

# eProCon: electronic Product Information in Construction

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**ABSTRACT:** The lack of industry standards and agreements for electronic presentation of information on building products is hampering seamless eWork, eProcurement and integration of value chain activities in the construction industry. Technical and trade information about building products is not available in electronic form to designers, contractors and facility managers that would make it possible for them to easily re-use it in design systems and to find, compare and procure products on-line. The eProCon project brings together nine partner organizations: the Building Information Centers in all five Nordic countries, two technology partners and two research institutes. The purpose of this consortium is to demonstrate a dynamic value adding information services network in the Nordic countries for brokering building product information by electronic means. The Building Information Centers have been brokering building product information on behalf of manufactures for more then 20 years to the construction sector, using proprietary information systems that are incompatible in content, functionality and technical solution. The primary impact the eProCon project will have on the current state of the art is enabling interoperability between these systems and allowing them to share content (and enrich the content), thus becoming one virtual service available for all Nordic end-users. The demonstrated integration platform, applying Service Oriented Architecture, includes: 1) the core integration layer enabling the existing Nordic information services and a new product portal to act as a single Nordic virtual service to its end-user, 2) the update layer enabling manufacturers and suppliers to interact with the information contained in the services and 3) the catalog layer, which enables 3rd party buy applications to access the information. The paper will report on the approach selected in the eProCon project and first prototype implementations.

## 1 INTRODUCTION

As the use of ICT systems is becoming more advanced, requirements for data exchange and enterprise wide interoperability is seen as a key issue for improving productivity and information management in the construction value chain. While software vendors focus on intra-enterprise and inter-enterprise interoperability requirements, the majority of organizations in the Construction Industry (97% with fewer then 20 employees) are Small and Medium Enterprises (SME) and Very Small Enterprises (VSE). Typically these organizations operate low-end software solutions from multi-vendors that where not designed to interoperate across platforms and find it a challenge to collaborate in the virtual enterprise and exchange information between activates in the construction value chain. Kazi and Hannus (2001), Hannus and Kazi (2000) described linking between enterprise systems hooked through flexible interfaces to a central VE repository as the means for inter-enterprise information exchange,

while the International Alliance of Interoperability (IAI) develops Industry Foundation Classes (IFC), neutral conceptual model for describing the building product that can be exchanged between applications. Despite these efforts and several major research initiatives to create an interoperable platform for the construction industry, the Product Data Technology (PDT) has not yet made high enough impact in the industry. Standard objects described by product data model, in shareable libraries, are still not readily available for use in design, construction and maintenance/operation processes that may move the industry towards model based construction and integrated solutions. To move the building product and material industry which represent a significant part of construction value chain (estimated at 40% of total construction works) towards new ways of working there need to be an underlying economic motivation. Meanwhile no common agreement exists for electronic description of building products and multitude of representations will emerge as readily available technology makes new start-ups easier and less



costly – multitude of web-sites, information brokers and eMarketplaces.

Later in this section several initiatives are discussed that have addressed the different needs of building product information delivery so that it can be transparently shared, exchanged and re-used in different construction applications across platforms.

### 1.1 Background and Motivation

Building Information Centers in the Nordic countries have for more than 20 years provided services to the building product and material industry by operating show rooms for display of building products providing industry practitioners with access to information and a place to learn about available product ranges. Additionally they have published paper-bound product information sheets covering a wide range of building product types. In recent years information about manufacturers and their products have been made available on the Web.

Currently the Nordic building information centers have a dominant market position and collectively represent over 7000 product manufacturers and suppliers in the Nordic countries and provide information on hundreds of thousands of products. The Building Information centers have developed proprietary information systems based on their own data models and national classification systems resulting in incompatible systems, at the Nordic level, both in content, functionality and technical solution (e.g NOBB in Norway, RT-files in Finland and VaruDB in Sweden).

Industry requirements for open systems capable of data integration on the application level and support for on-line trade are being recognized as necessary steps to maintain market leadership as similar systems from elsewhere are trying to penetrate the market.

