 communications that fit herein, none of them come from Industrial Engineering experiences; most of them, 52%, are communications forwarded by architecture schools, 20% from building engineering schools, 8% from civil engineering, and the remaining 20% corresponds to communications by different authors who are not ascribed to *any university, but nevertheless talk about or propose BIM training experiences. Once again, the scarce involvement of Industrial Engineering Schools with BIM methodology training is significant.*

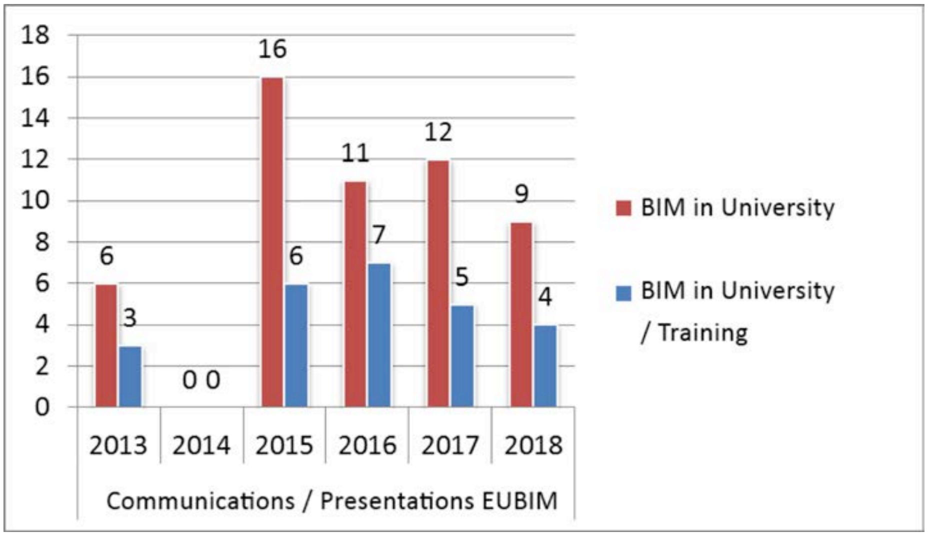

Chart 1. *Total number of talks about BIM in the university versus specific talks on BIM training in the university.*
Source: Self-prepared

Consequently, the training on BIM methodology has been limited to only four subject matters (Projects, Graphic Engineering Techniques applied to Mechanical Engineering, Industrial Applications of CAD and TFG) included in Engineering or Industrial Technology degrees of five universities (Table 1). The teaching load of these courses are mainly concentrated on the final course, with the exceptions of Graphic Engineering Techniques applied to Industrial Engineering of Mechanical Engineering Degrees of the University of Jaén, which is taught during the 6th term and the course on Projects/Technical Office taught in the second course of Engineering in Industrial Technologies of the University of Valladolid. Moreover, most credits are required in the Thesis course (Thesis Projects in the University of Oviedo), where the load of classroom hours and teaching activity is considerably lower. The contextualization of this course aims at the importance of integrating the acquired knowledge and, therefore, its contribution to acquire new ones is insignificant, which further reduces, if possible, the relevance of BIM training in the curriculum of these degrees.

Table 1. *Ratio of Industrial Engineering School courses with BIM*

UNIVERSITY	DEGREE	SUBJECT	COURSE / SEMESTER / FOUR-QUARTER	CREDITS
Universidad de Extremadura	Industrial Engineering	Proyects	7º Four-Quarter	6
Universidad de Valladolid	Industrial Technology	Industrial Technical Projects	4º Course	6
		Final Degree Project	4º Course	12
		Projects / Technical Office	2º Course	12
Universidad de Jaén	Mechanical Engineering	Graphic Engineering Techniques applied to Mechanical Engineering	6º Four-Quarter	6
		Final Degree Project	8º Four-Quarter	12
Universidad Politécnica de Cartagena	Industrial Engineering	Final Degree Project	4º Course	12
Universidad de Oviedo	Industrial Technology / Industrial Engineering	CAD Industrial Applications	4º Course	6
		End of Degree Projects	4º Course	12

Furthermore, different teaching programs of BIM training courses have been analyzed by comparing different competencies that can be acquired in each of them, with the purpose of seeing to what point the objectives related to the BIM methodology are homogeneous.

