SPECIFICATION STANDARDS FOR THE NEW MANAGEMENT SETTINGS OF CONSTRUCTION

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ABSTRACT

The new forms of management, which have been applied to construction, imply a differentiated demand of information contents on products and services. The alterations in the contract models, project development, control methods, as well as the quality management system requirements, need both content and form of product and services data dissemination to be homogeneous, in order to allow the interoperability of systems and agents.

Many product-classification systems already co-exist and, at the moment, an impressive international standardisation effort is taking place through OCCS. This proposal, which is mainly focused on products, does not encompass important points for the management of the whole life span of a building. For this, it will be necessary to add new facets to the classifying structure and to deepen product definition, including the description of the production space. The creation of descriptive standards associated with these classification systems may consolidate a more understandable language for construction management, which may be transcribed or incorporated by languages such as XML or IFC standards.

The basis for building these standards must be a consolidated terminology. Based on this, it will be possible to establish associative networks of concepts linked to building management and production processes. It will also be possible to define the most common characteristics linked to each category of products and services, treating them as attributes of these items, as well as all types of uses, elements and spaces composing the environment where the management process takes place.

KEY WORDS

Specifications standards, building management systems, terminology.

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INTRODUCTION

Many studies (e.g., Amorim 1995 and Lantelme 1993) point to construction management systems as one of the main factors for the improvement of construction efficiency. In the case of Brazil, a MacKinsey study indicates a productivity gain potential, linked to this aspect, in the order of 45 percent above the general level of productivity in habitation buildings, which is equivalent to almost 70 percent of the difference between Brazilian and North American levels of productivity. In Europe, back in 1998, Egan (1998) stated that *integrated processes and teams has been indicated as one of the five key drivers of change for building industry*.

In this context, the implementation of computerised tools for management support has been standing out in the quest for fewer losses of applied resources. These tools facilitate both process standardisation and activity marking, though maintaining the flexibility inherent to different situations encountered in building completion. It is important to differentiate process standardisation from product standardisation. The later has already been abandoned as a business strategy. Even though it is a "prototypes industry" (e.g., Gallon 1990), with unique products, the activities that take place on construction sites are repetitive. A process approach, such as that approved of by the principles of lean construction, facilitates this perception.

Despite much theoretical progress, the effective implementation of systems with a full integration or interoperability has been quite disappointing in practice; multiple translations are still needed for each system change, with the resulting losses and failures. For example, product research (e-procurement) is still limited to single descriptive standards, making it necessary to adapt specifications to each case. Also, losses of information occur during data exchange between the different designers. Furthermore, the distribution of products to constructors does not have standards which common with production control systems on the sites. As a consequence of this occur alterations and adaptations, activities which are counterproductive and increase the possibility of errors.

At the root of the problem we find the lack of terminology and reference concepts that would be able to compose a common reference, or a "frank language" as favoured by some authors, for specific systems oriented towards the knowledge areas in question.

It is in view of these problems that Woestenenk (1998) proposes a common vocabulary for construction, based on the "Built object" concept; this idea has being developed in the central dictionary presented by the web site www.econstruct.org. But a problem remains for its usage on project and construction processes management. During the project development, its component objects are not immediately inserted in a well-defined way, but rather, they go through a progressive definition. For example, a designer firstly stipulates the existence of a wall, later specifying that is made of gypsum plasterboard or masonry, then defining the finishing and finally incorporating all the data necessary for purchasing and carrying out the components. Cases in which a perfect specification occurs from the beginning of conception, known as inception, are very rare.

Otherwise, the definition of objects is usually negotiated by many intervenients during the production process. That is: a specification is not a finished object which is incorporated to the process at a given moment; it is the result of a process of negotiation and communication between different agents. There is a relationship between definition level, process and momentum.