### 1.2 Objectives

The eProCon project is funded by the Nordic Innovation Centre and brings together nine partner organizations: the Building Information Centers in all five Nordic countries, two technology partners and two research institutes. The purpose of this consortium is to demonstrate a dynamic value adding information services network in the Nordic countries for brokering building product information by electronic means. The primary impact the eProCon project aims at over the current situation is enabling interoperability between dissimilar information systems and allowing them to share and exchange product information, thus becoming one virtual service available for all Nordic end-users. This will:

- Enable construction professionals and facility owners to search for building products across the Nordic countries
- Provide synergy across the Nordic building product and materials market and strengthen its competitiveness and international standing.
- Provide infrastructure for small and medium sized enterprises to participate in the rising electronic market, to extend their market reach and lower their cost to market.
- Improve the Nordic position to influence development initiatives in this area
- Create a fair market environment for SMEs in which they can compete on equal terms
- Increase information value and re-use.

Additionally the eProCon project aims to provide a domain model for enriched catalogue and product information (demonstrated in a “Product Portal”) and services that enable access of information providers (manufacturers and suppliers) for producing and maintaining product catalogues and 3rd party eProcurement and buy-side applications and eMarketplaces.

### 1.3 Past Initiatives

Projects in the past have addressed the requirements of the construction participants for electronic product information, more efficient search mechanisms and procurement of products. RINET ([cic.vtt.fi/rinet](http://cic.vtt.fi/rinet)), CONNET-MPS ([www.connet.org](http://www.connet.org)), PROCAT-GEN and ARROW (Newnham and Amor, 1998) aimed at demonstrating product model approach to product information and use of parametric search methods.

Others initiatives of particular interest that focused on need when working and trading across borders, aspects of a single market e.g multi-lingual content and construction semantics.

#### Lexicon - ISO 12006-3

The Lexicon is a product of STABU in the Netherlands (Woestenenk, 2000a,b). The Lexicon is a tool for developing and maintaining vocabularies (taxonomies). The Lexicon was one of the source documents for the ISO 12006-3 standard, (ISO, 2000), prepared by working group WG6 of ISO TC59/SC13 and defines the information model on which the standard is based. The scope of the standard is to specify a language-independent information model, which can be used for the development of vocabularies used in information about construction works.

Two efforts are concurring to partially populate the Lexicon, in Holland the BAS project for Civil-Engineering works in the Dutch and English languages and the Norwegian BARBi (BARBI) project, which is now testing the use of reference data for



product catalogues based on sawn timber, windows and doors.

#### E-Construct project

The eConstruct project developed a communication technology for the Building Construction (BC) industry and a BC vocabulary called the bcXML. The developed solutions are focused on eCommerce and eBusiness in the supply chain of construction. Like Lexicon, the eConstruct project presents Meta-Models for a common neutral BC vocabulary (Taxonomy) in multiple languages that will enable exchange and language translation of information without losing meaning (semantics). The model collects BC objects (terms) and property definitions in dictionaries. Some constructs of the Meta-Model have been harmonized with the IAI IFC to enable integration with PDT. The object of interest is the shared ifcXML\_COS model (Common Object Schema), which provides among other things, the definition of object properties and collection of properties into property sets. In the bcXML model the property definition is called a "Specification". The specification describes the characteristics of construction objects contained in the "bcDictionary".

#### E-Construction CEN/ISSS workshop

The CEN/ISSS E-construction workshop (van Nederveen et al., 2002) took off in end of 2002. The objectives of the workshop is to consolidate and draw from previous efforts and results of EU research and cluster projects and international initiatives and to set forth a holistic standardized approach to implement ICT in relation to eCommerce and eBusiness in construction. The workshop will develop five interrelated standards to meet its objectives.

- European eConstruction Framework, a high abstraction level which describes the of the world of construction
- European eConstruction Architecture identifying common meta-schemas, schemas, taxonomies, APIs and software tools
- European meta-schema consolidating on-going and previous efforts from eConstruct, ICIS, IAI etc.
- European eConstruction Ontology that will be an open, agreed taxonomy for the European construction industry
- European eConstruction Software toolset, which will comprise of tools for realization of the standard architecture and that can be shared among actors

## 2 PRODUCT INFORMATION - MATCHING THE REQUIREMENTS

In the introduction we mentioned that manufacturer's need to be economically motivated to meet the requirements of the industry for re-usable product information Table 1.

