

# Holistic Cost-Information Management in Building and Construction

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*In the building and construction industry the need for a more holistic enterprise-overlapping information exchange is obvious. Especially the management of cost-information from the very beginning design-phase to the point of controlling and billing is a very important task. Co-operation between architects, construction companies, engineering consultants, and authorities using digital information exchange becomes a strategic success factor. Solutions which cover all stages of the value creation chain such as e-tendering, cost-estimation, cost-determination, and production must be anytime accessible and platform independent. While the basic conditions of IT-infrastructure (digital networks) are today fully sufficient, the compatibility between the systems and the information to be exchanged represent the largest problem. The main problem is in the range of different systems and various information domains. Transformations and adjustments of the exchanged information still cost nearly 40 % of design and engineering time. Efficient information exchanges require a universal exchange format, which makes the existing systems compatible. This paper describes the German approach for a holistic information exchange in the building and construction industry. Furthermore the new approach to integrate the German GAEB Standard and the Industrial Foundation Classes (IFC) and the possibilities that can be obtained out of this integration will be explained.*

**Keywords:** GAEB standard; e-tendering; cost-estimation and cost management; bidding and billing procedures; integration of cost and graphical information (BIM).

## Introduction

The building and construction industry is based on a very heterogeneous IT landscape, which makes an economical integration of software systems extra difficult. Co-operation between architects, building and construction companies, consultants, and authorities by digital information exchange becomes a strategic success factor. In the building and construction industry a change can be determined from a sub structured to a more holistic information exchange. The integration is prevented by the existence of different software systems and their proprietary data standards. Therefore the necessity of standards for information exchange within the construction processes is ever more obvious. These construction processes begin for example, with the first request for bids by the project owner that could end with the distribution of construction material and elements from the supplier to the contractor. Between the construction processes there usually lies a multiplicity of individual activities, which must be accomplished frequently by different project participants by means of different software systems. According to these fragmented processes often a complex information exchange with multiple data input follows, which increases information errors and time delays (Kalantari, Díaz, 2001).

By the possibilities of an integration of model-oriented information with more or less plain cost information especially in the tendering and bidding procedure, and procurement, a large cost-reduction potential is achievable. Using a comprehensive information exchange the transparency and the quality of the building and construction processes increases. Simultaneously the costs decrease.

Generally spoken the tendering, procurement and bidding procedures are divided into three totally different business domains: planning, execution and supplying (see fig. 1). Furthermore there are two main sectors within the tendering, procurement and bidding procedure: e-commerce and project communication. On one hand the task of the German

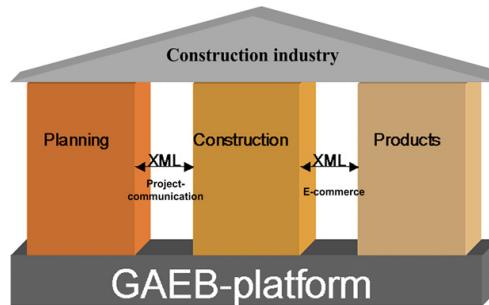


Figure: 1  
XML Integration in the  
Domains of the Construction  
Industry

GAEB project was to develop an efficient method of collaboration. On the other hand it also shall develop an enterprise overlapping exchange of information within the tendering, procurement and bidding procedure (Díaz, J. 2002).

### GAEB (joint committee for IT in the construction industry)

A holistic solution for the purpose of information exchange is offered by the German group GAEB (Joint Committee on IT in the Construction Industry) ([www.gaeB.de](http://www.gaeB.de)). GAEB offers a distributed approach, which makes the information exchange by a common standard on basis of XML technology possible and helps to solve existing communication problems. The developed standard and information structure defines the holistic information exchange format and is based on the XML technology. The following three points describe the decision of using XML as an overall standard (Kalantari, Schäffler, Díaz, 2000):

- separation of structure, content, and layout in the documents,
- compatibility, flexibility and internationality (UNICODE) and
- platform independence

The Joint Committee on Information Technology in the Construction Industry (GAEB) promotes the use of data processing in building and construction. Public and private owners, architects, engineers, the construction business, suppliers, research institutions,

and construction software companies are all represented by their own federations or professional associations in the GAEB. The GAEB establishes the preconditions necessary for the use of integrated information exchange in the execution of construction work and supports all partners involved in the building and construction process to use this open standard, which serves as a specification for the creation of different interface software.

