

INNOVance: Italian BIM Database for Construction Process Management

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ABSTRACT

INNOVance research project, funded by the Italian Ministry of Economic Development, wants to push a radical innovation into the Italian Construction sector by creating the Italian construction database, containing information about products, works, spaces, etc., along the whole constructions service life. This research wants to improve the efficiency in using and maintaining objects information, which is achieved by linking continually updated extensible life-cycle objects data to independent software, by using Building Information Models, throughout the entire life cycle. The work done consists of three main steps: a) to give an unambiguous name to everything in the construction process, from products to spaces, from activities to buildings, etc.; b) to define structure and content of the information related to each named entity; c) to pair each entity in the database with a BIM object.

The multitude of rules, definitions and practices that characterizes Italian construction sector causes difficulties in data transmission among stakeholders, so the first priority of INNOVance was to create a coding system based on a standardized and unequivocal name. To manage and use information through the construction process technical datasheets have been defined and standardized among homogeneous objects categories (construction products, spaces, construction operations, etc.) to allow users in easily and quickly comparing and retrieving information. Data will be freely accessible throughout a web-based portal that relies on the INNOVance database. In addition to this, specific plug-ins allow creating, updating and linking objects directly from BIM software.

Database interoperability at the end of the project is guaranteed by BuildingSmart Italy, with the adoption of the IFC protocol.

INTRODUCTION

A strategic step toward the optimization of both the building process and the whole construction sector, is represented by the rationalization of the information flows connecting construction process stages (planning, design, construction, use, management, maintenance, disposal or reuse) and the various actors involved (customers, users, designers, contractors, components manufacturers, etc.).

Nowadays Italian building sector is changing fast; 80s and 90s, with their deregulation, are past and there is a increasing need of clearness and transparency; this is mainly due to the increased projects complexity, which brings more effort to all stakeholders in producing documents, obtaining permissions and achieving the right performances. Transparency can be achieved through a correct information transmission among clients, consultants and contractors, which is one of the main objectives of the INNOVance research.

Italian contractors are improving their way of working but not all of them are ready for further changes: most of them do not want to spend much money in R&D or to improve their management. This happens not just because they are “bad companies” but simply because they are very small enterprises, with few workers and almost no economical possibility of improving their own structure. INNOVance wants to help all these companies by easing their work, thanks to an efficient management and data sharing system.

The INNOVance first interoperable construction database, based on the standard UNI 11337 “*Building and engineering works – Coding criteria of works, activities and resources – Identification, description and interoperability*”, helps improving constructions energy savings and environmental sustainability , by placing the whole sector in an information network.

Partners such as ITC-CNR, ANCE, SAP and others more, under the scientific guidance of Politecnico di Milano, are developing the prototype of a management structure to exchange technical and economic standardized information; more profitable organizational flows and knowledge transfer time reduction are the starting point to assure building objects efficacy and efficiency.

First and second years results are here reported, with special attention to: building coding system, database structure and definition of standardized technical datasheets, agreed with some important Italian producers’ trade associations and building contractors.

OBJECTS STRUCTURE

The classification of every object (more or less aggregated, material and immaterial) involved in the construction process has been the first step done in this research.

First of all, the objects pertaining to the construction process have been organized into a hierarchic scale, from the more complex (construction works - the final results of the process) to the less ones (construction products), as seen in Figure 1.

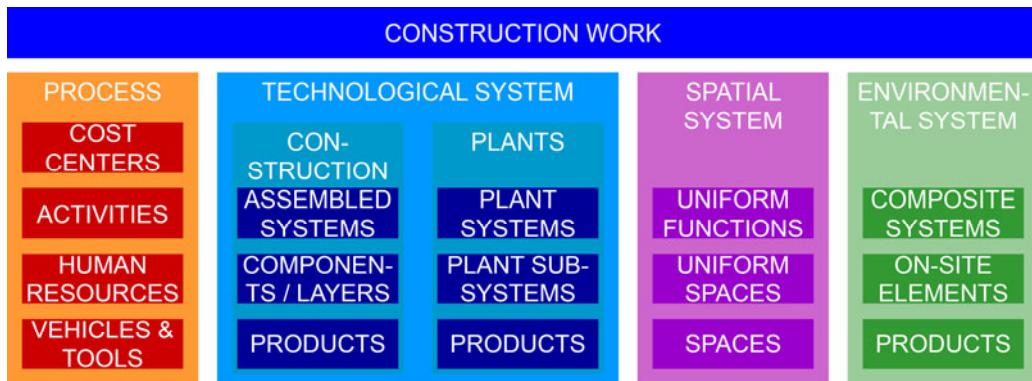


Figure 1. INNOVance objects structure.