Table 1. Example of re-usable Product Information

Product specification	Can we use a descriptive or performance based description of the product directly in our specification?
Construction classification schema	Does the product information contain the ordering and identification we use in our project?
CAD object	Can we drag and drop or import the graphical representation and technical properties of a product into our design system?
Product certificate	Does the product carry quality certificate and code compliance?
Guidance	Can installation and maintenance guides be imported into design and product documentation?
Environmental declaration	Is there a statement by manufacturer that gives declaration of environmental performance?
Product catalogue	Can we use manufacturer article number, product description and price directly in our ERP?
CE-Marking	Can the product in question be freely exported/imported in the EU market?
Global identification	Does global identification of the product match ours e.g. DUNS, EAN, UN/SPSC?
Business documents	Is the information following standard procurement documents?

The question most frequently asked is how can we solve the technical and functional requirements for re-usable product information from the industry practitioner point of view, but to much less extent how do we also, provide the mechanisms that match the manufacturer requirements for re-usable information, ideally from the same information source, which must be the key to motivate manufacturers to produce re-usable product information the industry requires, especially when taking into consideration the large number of SME participating in the construction value chain.

The eProCon project looked at three information processes as the bases for re-usable product information:

- eWorking during design and construction of a facility. eWorking deals with the data integration in the building lifecycle where product information is shared, exchanged and re-used transparently between application and lifecycle stages over networks through standard interfaces and data models.
- eProcurement where material and product suppliers are identified that can supply the needed





goods, matching the design specification and agreement on prices, order and delivery is reached. eProcurement provides the technology so that buyer and seller business applications can handle electronic transactions and exchange business documents transparently.

- eProduct and eCatalogue content management broadly described as the process where product information is created, filtered, organized, archived, published and disseminated. eProduct content management focuses on product data (the corporate asset) and the integration of that data into business and eCommerce applications, whereas eCatalogue management focuses more specifically on data within product catalogues. eProduct and eCatalogue content management systems generally provide the technology that integrates structured and unstructured information sources so that they can be maintained and accessed as if they were a single source to produce enriched product information e.g. literature, catalogues, promotion and sales material in the proper format and codification and for integration with supply chain collaborators.

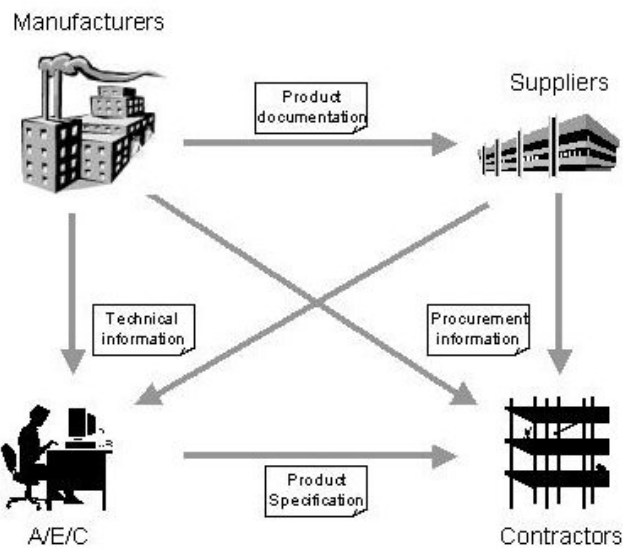


Figure 1: Product Information in Construction

Put into context Figure 1 illustrates the basic roles and relationships between actors in the construction value chain.

Traditionally, product information is discovered in a peer-to-peer topology. Designer and contractors use established contacts to obtain information, company archive, browse the web or follow-up on advertisements to find the products they need on each occasion. Similarly manufacturers discover suppliers of components for assembly into their products (not shown in figure) and as re-sellers for their products and vice versa. In this arrangement valuable effort is spent in searching for the right organization, product or component often by trial and error approach.

As the Internet majored a large collection of information services have entered the marketplace (Figure 2) that provides single access to company and product information from an array of manufacturers and suppliers. This topology has proven efficient in dynamic markets where fragmentation is high such as in the construction industry.