Through this negotiation, the object definition deepens in a progressive and incremental way. For example, the designer initially defines the existence of the wall and some of its dimensions; afterwards he/she defines the basic components, until obtaining a list of effective components that have well-characterised performances, either for themselves or for the building elements. Furthermore, it will not always be necessary to reach the final level of definition; one may want a definition capable of leaving greater margins of choice to those responsible for the project execution. For example, it is possible, in certain types of projects, to establish that a particular component must be installed but without specifying colour or model or even defining boundaries for some performance characteristics while leaving the final choice of a solution to the builder.

Although this situation might seem odd, flexibility during execution is common and even necessary in less developed countries, and also emerges as a positive factor in performance based or in "design-build" projects. The possibility of negotiating solutions based on simpler criteria bypasses the easier option of always pointing out a solution instead of proposing an enunciation. This is a common practice in construction, given the nature of our issues, already characterised as "ill-defined problems" by William Mitchell (1977).

In order to make this possible, we will need a clear conceptual reference, common to the various systems which will contemplate the link between the term's application environment and its meaning; that is, the relationship between process and related concept, at the moment of their insertion in systems.

The concept of a design process as a flow of information through time and space (e.g., Koskela 2002) reinforces the importance of computerised tools, since they are often used as the interface between the different players in these activities. A significant contribution have been established in the ISO DIS 12006-2 proposal for a "Framework

for classification of information". However, as it is based in the concept of a "*simple process model:* ***construction resources*** *are used in or required for* ***construction processes****, the output of which is* ***construction results***", it presents some limitations for a representation of the whole construction context.

A better approach is made when agents and constraints are included separately in the process model, as represented in Figure 1. A mainly difference is distinguishing information in two genders: it can be a restriction, as a standard, or an input, as a site information. Following this idea it is necessary to rearrange the construction properties and classes schema proposed in the ISO DIS 120006-2, resulting in the Figure 2. This new schema allows a better structure to establish the basic conceptual map, which will be naturally further detailed as the terms database increases.

Combining terminology with this map of contextualised relationships make possible define descriptive standards for construction. For example, a "ceramic tile" is a term associated with its attributes, as dimensions, thermal coefficient etc. Grouping the associated terms within the same process will result in the list of data necessary to perfectly define this product. These descriptive standards can be freely associated, without acting as restrictors to the product variability craved for by the market. These components for management systems will contribute to more efficient management. By eliminating the repetitive activities in the handling of information characteristic of the management process, it contributes to being a "lean project management", in the sense proposed by Holman (1996). In our opinion, management resulting in a "lean product" is not enough, but rather it must itself present effectiveness and efficiency.