This organization has been done on the basis of existing coding standards, i.e. UNI 11337 (UNI, 2009), UNI 8290 (UNI, 1981), OMNICLASS (Omniclass, 2013), CI|Sfb (Sfb, 1950) and Masterformat (CSI, CSC, 2013). Moreover, each object has been described with an unequivocal name.

This structure is mandatory to organize the complete system because INNOVance does not want to be a static instrument but a dynamic one, with a deep connection with users, which eventually will be able to create/search/download/manage objects (in the BIM library mainly), to organize projects and tenders (in the BIM server), always staying within INNOVance boundaries.

The system actually allows users creating objects and linking them to a sort of dynamic Work Breakdown Structure (WBS): starting from any point of the system (entire work, simple or aggregated components, etc.) it is possible to create objects within the INNOVance hierarchy and to define all the possible interconnections, as instance: how many functional layers have to be used inside a wall, construction products selected for each layer, the space to which a wall is connected, what is the function of the space and of the entire building, up to the complete definition of construction elements, plants, spaces and resources to be committed.

Eventually, this structure, where each object is associated with an unequivocal name (the code), a technical datasheet, its life-cycle indicators and a BIM object, is the core of the INNOVance system and it will be accessible through a web portal.

INNOVance DATABASE

INNOVance project relies on a database that contains all the above-mentioned features. Here main system characteristics are presented, from coding to technical datasheets and web portal, mandatory for having a user-friendly interface and information management.

Coding system. It is the instrument that allows both creating, managing and searching objects, by giving them an unequivocal name. This has to be seen as a first data set able to identify objects; other important information are contained in the

technical datasheets and in the BIM objects associated. This name, in combination with the database code (SAP ID), allows users avoiding ambiguousness and problems related to data transmission errors; it is also the bridge between the database and external interoperable software (in this project an Autodesk partner is testing connection between Revit and the database, but in a short future many other companies will be involved).

Each object name is made by the aggregation of seven characteristics that make it unequivocal. These seven fields, once defined, describe the object in a complete way: category, typology, reference standard or function, principal performance, geometry, dimensions, physical-chemical characteristics. The fields are organized in a way that allows the addition of new characteristics, following the construction sector evolution. Objects inside INNOVance are also associated to different lists of attributes. There are different levels of complexity, from simple products to the entire work, passing through activities, workmanship and equipment. Users can either create objects, name them, insert data and BIM models or search for a specific object or category. In Table 1 a short example of the code for a window is given.

Table 1. Example of INNOVance code for a window.

FIELD NAME	INNOVANCE PROPERTY
1. Category	window
2. Typology	internal bottom hinged
3. Reference standard	UNI 14351-1
4. Main performance	1.2 W/m ² K
5. Geometry	single wing
6. Dimensions	TxWxH 7x90x140 cm
7. Physical-chemical properties	PVC frame

Technical datasheets. Technical datasheets associated to specific objects categories give the second level of information and can be seen as the complement of the INNOVance code (the code and a technical datasheet together, in combination with the SAP ID, define a specific and unique object). The necessity of a standardized template for each category of construction objects is clear: having all the data in the same place allows comparisons, statistics and simplifies decision-making process.

Datasheets contain all useful characteristics related to the following sets of topics: code, description, use, manufacturer's data, performances (mandatory by CE laws, by Italian laws and/or voluntary), sustainability, safety, geometry, visual aspects, physical-chemical properties, tolerances, composition (with brief components description), homologations, transportation, packaging, product declarations and attachments (including photos, videos, drawings, QR, etc.). Attached to technical datasheets, some objects may have an "installation&use" guide, containing information about installation (with also consumables and components to be used), correct use, maintenance (suggested interventions, with frequencies and service life) and disposal indications.

Figure 2 shows an example of a technical datasheet template, made for construction products (bricks, parquet, paint, etc.).

SCHEDA TECNICA
Prodotto da Costruzione

ELEMENTO DI LEGNO PER PAVIMENTAZIONI PER INTERNI

Descrizione da capitolato tecnico
Elemento per pavimentazioni multistrato prefinito di legno a due strati con incastro femmina-maschio di spessore totale di 13 mm costituito da un supporto in multistrato di betulla fenolica e da uno strato superiore di 4 mm di legno nobile di doussie.