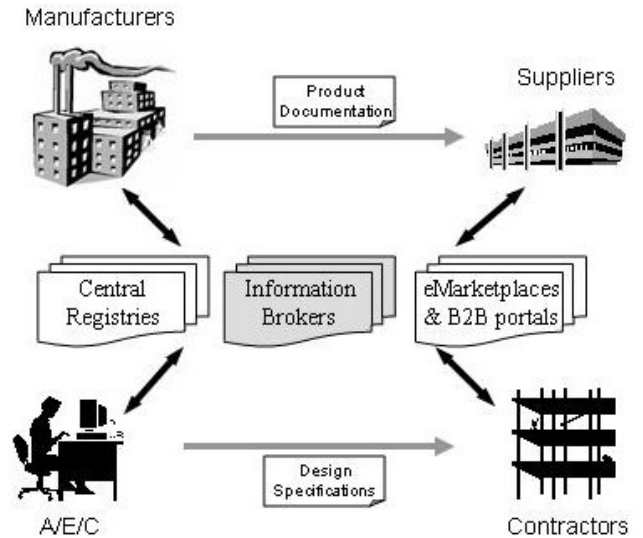


Figure 2: Service Providers as Infomedieries

Figure 2 identifies three types of information services, each of which perform a special role in the product information delivery, but provide different type of services to its customers and use different methods, detail and classifications to present its content. Providers may offer one or more of these services consolidated to their customers or separately as standalone information products.

Registries provide repositories for information about businesses including information about the services and the products they provide to be discovered by potential business partners or autonomously by applications. The more widely recognized registry standards are Universal Description, Discovery and Integration (UDDI) ([www.uddi.org](http://www.uddi.org)) and OASIS ebXML Registry/Repository ([www.oasis-open.org](http://www.oasis-open.org)).

The UDDI provides a platform-independent, open framework for describing services, discovering businesses, and integrating business services using the Internet. A UDDI implementation is primarily a mechanism to advertise and discover Web services. However a UDDI registry is a general-purpose registry and therefore not limited to registration of Web-services. It contains categorized information about businesses and the services that they offer that can be discovered by business partners over standard interfaces. Cope and Amor (2002) conducted an investigation into using UDDI registries as alternative to traditional catalogues offered by vendors and the ability of UDDI to handle information about product manufacturers and suppliers, their business offerings and further information in a brokering framework.



The work further studied searching for products matching a particular classification and extensions that could include product parameters.

The OASIS ebXML Registry/Repository standard is emerging as a key component of developing Web Services for e-commerce and many other uses. It is also a general registry, which can be used not only for business but also for any other organization and for any purpose. The OASIS standard uses a generic and extensible information model that can be adapted to many uses. This information model includes the ability to have arbitrary associations between entries in the registry. Furthermore, the standard includes a repository. Any type of data can be stored in the repository including Web Service descriptions, XML data and documents, binary data (such as images, sound files, video data, executable application files, CAD files etc.). Consequently, the OASIS ebXML Registry can be deployed as a public registry, a private registry used within an organization, or a registry shared by an organization and its partners.

The Information Broker's core activity is to collect and aggregate varied information from a range of information sources and make it available as a collection to their clients. Its business model aims for the broker organization to add value by further processing, organizing, profiling, cross indexing and making reference to external information as part of the service. Information brokers may in fact author much of the content themselves and provide expertise and service to their clients in content provision - as is the case with the eProCon information services partners. The McGraw-Hill Construction (Sweets) ([www.construction.com/ProductCenter](http://www.construction.com/ProductCenter)), Corenet - Construction and Real Estate Network, E-Catalogue ([www.corenet.gov.sg](http://www.corenet.gov.sg)), and the Barbour Index ([www.barbour-index.co.uk](http://www.barbour-index.co.uk)) are well known examples of product information service that fall into this category.

eMarketplaces and B2B portals main focus is to bring buyers and sellers together and facilitate transactions in business-to-business (B2B), business-to-consumer (B2C) relationships. eMarketplaces are mainly sell-side i.e. represent the selling agent and specialize in particular vertical markets e.g. Steel24-7 [[www.steel24-7.com](http://www.steel24-7.com)]. The content in general is characterized by the business transactions and business services available in the eMarketplace, although it is evident that the detail of information is becoming of higher standard including detailed product information, design details and technical specifications that can be used for making design decisions as well as for procurement.