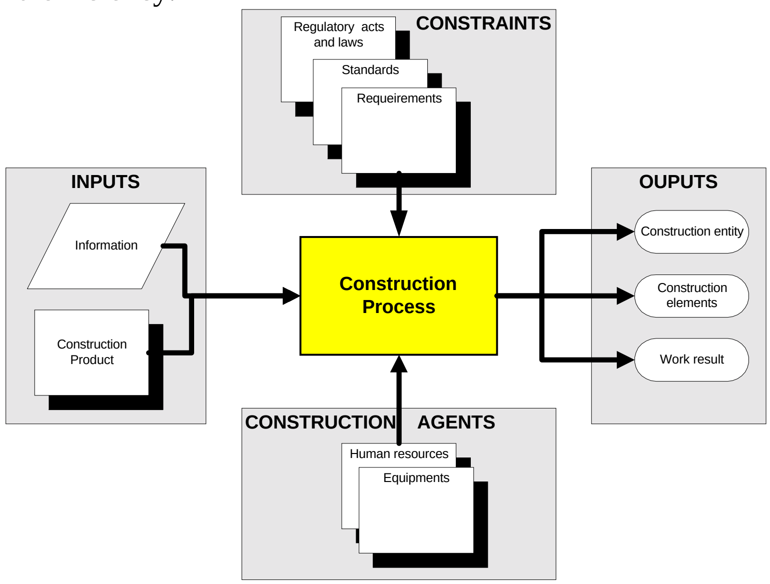

Figure 1: Basic Construction Process Diagram

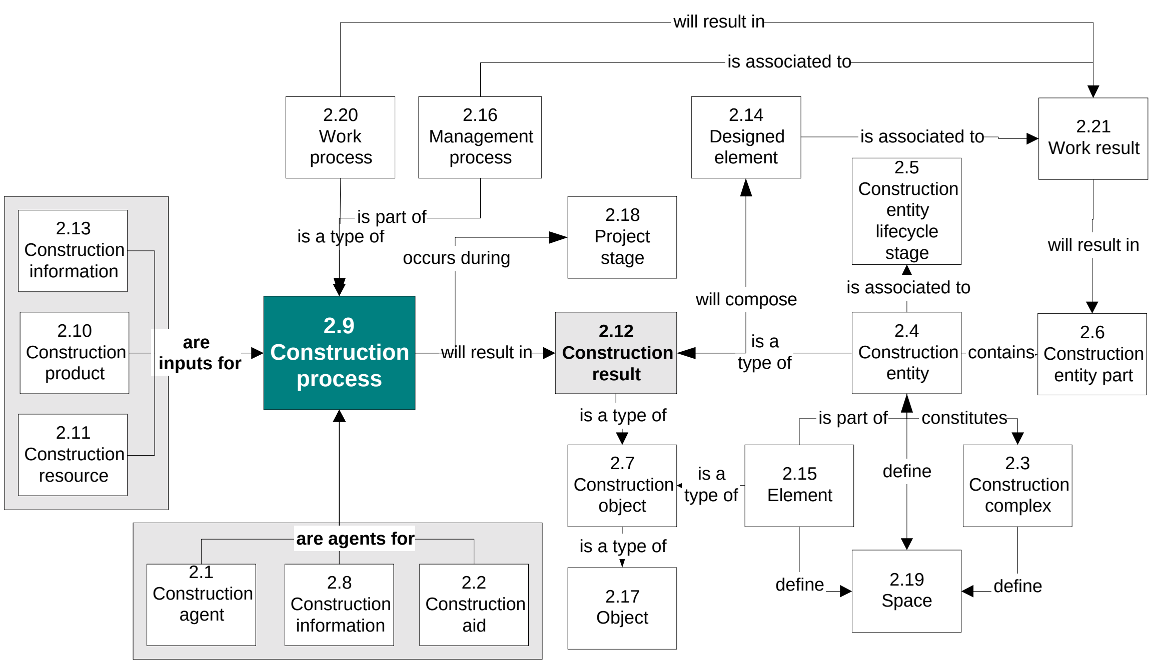

Figure 2: Classes and their general relationship (Adapted from ISO DIS 12006-2).

A CONTRIBUITION FOR SYSTEMS INTEROPERABILITY

We believe that systems interoperability proposals will receive a significant contribution through the development of a reference terminology and its own concepts and semantic relationships, which will make the elaboration of a construction thesaurus possible. The principles of terms systematisation, common to terminology and classification, contribute to representing and structuring of information from the knowledge base. Through adequate technology, the database will be made available to other systems that will then obtain terms and their concepts related to the building process objects.

This is the central objective of the CDCON project, in Brazil. It emerged as a response to a FINEP Edict, at the HABITARE Programme, presented by construction-oriented research teams at three federal universities, UFF, UFSC, UFRGS, organised by the ANTAC – Associação Nacional de Tecnologia do Ambiente Construído – National Built Environment Technology Association - (see www.antac.org.br).

This project intends to consolidate a terminology, which was initially limited to the building sub-sector. Along with associations and logical relationships between terms, defined by the approach to construction processes, the project aims to offer a system interoperability basis. This project also includes in its guidelines both attention to the peculiarities of the Brazilian situation and respect for the compatibility between interoperability proposals developed in the international arena.

Different from a dictionary, where one finds only an alphabetic list of terms and its concepts, the project intends to consolidate a national terminology, now scattered and sometimes conflicting, as well as to conceptualise each term and to establish their associated and partitive relationships and synonymies, with the due respect to Brazilian construction's organisational logic and practices.