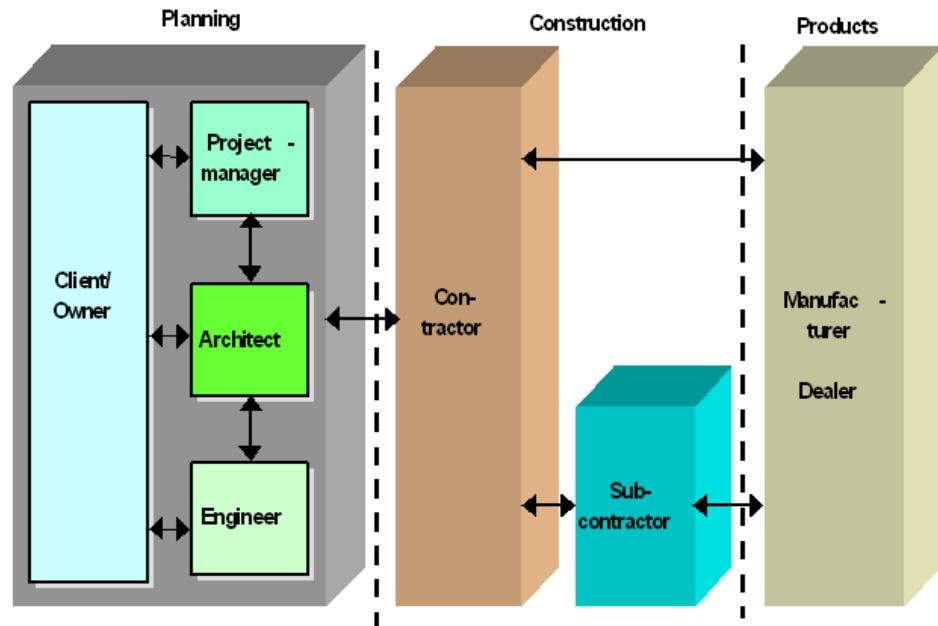
The current GAEB standard is called: GAEB DA2000-xml. The main objective of the GAEB DA2000-xml project is to support the building and construction industry to co-operate faster, cheaper, and more effective, by using the new xml-based technology, which is specifically tailored to the needs of the building and construction (BC) industry. DA2000-xml covers all needs mentioned above by providing the right information infrastructure for the building and construction industry. Furthermore it is very important to bridge the gap between the

above mentioned German BAB-process (GEAB) and the model-oriented Industrial Foundation Classes (IFC).

### Overview of information exchange for bid call, award and billing processes

The bid call, award and billing (BAB) process is an important part of the construction process, which for example regulate the first request for bids by the project owner. It ends with the distribution of construction material and elements from the supplier to the contractor and the billing of the services. For a holistic and economical information exchange in the BAB process, the various BC partners using heterogeneous software systems must be integrated based on this standard. This is the most important requirement for an optimal communication and value creation in the building and construction industry. The BAB process for construction tasks also requires that a common set of rules are defined and are available

Figure 2  
Partners involved in the BAB  
process



for free. It is required that the generated information (specification, bill of quantities/materials, product descriptions, bills etc.) must be exchanged in a digital way and therefore they must be well classified and well structured (Díaz, J.: 2002).

Such a course of action has following advantages:

- It makes information available and reusable on a digital basis.
- It reduces working time managing the information.
- It optimizes workflow processes.
- It reduces input errors because there is no need to reenter the data.

The diagram below illustrates the parties involved in BAB processes.

### Information flow using GAEB-XML

The GAEB specifies different document types to cover the communication needs between the different partners. Each document is assigned to a so called data exchange phase, e.g. the data exchange phase D83 represents the call for bids (see fig. 3). During each of this phase's additional information like the description of work items, prices etc. are incorporated into the data structure. The specific information must be available in the assigned construction sequence. Therefore the construction sequences form the basis for the data exchange phases, which contain logical objects in which elements comprising keywords and their values are embedded. It makes no difference whether the information is