Registries are likely to play a major role in facilitating integration in eBusiness and provide the infrastructure for single electronic markets. One example of a worldwide registry is the Internet Domain Name Server registry that enables identification and loca-

tion of computers in the global network. The important concept of registries is that it allows companies to maintain their services and product information in-house vs. outsourcing it to information service providers like described above and yet still be equally visible in the marketplace. Registries also support the generation of dynamic supply chains in the virtual enterprise.

Clearly, for manufacturers to be visible in the electronic marketplace they may need to register with several service providers and re-enter company, product, catalog, and service information into dissimilar systems and formats. One point of service aimed at by the eProCon project was to facilitate a single source of information that could autonomously be syndicated to various types of services or be referenced, downloaded when greater detail and other documentation is needed such as in the case of eMarketplaces.

### 3 METHOLGY AND DEVELOPMENTS

#### 3.1 *eProCon Integration Model*

When developing the solution for interoperability of existing product information systems hosted by the building centers and for them to provide re-usable product information several alternatives for neutral data representations were reviewed as considerations: A) The Industry Alliance for Interoperability (IAI) Industry Foundation Classes (IFC) information model - the key technology for interoperability and information sharing between heterogeneous software applications in the building industry (the IFC 2x introduced the ifcXML specification that defines the complete IFC Model in the XML Schema Definition Language (XSD) as opposed to EXPRESS and provides an alternative approach to information sharing), B) existing XML/B2B standards and C) proprietary solution designed for optimized response and minimized complexity.

In order to support the varying data already available in the existing systems a normalization of the product information data models was carried out. The normalized data model was then analyzed with respect to the standards. The review lead to the shared view and conclusion of the consortium, despite the fact that great interest was to follow the IAI-IFC standard, that a custom-tailored solution adhering to the standard when possible should be adopted as the integration solution. The risk and potential cost involved following or adopting one standard over another, especially in the XML/B2B field, was a deciding factor. Also taking into consideration, complexity and ease-of-use of the core integration specification to enable the building centers to exchange product information transparently and for end-users to find information across the Nordic ser-



vides the requirement for 3rd party application integration support was not considered feasible using the proposed specification. The alternative solution was to implement programmatically a three-layer approach, Figure 3 that could be incrementally realized by the building centers and fitted more readily to their business plan. The solution further aimed at greater flexibility and support for current and emerging XML/B2B standards.

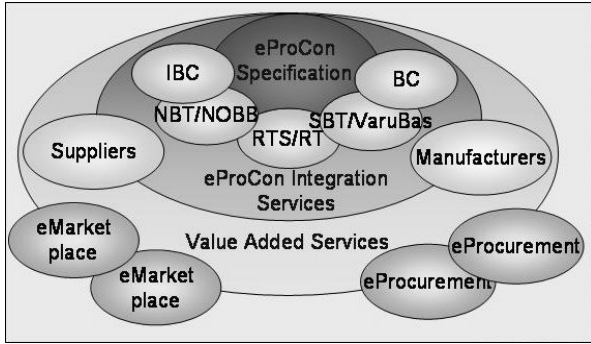


Figure 3: eProCon Value Network

Figure 3 identifies the three main integration points aimed at in the eProCon project:

- 1 Data integration of building centers information systems
- 2 Controlled data access by information providers
- 3 Data sharing with 3rd party eProcurement and buy-side applications and eMarketplaces

### 3.2 Technology description

eProCon underlying integration strategy is based on Service Oriented Architecture (SOA) where web services are leveraged as integrators between distributed applications.

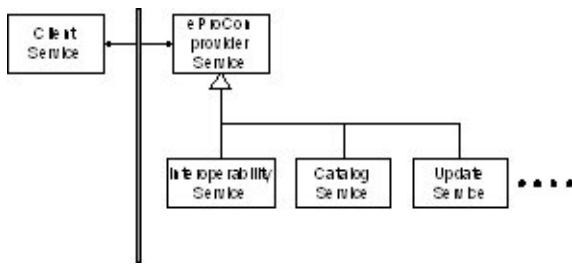


Figure 4: The eProCon Integration Services

The web service architecture provides a standard, technology independent platform to expose the functionality of an application regardless of language, operating system or vendor component architecture used for its implementation. Web services are self-describing and use open Internet standards for message transport and discovery, description and invocation respectively (XML, HTTP, SMTP, UDDI, WSDL and SOAP). The SOA further provides a component model that inter-relates the different

functional units, in this case web services, through well-defined interfaces and contracts.