Even if one of the objectives is a compatibility with the proposed international systems of classification, it is still early days to know if and how will it be obtained. Perhaps it will be possible to achieve this compatibility through simple tabulation or perhaps more sophisticated components might be necessary.

THESAURUS AND CLASSIFICATION SYSTEMS

Terminology and Thesaurus are distinct tools that represent the same concepts of a given area of knowledge, only structured in a different manner. A term's concept must express the essential characteristics of the object, its functionality and its reference value into the knowledge area, in a linear way. The thesaurus expresses those same characteristics, functionality and reference value in the shape of a graphical structure.

Through the relationships, which are defined inside the very concepts, it is possible to establish links between terms, be they hierarchic, partitive or associative. The thesaurus structure however must take into account some common central concepts that allow their insertion, highlighting the need for a classification order that reflects the importance of diverse aspects considered during the building process.

At the moment, an impressive international standardisation effort is taking place through the OCCS – Overall Construction Classification System. But this proposal, which is mainly focused on products, does not encompass important points for the management of the whole life span of a building. It is limited to the production phase, and does not encompass use and maintenance, refurbishment, alteration, re-commissioning and decommissioning or demolition. For this, it will be necessary to add new facets to the classifying structure and to deepen product definition, including the description of the production space.

ISO DIS 120006-2 presents quite a solid proposal of classes and is an indispensable reference, but as we discuss before, it only offers to the initial structure for the different classes. OCCS has significantly developed its proposal and it intends to establish the basis for a system with international validation. There are, however, certain limitations. Among them are the system's origins, which reflect their organisational culture. Developed on the Masterformat (CSI) structure, OCCS naturally presents an Anglo-Saxon culture prevalence, due to its original language. The difficulties of translating between idioms reflect these aspects, since a literal translation does not always contemplate the different organisational nuances and process models in each country.

The approach to construction-pertinent processes is another point in need of development in the OCCS proposal: in Table 08 - Process Services, the "Construction" division does not show any subdivision. In contrast to design or project management for example which has a much more detailed granularity. Also, conceptualising the Process phases as "*the time dimension of a constructed entity*" as proposed by OCCS, which although is correct, does limit its contents. Restricting phase to time excludes the associated targets which are always more important since they are the results of the processes completed during the phase.

These limitations may have their origin in the OCCS structure, since their facets are aggregated with different levels of detail: construction processes are subdivided into phases, services, participants, aids, information, while other dimensions are more condensed. This makes sense to OCCS' proposed objective, but as regards the thesaurus organisation there are "crossroads" between those aspects, which make control much more difficult. It is obvious that the OCCS will be not sufficient in order to fulfil information classification needs for project management, and it will present serious limitations for applications regarding knowledge management for construction.

In considering the need for more facility in this system management, we have adopted a structure composed of seven facets, which could easily relate to OCCS' structure:

<u>Construction Processes</u> (Process Facet): Group of activities whose completion results in the Building product.

<u>Construction Products</u> (Component Facet): Materials and products consumed at production level.

<u>Building Elements</u> (Element Facet): Products of a constructive process.

<u>Building Spaces</u> (Space Facet): Construction parts, delimited according to their spatial usage.

<u>Building Typology</u> (Using Facet): Different uses for construction products.

<u>Building Attributes</u> (Attribute Facet): Classification of the construction objects characteristics.

<u>Construction Agents</u> (Agent facets): People and equipment which permit or are responsible for the construction processes.

THE RELATIONSHIP BETWEEN TERM CONCEPT AND OBJECT DEFINITION

After the thesaurus structural facets are defined, it is necessary to establish rules for term conceptualisation, so they may contain a clear relationship between the different facets, when pertinent. Although each term is conceptualised in only one point of the thesaurus, it must be associated to other facets' terms, and the highlights will be the attributes, which will always be present in some way.