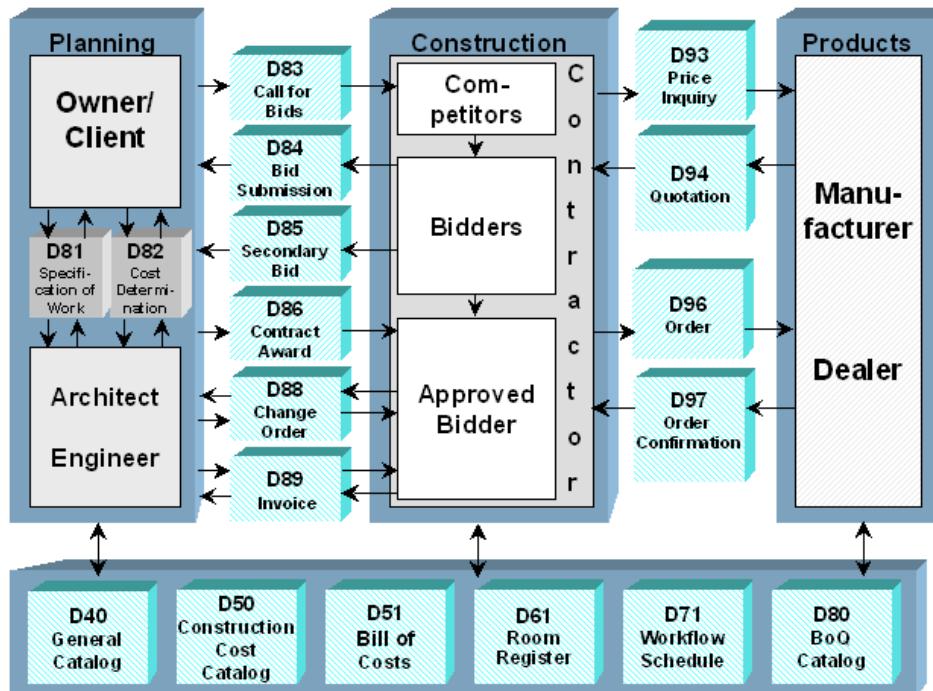


Figure 3  
Holistic Information Flow  
in the GAEB DA2000-ML  
Standard

exchanged between sophisticated cost estimating systems, or cost calculation systems, or is used for viewing purposes on site. The following figure demonstrates all partners and specified document types (data exchange phases). The figure shows all possible scenarios of information exchange between the BC partners. The partners have to use for each data exchange phase the specific document type for co-operation. This is based on public building law. The most important data exchange documents in the GAEB standard are defined in the so called 80's and 90's phases. The phases D80-D89 are responsible for the co-operation on basis of bills of quantities/materials and the phases D90-D99 for procuring processes (e.g. ordering products). All these documents are specified with the platform independent and programming language independent XML technology. The XML technology makes the implementation of BAB software systems easy and economical. For the definition of different document types the XML schema technology is used, which enables on a much better way the definition of data ranges, exceptions etc.

### **Internet based BAB processes using GAEB-XML**

Internet and Web technologies start to penetrate many aspects of our daily life. Its importance as a medium for business transactions will grow during the next years. B2B market places provide furthermore new kinds of services in the construction industry. Construction projects become ever more complex. It also exist a large number on project participants, which are at different places and have to co-operate with one another. This requires a new methodology of collaboration that particularly applies to the execution of BAB-processes. BAB-processes are to be controlled economically and supervised in time. Therefore the use of modern and intelligent collaboration platforms is necessary. These must offer a holistic and process orientated information management. A system for BAB-processes essentially

consists of the ranges: cooperation, communication, and management of projects (Leukel, Schmitz, Dorloff, 2002)

There are software companies which support parts of the BAB-process via internet. These distinguish BAB platforms have different goals, technologies, and usability. The media discontinuity is a substantial lack according to existing BAB-platforms. Therefore such systems could achieve only a limited spreading. Only a holistic system could lead to success. In future, the internet will become the information exchange platform and XML will become the language independent data description format for the building and construction industry. These are the substantial conditions for the intelligent control and monitoring of projects in the area of BAB. The describing of an information exchange using the neutral XML technology for the construction industry will enable tendering, planning, procurement, regulation, invoicing, and other business processes to be conducted online. (Fensel, Ding, Schulten, Omelayenko, Botquin, Brown, Flett, 2001)

A BAB-platform which considers the advantages mentioned before is the e-tendering platform of the German government ([www.e-vergabe.bund.de](http://www.e-vergabe.bund.de)). This Initiative is called e-government "Bund Online 2005" and defines technical specifications to allow electronic communication between public sector bodies in Germany and private suppliers. It is core to the government's aim of making all public sector services available online by 2005. This system uses the advantages of the internet on the one hand and on the other hand permits an entire document exchange on the basis of the language neutral data exchange format XML.