- Reazione al fuoco: Cfl-s1
- Emissione (e rilascio) di formaldeide: E1
- Durabilità biologica: 1 (uso interno)
- Resistenza termica: m² K/W 0,076

Norma di riferimento per marcatura CE: UNI EN 14342:2008 – UNI EN 13489:2004
Pavimentazioni di legno - Elementi multistrato con incastro
Elemento a costruzione lamellare costruito da uno strato superiore di legno massiccio e da uno o più strati aggiuntivi di legno, o materiali a base di legno, incollati insieme

Denominazione INNOVance:
Elemento di legno per pavimentazioni per interni, multistrato con incastro, UNI EN 14342 – UNI EN 13489, conduttività termica 0,171 W/mK, 2 strati, spessore legno nobile < 2,5 mm, 1200x90x13 mm, doussie

Codice INNOVance:
A.A010.T34u.VxsL.dpIB.ra3u.Zu.kpE

Spessore	mm	13
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Figure 2. Example of an INNOVance technical datasheet.

Thought it seems to be a normal technical datasheet, the information standardization, hierarchy and connection with the database make the INNOVance technical datasheet a powerful instrument, able to deal with daily problems of the construction sector: lack of information, misunderstanding in ordering materials, low performance of the finished work, delays and, eventually, low yield investments.

The INNOVance datasheet, made to satisfy designers' and construction companies' needs, contains all the required information, if need be, differentiated by Level of Detail (LoD) (Hamil, 2013) (PAS 1192-2:2013). Depending on the project phase, data can be entered in the technical datasheet and shared to all the stakeholders, avoiding again delays and overcosts for data transmission and calculation.

Web portal. The portal, which will integrate the actual website (www.innovance.it) and the database, currently under development, will be the tool that allows the use of the knowledge management structure depicted above. Technical datasheets, codes and BIM objects will be soon accessible online thanks to a web-service with a user-friendly interface, which is under development. The web portal will allow users to manage their projects, by these functions: a) objects creation: thanks to the INNOVance objects structure, navigation in the database becomes easier and users have the possibility of creating BIM objects, entering codes, technical datasheets and additional life-cycle information; b) object search: as previously stated, users (also inexperienced ones) can search, download and manage information related to INNOVance objects, also with pre-formatted “views” targeted to different users' categories (clients, designers, contractors, constructors, producers, etc.); c) project

management (BIM server): consultants and professionals have a specific section of the web portal dedicated to project management, from the early phases (design brief, site acquisition, etc.) to construction, use, maintenance and disposal or handover. This section contains standardized “folders” in which users can upload documents and drawings, associating them with INNOVance objects. With a “drag and drop” process interaction between database and BIM server would become easier. The BIM server can be used also as a repository, to store BIM models (not depending if they are complete or not) and d) BIM library: users can exchange standardized BIM objects, to be used in their own models.

Eventually, web portal will be neither a simple interface for objects download nor a complete substitute of existing BIM modeling, structural and energetic analysis software but, as seen in Figure 3, it will be an instrument able to manage the whole process, exchanging and storing data, making them accessible to everybody.

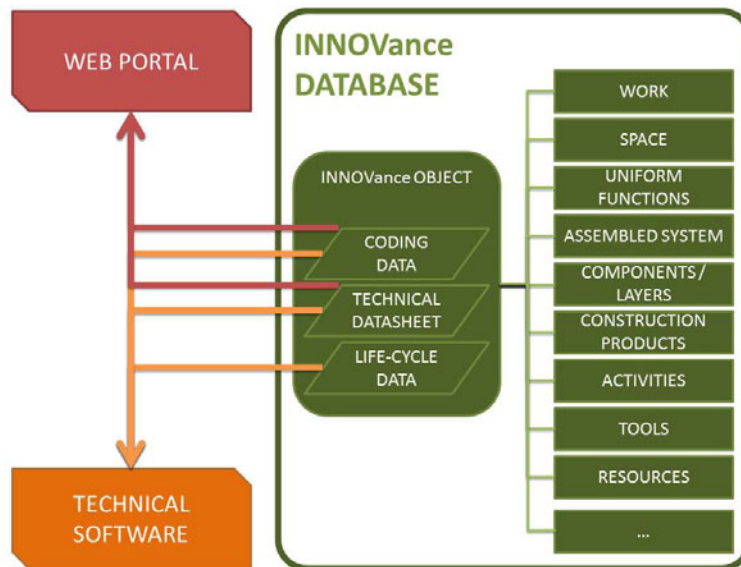


Figure 3. INNOVance web portal working scheme.