Figure 4 illustrates the selected approach satisfying the generic requirements of the business services. The pilot implementation of the eProCon Integration layer includes three service types: 1) The eProCon Integration Service, which provides data integration of existing information services, 2) Update Service, which enables information providers to access and update product data and 3) Catalogue Service, which enable buy-side applications to retrieve catalogue and product information in standard format. The eProCon Integration Service exchanges product information using the proprietary eProCon Specification, which was especially crafted to optimize the communication process between the existing services. The specification is composed to three main data elements which can carry information about companies, products and documents. For IAI-IFC 2x compatibility, elements include property definitions, property sets, classification and other elements that match the IFC model concepts. The Update and Catalogue services on the other hand use the standard XML/B2B catalogue interchange format BMECat, which is an enriched data protocol and widely supported by business applications. BMECat can similarly carry information on properties (features), hierarchical classification systems and varied document types that make it ideally suited for both purposes.

The Provider abstract layer encapsulates the service functional parts: a) an adapter/provider framework to achieve retrieval and mapping from native data repositories to the required application protocol and b) delegation framework that enables delegation according to the requesting application protocol.

The adaptor/provider framework dynamically incorporates components through an external configuration file that enables adoption and support for different business protocols, versions and integration strategies. The configuration into separate functional units aimed for easier scalability, load balancing and future expandability.

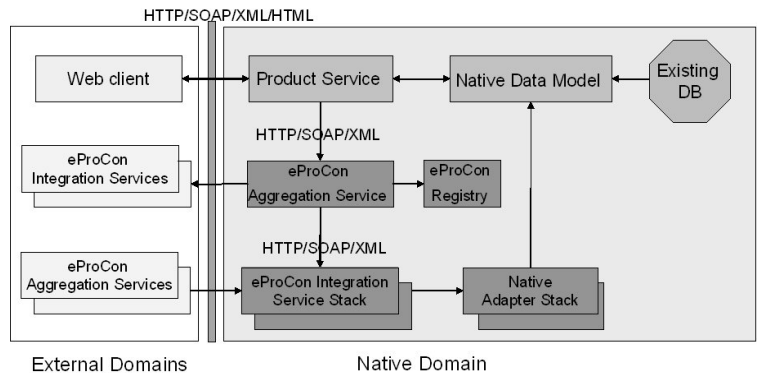


Figure 5: Implementation of the Integration platform





The implementation architecture of the eProCon integration platform in existing information services environments is shown in Figure 5. Development aimed for easy transition of the native product services to the Nordic virtual service. The architecture provides for, besides the integration services, an aggregation service that handles transparently request forwarding between the individual Nordic services enabling users to search across the Nordic Domain.

### 3.3 *GDL Objects Way to Re-usable Product Information*

Intelligent design objects are important to Architects and Engineers because they accelerate work, make project management easier and allow them to design instead of just drafting. As product modeling technology is getting more mature and more widely accepted in the industry the requirements for smarter “3D objects” are surfacing instead of drafting in 2D or 3D. A building element like a window needs to be able to carry intelligence or building construction knowledge about itself. Intelligent building objects behave parametrically. Parameters are rules embedded in the object that govern its appearance and behavior. A window might have parameters that allow the architect to define its height, width, number of panes, material and frame style. Similarly a wall might contain parameters to define its composition, surface, finish, height, and connection to other walls, columns, floors and ceilings. The internal logic of the intelligent object also knows about manufactures business rules and is an integrated part of the object component. For instance a window knows that available sizes delivered follow a modular system and no sizes can be used in between.

GDL technology (GDL) is an intelligent object technology, a base technology to be integrated into tools. GDL is a container for product data that understands the logic of the product being described (virtual product), can evolve into 3D geometry, 2D geometry and a property specification and can include information from external sources such as databases and Excel sheets or from the web. GDL objects can describe simple components or very advanced products. GDL contains all of the information necessary to completely describe building elements as 2D CAD symbols, text specifications, and 3D models for calculations and presentations. Building product manufacturers can define their entire product families efficiently, as parameters can be constrained to pre-set values to reflect available product styles.