The competency-based teaching-learning process using a systemic approach demands the concatenation of all its components (objective-content-method-means-evaluation), which embraces all psycho pedagogical principles, systematization, logic of the course, and didactic process to allow students to acquire knowledge and develop skills (Marrero et al., 2017). The same premise has also served to analyze the alignment with professional competencies and skills required in the organizations that apply or wish to apply the BIM working methodology.

According to the new structure of the European Higher Education Area (EHEA), and following the trail of the Bologna Process, education is based on the acquisition of competencies. Although there is not a single definition, according to the National Agency for Quality Assessment and Accreditation (ANECA, in Spanish), competency is understood as the set of knowledge, skills, and attitudes acquired or developed through coordinated training experiences, whose purpose is to achieve functional knowledge that allows to respond efficiently to a task or problem of daily or professional life that requires a teaching and learning process (ANECA, 2012). On the other hand, and according to the classification used by the Ministry of Education in the Registry of Universities, Centers and Degrees (RUCT, in Spanish), competencies can be differentiated by their level of concreteness:

a) Basic or General Competencies, common to most degrees, but adapted to the specific contexts of each one. They are developed with more or less intensity, based on the characteristics of the degree in question.

b) Specific Competencies, inherent to a field or degree, aimed at the attainment of a specific profile of the graduate. These competencies must deal exclusively with training aspects and knowledge fields very close to the degree.

c)Cross Competencies, common to all students of the same university or university center, regardless of the degree they are studying.

Based on this classification, it is easy to find a certain disparity and heterogeneity in the assignment of competencies, types and denominations in the different courses, degrees and universities (Table 2). Thus, the Universities of Extremadura, Oviedo and Cartagena regard the basic and general competencies as two separate groups, while the University of Jaén regards all of them as basic competencies, and the University of Valladolid, as general ones. At the same time, the Universities of Extremadura, Jaén and Cartagena have defined the same basic competencies, while the University of Valladolid uses a different classification of general competencies. On the other hand, the University of Oviedo leans towards assigning basic and general competencies that are different from the rest. Something similar occurs with specific and cross competencies; the Universities of Extremadura, Jaén and Cartagena make a difference between them; the University of Valladolid only refers to specific competencies, while the University of Oviedo classifies as common competencies those that other universities regard as specific. And these are not the only disparities among classifications and denominations; a clear quantitative difference was also detected among the competencies assigned by one or the other university.

Table 2. *Classification of different competencies assigned to each course, based on the university*

UNIVERSITY	SUBJECT	BASIC COMPETENCES	GENERAL COMPETENCES	TRANSVERSABLE COMPETENCES	SPECIFIC COMPETENCES
Universidad de Extremadura	Proyects	5	11	10	1
Universidad de Valladolid	Industrial Technical Projects		2		7
	Final Degree Project		15		1
	Projects / Technical Office		2		1
Universidad de Jaén	Graphic Engineering Techniques applied to Mechanical Engineering	2		4	2
	Final Degree Project	2			
Universidad Politécnica de Cartagena	Final Degree Project	5	5	6	1
Universidad de Oviedo	CAD Industrial Applications	2	12		1
	End of Degree Projects		16		

It is also necessary to consider that, apart from their different classification, the competencies defined by each university are not totally consistent with each other. This competency scenario makes it difficult to envisage uniform and homogenous criteria in any new teaching project, especially when the competencies demanded by the labor market are in turn grouped into other several big chapters.

