ICT-Platform for Object Oriented Knowledge in the Building and Construction Industry

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1 ABSTRACT

The building industry is going further into the information- and communication technology based society. This paper describes a proof of concept of a knowledge based service, connected to the Norwegian part of an infrastructure for sharing interoperable and semantic flow of information on all levels in a building project. The problem today is that the various application developed are company and building phase specific. The presentation will describe utilisation of the IFC-standard and ISO/DIS-12006-3 that are developed for this purpose. NBI want to be heavily engaged in developing a knowledge platform for the construction industry to obtain more efficient collection, administration, distribution and exploitation of information, experiences and knowledge. The base for this work will be the Building Research Design Sheets that are widely known in the industry. This will strengthen the Norwegian Building Industry in an International market, and further spread our unique tradition of knowledge management internationally. In addition to increased cost efficiency by sharing, saving and reuse information and applications in the building process, it will reduce the risk of building default as a result of lack of information.

2 INTRODUCTION

2.1 Background

The ISO standard known mostly as Industrial Foundation Classes (IFC) has steadily reached an implementation level where it now provides real value for users in projects. IFC allows, among other things, two or more unrelated applications in the building process to exchange information about the underlying model the project wishes to realize. We can now move away from drawings and focus on models. This allows us to continuously enrich the model with relevant information throughout the building process.

International Framework for Dictionaries (IFD), or the ISO 1200-3/PAS, extends IFC to include unique and specific definitions of concepts used in the building industry. A simplified analogy would be to describe IFC as a communication method, just as speaking is a communication method commonly chosen in certain situations, as opposed to sign language used at other times. IFD is then the language used while speaking. A Japanese person speaking Japanese, will most likely make no sense to a Norwegian, but if she chose English as the language they will get better along. IFD provides the dictionary, the definitions of concepts, the common understanding, necessary for the communication to flow smoothly.

The current building process is primitive in terms of information exchange. Various stages in the building process, although depending on the same information as other stages, will not share that information. The information is reentered, reinvented, or worse, wrongly reinvented or reentered, in
each stage. A large amount of resources is wasted in these transactions, and errors sneak in. There is a strong need to find an alternative way of working.

2.2 Motivation

The Norwegian Building Research Institute (NBI) has for over 50 years developed and collected knowledge related to building buildings. Our knowledge base is unique and highly regarded in the Norwegian Building Industry. We have over 800 design sheets, describing best practices, research results, and experience, which is frequently used in the construction industry. They are used by “do-it-yourself” amateurs, professional carpenters, lawyers, builders, etc., for practical advice on the construction site, as legal foundation for contracts or as knowledge support during various phases of a building project.

The new IFC and IFD standards allows for new ways of delivering and gathering this knowledge. That will improve the usefulness to the end user and ensure easier access to experience by future users. It is no longer necessary for a user to read, process and understand all the information contained in a typical design sheet, but “in-your-face” knowledge can pop up during, say, the design phase of a project, to warn of potential complications with the chosen solution. We move the burden of keeping up with all the information and analyzing its meaning, from the individual to an application or computer system. Although it will always be necessary for experts or interested persons to read, analyze and understand this information, the information will increase its value with an additional simplified usage and access.

3 PRODUCT DESCRIPTIONS

3.1 “BARBi”

“BARBi” is an acronym play on the Norwegian word for a reference library for the Norwegian Building and Construction Industry. It is a fully developed, compliant and working platform based on the IFD standard. This allows producers, engineers, architects and users to completely define products and concepts and populate the BARBi database. The product will be available through an open and clearly defined Application Programming Interface (API), and be free to use for the Norwegian Building Industry. A neutral organisation will maintain and run the database. The goal is to synchronize the definitions with other national IFD based dictionaries, like LexiCon in the Netherlands. As of April 2004 the Netherlands' LexiCon and Norway's BARBi was fully synchronized.

One vision the IFD standard make possible is to allow a project in, say, Norway, to order products from anywhere in the world, by just specifying the necessary values of the interesting properties on the products, as defined by the national dictionary. Any producer, anywhere in the world, will know exactly what kind of product the project needs, since the national dictionaries are synchronized.