The associative network between terms intends to allow for an element to bring associated characteristics that are related to its components, in a kind of "inside out hereditary" link. For example, the term "roof" (*building elements* facet) is associated to the term "*heat performance*" (attributes), since it is a significant characteristic of this element. An associated component to "roofing" ("*Construction products*" facet), like a roof tile, inherits the need for description of this coefficient. Even though its respective coefficient is different from the whole, it will always be a part of its composition. They are, however, different measures of the same amplitude and there will be other attributes that are characteristic solely of the component and, besides, not all the links are transmitted in the same level of importance: in this example, the roofing's heat performance is usually irrelevant.

The associative relationships between the facets' terms, named elements, processes and components take place in a progressive manner, respecting the building project and execution processes, since these relationships are found at the conceptual basis of the thesaurus model. The valuation of the associative links is a complex task and the solution achieved has been the resource to the practical experience of specialist groups, in a wide collaborative network. They have validated the associations, starting from somewhat subjective criteria for today's eyes. With the march of time, we hope it will be possible to extract these relationships' best-structured criteria from the database, in order to allow the definition of specific rules on the matter.

Even so, this network enables the setting up of standard descriptors of components, processes and other building descriptive items. It is possible to extract, from the concept's list, the pertinent associations, which are truly blank forms to be filled in by one particular construction aspect, while keeping the capacity of description contextualisation, according to the process' phase. Its availability to other systems, in a structured mode, may be very useful to set up catalogue systems, with consistent and interchangeable information, or CAD systems that contemplate the data needed for the specification's transport or re-usage in other systems that flow in the same direction of the construction production process, such as IFC standard, as well as XML standards, like the ones developed by the AECXML.ORG consortium.

Finally, this approach facilitates the development of multilingual dictionary systems starting from the relationships structure. The comparison between concepts and their insertion in a relationship network enables more exactness in translations, since context differences must be addressed.

RESULT DISTRIBUTION

A question that is still open is the issue of standard formatting for the availability of terms inter-relationship. Until now, there has not been a standardized distribution of relationship networks for the different systems that will have to access them. A single document containing the entire network would be excessively long. Focusing on an extract depends on the description of the focus's range, which leads to new difficulties. If one wishes to add information from various sources, such as product suppliers or representatives from different origins, one must consider the original formats. Interoperability is very well faced with the using of XML standards. Applications of this technology, however, are still in the cauldron; it evolves at a remarkable pace, making its immediate acceptance for universal usage difficult, especially for very lengthy documents.

It is also worth considering that the implementation of data exchange via INTERNET presupposes interaction between human beings and computers, whose pre-requisite is the existence of a common ontology. But there is no consensus for the implementation of a common taxonomy, at the moment. Extrapolation efforts through information extraction and evaluation (e.g., I.A.I 2001) are initiatives that begin with automatic translation. Translation requires plenty of knowledge of the languages concerned, which means that as long as there is no consensus on ontology, taxonomy and a "neutral" language, any availability will depend on a huge dose of replication.

We believe that the implementation of XML gateways, as intended by the European Industry for Building and Construction (e.g., Tolman et al. 2001), would be the most adequate way to converge Information Systems. Another possible alternative is to fraction the base into sectors in order to obtain shorter documents, which will now be portable using current technology. The presented proposal, since it just focuses on building, encompasses both possibilities. It may be made available to other systems either through a central database, or thorough a distribution of documents in XML standard, given the pre-defined domain limitations.

CONCLUSIONS

Although it is a complex task whose success depends on an ample mobilisation of experts, the development of a thesaurus with the proposed methodology may represent an effective contribution to major system interoperability, with significant profit to building productivity. If the quality of management improves, it is only natural to expect the best construction performances as well as the elimination, or at least, the significant reduction in projection, acquisition and supervision errors. This will certainly contribute to the objective of better building management efficiency, as well as to the existence of dependable translation systems, which will facilitate international transactions, through the dissemination of the data of different cultures in a trustworthy and compatible way.

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