However, this situation should not surprise us, since the literature offers many definitions for the word competency (Figure 4). The following list (Cano, 2008) includes some of the many possible definitions available:

COMPETENCES

- Ability to effectively face a group of analogue situations by consciously, and at the same rapidly, pertinently and creatively mobilizing multiple cognitive resources: knowledge, capabilities, micro-competences, information, values, attitudes, as well as perception, evaluation and reasoning schemes.
- Complex knowledge as a result of the integration, mobilization and adaptation of capabilities and skills (either cognitive, emotional, psychomotor or social) and knowledge (declarative knowledge) used efficiently in situations with common characteristics (similar situations, something that cannot be generalized to any situation).
- Complex knowledge requiring a set of knowledge, skills, attitudes, values and virtues that guarantee the good nature and efficiency of a responsible and excellent professional practice.
- Capacity to apply knowledge, skills and attitudes to the performance of the respective occupation, including the response capacity to problems, unforeseen circumstances, autonomy, flexibility, collaboration with the professional environment and the work organization.
- A professionally competent person is someone who has the necessary knowledge, skills and attitudes to practice a profession, can review professional problems with autonomy and flexibility, and is prepared to collaborate in the professional environment and the work organization.
- Being capable, prepared or skilled in something. Competences tend to communicate the meaning of what the person is capable of or is prepared to execute, the level of preparation, competence or responsibility for certain tasks.
- Knowledge application level, capabilities and good judgment associated to the profession, in all situations that a person is liable to face during the professional practice.
- Capacity to successfully develop a specific action obtained though learning.
- Learnt ability to adequately fulfill a task, duty or role. It contains two different elements: it is related to the specific work within a particular context, and integrates different types of knowledge, abilities and attitudes. It is acquired through learning-by-doing. Unlike knowledge, the abilities and attitudes cannot be evaluated independently. You must also distinguish the competences of personality features, which are an individual's most stable characteristics.
- They represent a dynamic combination of attributes, with regard to the knowledge and its application, the attitudes and responsibilities, which describe the learning results of a specific program or how students will be able to develop themselves at the end of the educational process.
- Integration of knowledge, abilities, personal qualities and understanding, used properly and effectively in both familiar contexts and new and changing circumstances.
- Capacity to respond to complex demands and carry out different tasks adequately. It means a combination of practical skills, knowledge, motivation, ethical values, attitudes, emotions and other social and behavioral components that are mobilized together to make an efficient action.
- Integration of knowledge, skill and attitudes in a way that enables us to act effectively and efficiently.
- It implies having an ability regarding a basic mastery, but most of all, it implies regulation, monitoring and initiative capacity in the use and development of that ability.
- Capacity to functionally use knowledge and abilities in different contexts. It embraces understanding, reflection and discernment, by simultaneously and interactively considering the social dimension of the actions that are going to be carried out.

Figure 4. *Different meanings for the term competency*
Source (Cano, 2008)

As mentioned above, from the labor market perspective, competencies are grouped in a different way than those in the university teaching. Anyways, and if for no other reason, a competency study should serve as a link between the academic-teaching sphere and the labor world. According to (Olaz et al., 2011) the supply and demand in labor markets require a meeting point where both positions can reconcile. In this sense, and according to the Research Executive Report of (ANECA, 2007), "The Flexible Professional in the Knowledge Society", there are five big families of competencies required at work and, therefore, in the labor market: knowledge, analysis and innovation, time management, organization, and communication. When these competencies are developed to the fullest, they entail nineteen competencies (Table 3) required by the labor market, which reflect the following comparative table related to technical degrees:

Table 3. *Competency level required in "Current Work" and difference between the "Necessary Performing Level" and the "Level Acquired in the Degree"*
Source: ANECA.

	Level of competencies necessary for performance of "current work" Scale 1- "very low" to 7- "very high"	Difference `Required level` - Level acquired in titration` Scale from -6 to +6
Ability to make oneself understood	5.8	2.0
Ability to coordinate activities	5.7	2.0
Ability to use time effectively	5.7	1.6
Ability to find new ideas and solutions	5.7	1.4
Capacity for teamwork	5.7	1.4
Ability to perform under pressure	5.7	1.4
Ability to use computer tools	5.6	1.7
Domain of your area or discipline	5.5	1.4
Ability to quickly acquire new knowledge	5.5	0.6
Ability to write reports or documents	5.4	1.3
Ability to assert their authority	5.3	2.3
Predisposition to question one's own ideas or those of others	5.2	1.3
Ability to mobilize the capabilities of others	5.2	2.0
Analytical thinking	5.2	0.6
Ability to present products, ideas or reports in public	5.0	1.6
Ability to negotiate effectively	4.9	2.3
Ability to detect new opportunities	4.7	1.6
Knowledge of other areas or disciplines	4.4	0.9
Ability to write and speak in foreign languages	3.7	1.4