The INNOVance web portal has the potentials to become a really powerful instrument and also in this development phase improvements and possible functions are coming out. During next months the test phase will help in discovering criticalities and potential of this tool.

BIM OBJECTS

Here the procedure for the production of standard libraries of interoperable BIM objects for the INNOVance research project is outlined, as well as critical and innovative issues experienced.

The build-up of a collection of interoperable BIM objects is an important part of INNOVance, making this project one of the most innovative for the construction industry. Database interoperability, seen as the possibility to exchange data between

software and the database itself is currently under the test phase. Anyway, during project development, information coming from IFC (BuildingSmart, 2014) and COBie (WBDG, 2014) have been analyzed and implemented in the technical datasheets and in the INNOVance project in general.

BIM technology, which is now seen by many as a driving force for the constructions industry, needs operational standards useful to guarantee not only that the information would be shared, but also to make sure that the information could be actually used by any of the actors along the process. The development of interoperable building libraries is the necessary premise for this, and it is a fundamental step in order to facilitate the diffusion of BIM throughout the industry.

The work procedure that has been established can be split in four main points: a) analysis and definition of the object model of a technical component; b) coding of the component according to the INNOVance standard; c) BIM modeling, in this phase the code generated in the former step has to be linked to the component and d) set up of the objects for the check phase, in order to verify that they comply with the interoperability international standards of BuildingSmart (latest release of the IFC protocol).

A first group of BIM objects, a set of building components (taken from the case study of Figure 4), has been produced in order both to define operational standards and to check the issues related to the specific software tools used for this specific job. The research will go on in order to verify interoperability, to identify solutions to critical issues, and to produce technical elements being part of different subsystems, such as plants and others.

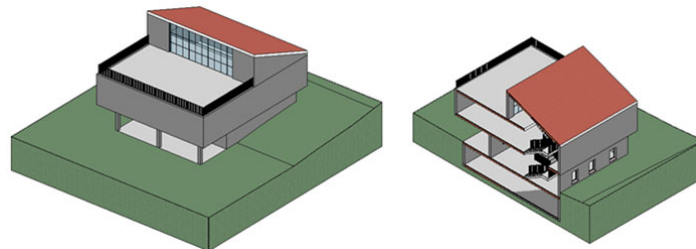


Figure 4. INNOVance test building.

INNOVance is also implementing an add-in (Figure 5) for Autodesk Revit Architecture able to link objects to the database, thanks to the INNOVance code. This tool is also able to check compliance with characteristics between Revit data and the database, allowing users to easily match and/or correct objects characteristics.

INNOVance is now developing BIM library and server sections, obviously in parallel with all the other above-mentioned project activities. Eventually, a stronger and deeper connection (guaranteed for interoperability) with the web portal is needed to allow users creating/modifying/managing objects both from BIM software and database.

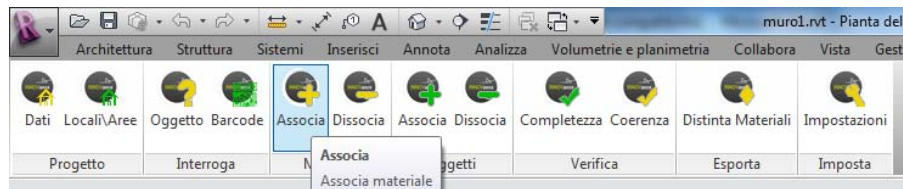


Figure 5. INNOVance Autodesk Revit add-in.

CONCLUSIONS

INNOVance project wants to improve building sector process quality, by helping stakeholders in avoiding misunderstanding, losing time in updating documents and ordering wrong products during construction and maintenance. By unequivocal names, technical datasheets and BIM objects, all organized in the INNOVance portal, each user can manage his projects, since the design brief and through all the further phases. The different tools depicted above (BIM library, BIM server, objects creation/research, products section, etc.) are in test phase or at the end of the implementation and they are made appositely to satisfy Italian construction sector needs. After almost three years of work, potentials have been assessed and main criticalities solved but there are still lots of important improvement that can be implemented. INNOVance database is going to be an enabler for collaboration, providing transparent definition of agreed deliverables from each contributing party at every single project work stage. This approach enables each party to understand their shared obligations to the project and also provides clear understanding as to the materials they can expect to receive at the start of each work-stage, thus enabling them to deliver appropriate information, data and geometry themselves.

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