One of the significant features of GDL objects is that they can export IAI IFC files, and can be dragged and dropped into e.g. CAD systems equipped with GDL support - the GDL ActiveX control - the key component for exchanging and transmitting object information between applications

and systems. The GDL-AXC is in it self a mini CAD system that can be used in web applications or regular application for accessing GDL objects. It provides for visualization, configuration and CAD drag and drop import.

### 3.4 *Smart Product Information – Taking the Next Step*

While GDL object provides a holistic method for re-usable product information including full geometry directly in design systems its main drawback is that although publicly open and free it is still a proprietary technology and continued support remains uncertain for that reason. Besides, creating GDL objects requires special skills in the scripting language that can be seen as a drawback for wide up-take, especially by SMEs with limited skills, but complex product ranges.

“Product Sheet” as a type of product documentation has been in use by the Nordic building centers and is widely recognized by the industry as reliable, quality information about product ranges. This type of product documentation has also been agreed on by the information providers and for many SMEs it is the only available information they provide for industry practitioners.

The idea of the eProCon consortium is to expand on the notion of the Product Sheets to transition to smarter product documentation or “Smart Product Sheets”. For this purpose W3C Scalable Vector Graphics (SVG) (W3C-SVG) is being tested as the enabling technology. SVG is an open XML-based language for representing two-dimensional graphics and adding interactive elements through linking, events, and scripting. Scripting also enables access to external data sources and inclusion of ActiveX/Applet Objects such as the GDL object viewer. Consisting only of XML and scripts they can be dynamically generated by any middle tier software or web service.

During testing, product configurators have been produced that promise interesting results. One of the benefits the SVG provides over the currently used Product Sheets is allowing manufacturers to maintain their distinctive market values and differentiating product characteristics by introduction of personalized templates while still maintaining a set of standard information currently available in existing Product Sheets. Smart Product Sheets can be seen as the dynamic media necessary to bring together the varying information types required by the industry and for serving information into applications.

The initial vision for a Smart Product Sheets includes:

- Smart, aware of its re-usable content and context
- Information content dynamic, pulled from different sources in the building centre (and outside)
- Presentation having different media types



- Interactive and self configurable
- Smart in presenting data to the viewer in right amount and according to viewer interests and profile
- Smart in presenting in right format and context based on viewer device e.g. product card for handheld devices.
- Personalized to manufacturer taste and marketing strategy.

#### 4 RESULTS AND CONCLUSIONS

The paper presented a solution for integration of building product information services in the Nordic countries into a single virtual service and extension of these services to add value for product manufacturers when advertising information about their products.

To date, the project has produced first versions of the specifications for both integration services and product portal pilots. Also, first prototype implementations have been demonstrated. Currently, the project is working towards finalizing the specifications, taking into consideration the first implementation experiences, as well as bringing the prototypes closer to commercially viable level, and at the same time testing ideas for new content type presentations, "smart product sheets".

GDL provides a key technology for product information to become re-usable in design systems. During the project, generic design object and parameter population from middleware to generate manufacturer specific object was developed as well as a GDL object broker for storing GDL objects centrally in relation to the information services. This enables them to make GDL objects available in their systems through links with minimal effort.

The co-operation between the Nordic Building Centres is based on a common business model agreement, which stipulates how manufacturers can make their product information known in the virtual service in different Nordic languages and classification systems e.g. when a Finnish manufacturer wants to make his product information available in Swedish and classified according to the Swedish national classification system. The Business model in a way circumvents the problem of multiple classification systems that exist in the Nordic countries and the language barriers between the countries, but yet makes it possible, from the user point of view to be seen as a single virtual service.

Naturally, a further study and development work of the proposed platform is still needed especially in the area of multi-lingual organization of information across Nordic borders. Even if the Nordic countries have the political will and backing to push forward, the lack of major players in the industry to take the lead in initiatives of this kind will al-

ways be an obstacle in advancement of standardizing product information for the construction industry, dominated by SMEs. Currently, business value and market demand will be the drivers – the technology exists but economic motivation of local market information providers is not as clear.

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