Nevertheless, there is once again a certain discrepancy with the reality of the labor world. Without going into too much detail, since it would be an exhaustive additional work, but as a complement to the purpose of the present paper, large headhunting companies at domestic level present their candidates quite a different list of competencies, which currently have a more defined orientation towards social and emotional intelligence than most of future graduates do. Maybe this difference is due to the fact that the emphasis on theoretical knowledge is very high in all degrees, especially in long duration ones, where our country is positioned among those where the theoretical teaching is most emphasized, and with relatively low comparative levels regarding practical teaching (ANECA, 2007). Already in 1996, Daniel Goleman wrote that "The academic intelligence does not offer the least preparation for the multitude of difficulties –or opportunities- that we will face throughout our lives". In comparison with the indicated list of ANECA competencies, the institution (DuocUC, 2002) built the Workplace Soft Competency Dictionary (Figure 5), whose theoretical framework was based on the competency approach of Hay/McBer developed by Hay Group International.

COGNITIVE CAPABILITIES AND INTELLECTUAL SKILLS	BEHAVIORAL SKILLS	PERSONALITY TRAITS	VALUIC ATTITUDES
-Critical judgement -Analytic Thinking -Conceptual Thinking -Rational Thinking	-Oral and written communication (Persuasion) -Leadership -Team work and collaboration -Work Organization	-Auto Control -Anatomy-Self-confidence -Interpersonal Understanding and Empathy -Disposition to Learn -Flexibility -Initiative-Proactivity -Achievement orientation	-Commitment (identification with the Company) -Ethics-Integrity -Order and Quality -Responsibility

Figure 5. *Competency List*
(DuocUC, 2002)

5.Conclusions

In light of the information provided above, it seems evident that the BIM methodology in the university field is at an incipient state. In brief, the following conclusions and work proposals may help and enable the adoption of a proper implementation model regarding this methodology:

1.We get the feeling that the incorporation of the BIM methodology in the teaching projects of Spanish universities is not very significant, especially if we compare it with the countries of Central Europe, and it is almost irrelevant in Spanish Industrial Engineering Schools. It is rather the schools of Architecture, Building Engineering and Civil Engineering that are leading this process.

2.There are no plans defined for the BIM implementation, or at least they are not accessible to the author, in Spanish university faculties. The processes are rather initiated by including BIM in the teaching programs with different approaches and always based on isolated initiatives that are not coordinated across schools.

3.There is a certain consensus regarding the formulation of BIM integration in the curricula, pilot projects whose results are expected to consolidate the implementation proposals, while considering that there are opportunity frameworks that can temporarily mitigate the lag of the integral BIM incorporation in the universities.

4.The poor implementation of the BIM methodology evidences a high lack of awareness on the side of the teachers, which should be solved by means of coordinate actions aimed at their involvement in the process as key players for the success of the process.

5.The EUBIM congress presents itself as an important point of meeting and discussion for a possible homogenization of teaching initiatives on BIM matters.

6.The heterogeneity of curricula, in general, and their assignment of competencies in BIM-related matters in particular, evidence a significant gap between the competency needs and demands within the labor market.

7.Emotional competencies should be a chief focal point in a methodology that, like BIM, is highly important among collaborative and multidisciplinary processes.

8.The BIM methodology implementation proposals in university schools should be strategic in the first place, and operational in the second, so as to minimize the effect of the "product" of our universities, the graduates, perceiving the huge differences between the academic world and the labor *market when completing their studies and starting their professional life.*

9.The creation of an inter-university commission appears to be absolutely necessary as an articulating element, which is capable of unifying the targeted goals, both in knowledge matters and interpersonal and intrapersonal skills, thereby detecting the competency needs of future BIM-specialized graduates.

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