3.1.1 Simplified Example of Usage
A door in Norway is defined by “bredde” (“width”), “høyde” (“height”) and “brannklasse” (“fire category”), as properties. A door in USA is defined by “width”, “height”, “fire category” and “security class”. In the dictionaries, “bredde” is given the same unique ID as “width”, since the meaning and definition is and exact match. Same with “høyde” and “height”, “brannklasse” and “fire category”. However, in USA there is an extra property, related to security class, that Norway has no concept of. This is no problem, Norway simply do not define it. When Norway then orders a door, it specifies the three properties, and producers in USA know exactly what that means. If a producer in Norway wants to sell doors to USA, it then will need to understand what is meant by “security class” and perhaps enrich BARBi with that definition, for use when issuing an offer to the consumer in USA.

3.1.2 Technology

IFC and IFD are defined in the open and standards based EXPRESS language. The database foundation for the BARBi platform is native EXPRESS and can thus easily accommodate and comply with the standard. EPM Technology's product, EDM, provides this database engine.

The API's used for accessing the database are currently under development, but will be based on standard web technology, and can thus be implemented using a large range of technologies and programming languages. A simplified API exist today, using standard HTTP URLs and XML. A web interface is also currently being developed to allow the Norwegian community to populate the database, and add terminology as more and more domain experts get together to define their domain specific products and concepts.

3.1.3 Current Status

The database already contains the following:
- 9 different languages
- 999 activities or processes
- 40901 names
- 6600 definitions
- 41 actors or roles
- 1939 properties
- 8757 objects and subjects
- Ca 680 groupings
- Ca 1300 relations between concepts

In addition to this, we are currently working with domain experts for windows and domain experts for timber related products to create template definitions for the domain's respective products. Other work groups like this are planned.

3.2 NBI Knowledge Base

NBI's knowledge base is currently kept in an internal electronic format, optimized for publishing design sheets as paper documents, on CDROM or on the web. All three formats are targeting humans directly.

3.2.1 Proof of Concept

As a proof of concept, we have taken a tiny fraction of the information in our knowledge based system, lifetime of materials, and stored the information using IFC and IFD technology. For example, we have stored a list of materials, using definitions and concept IDs from BARBi, in the IFC format. Furthermore, we organized the formulas describing the material lifetime, as properties related to geographical position. Everything consistent with IFC, using the IFD standard for semantical understanding of the stored knowledge.
3.3 **NBI Services**

NBI is currently developing several services that we will provide to end users. The way to deliver these services is currently under heavy investigation, to ensure openness, usability and effectiveness. Many requirements must be met at the same time, and some pilot case studies is most likely necessary to ensure a service that the market needs.

### 3.3.1 Proof of Concept

Again, as a proof of concept we developed a small service targeted human users directly, using web technology. The service chosen was lifetime of materials.

Starting with a model in IFC format, most likely from a model server, the user must upload a partial model of the building, containing the parts she wants to estimate the lifetime for. The upload is done using the standard IfcXml format. To estimate lifetime, the user must first choose the location of the building (or perhaps planned location), and then through a 3D viewer\(^1\), click on the part of the building lifetime is sought.

When the user clicks on a building object in the 3D viewer, the system does the following:

- Checks with BARB\(i\) what kind of material the object clicked on contains
- Looks up in the NBI Knowledge Base for the lifetime of the material, using the material definition from BARB\(i\)
- Returns the lifetime to the user

We assume that the IFC model contains material ids from BARB\(i\).

Three completely stand alone technologies come into play in this demonstration:

- BAR\(B\)\(i\)
- NBI Knowledge Base
- NBI Service

They are all necessary to deliver the end result for the user, and their interaction is made possible due to IFC and IFD.

### 3.3.2 Remarks

It is important to emphasize that this is only a proof of concept. It might have limited use for end users at this point, and the “in-your-face” knowledge we aim for as much as possible is not met. However, the concept solves all major technical problems, and opens up for new ways of delivering knowledge and experience.

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\(^1\) Provided by Octaga AS (www.octaga.com)
4  RESULTS

We have delivered a simplified NBI Service, using open standards such as IFC and IFD. The user is given a web based application, where she can upload part of an IFC model from her project, enrich the model with lifetimes for materials used in the building and thus increase the information available to the project.

The power of IFD is demonstrated, since the proof of concepts are totally dependent on the BARBi data. We have also shown that all the independent technologies can smoothly work together, provided they are used in a compliant way.

5  CONCLUSION

We have shown that the IFD standard is necessary in addition to IFC to allow for conceptually and semantically understood and clearly defined information exchange. It no longer matters what language you are familiar with, knowledge and experience based data can be available to end users in productive ways, as long as the IFD concept is properly used. Even more powerful scenarios will emerge when the effort is coordinated internationally.