### **Integration of cost-information in Building Information Models**

The German bid call, award and billing procedure and cost management (GAEB) is probably one of the most particular standards in the building and construction industry worldwide, since it already is

over forty years in practise and constantly extended and adapted on new requirements. Due to the long experience using the digital standard there were many questions to solve according the integration of digital bill of quantities (BoQ) oriented information and CAD-based information systems. Following questions were detected and deeply investigated:

- How can we link already existing IFC- elements with Quantity-(cost)-elements?
- How can we take different national systems and regulations into consideration?
- How can we show the benefits for practise?
- How can we calculate and determine quantities in CAD-Systems for the use in bidding systems?
- How can we integrate existing classification systems (e.g. the German classification system for items of BoQ: StLB Bau) and cost estimation systems?

A technical group and the German chapter of the International Alliance for Interoperability (IAI) decided to establish an IFC-Working-group with the focus of the "Exchange of Model Based Quantities". The working group has the goal to investigate different approaches for the integration of IFC and cost management systems. Furthermore the group

want to define a "common neutral interface", which can be integrated in IFC and allow the determination and calculation of quantities in CAD-systems. This process of determination and calculation is the first step needed for the link (integration) in Bill of Quantity software to CAD systems. One of the most important things to take into consideration was to regard as different national approaches like the German. GAEB progress. Following national and international companies (members) are involved or interested in the IFC working group: Graphisoft, m-g-h architekten+ingenieure; f:data GmbH, m G&W Software, Dr. Schiller & Partner GmbH, Ingenieurgesellschaft Hartmann, Obermeyer Planen und Beraten, Greiner Ingenieurberatung, Max Bögl, HOCHTIEF, RIB, FZ Karlsruhe, Nemetschek, TLConsulting, Bentley Systems, Bouwtaak KennisCentrum, Springer BauMedien, Autodesk and others.

The first result carried out from the group was a XML-schema, where the IFC- schema serves as the basis information model. The following figure shows an example of the XML-schema for the object *ifc-ElementCatalog*, which was basis for discussions in the group for the integration of catalogue information.

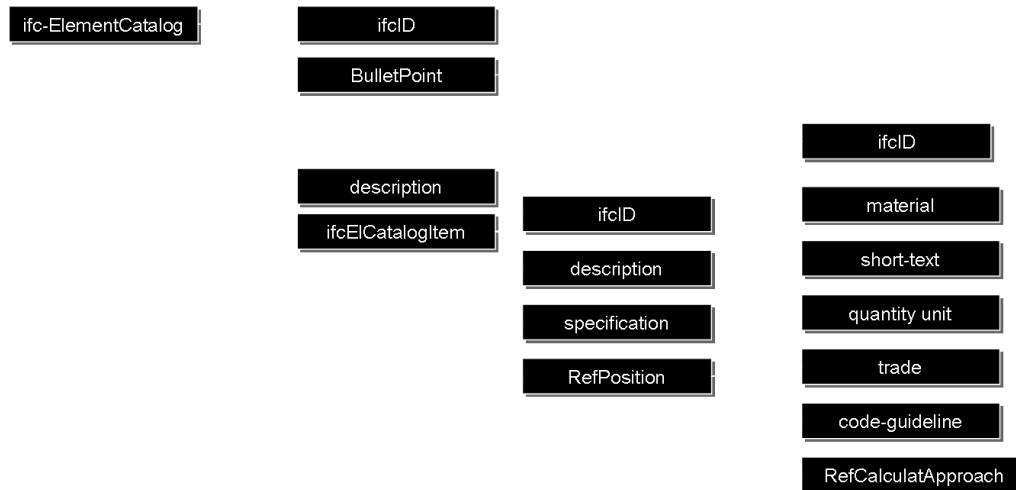


Figure 4  
Example of the IFC-  
Implementation for linking  
between IFC and GAEB

With this approach it is possible to link a CAD-system "X" with a bidding-system "Y" using quantity-elements and to integrate different catalogue items into the IFC model. For the link between CAD-system "X" with bidding-system "Y" co called room/space/segment-elements where used. The condition – to create a small and smart global quantity definition which enables the consideration of national regulations using external views – where reached.

### **Acknowledgements, conclusions and further work**

The definition of a holistic information exchange format and system for the construction industry increases dominantly the efficiency of planning and construction tasks. The development of schemas for the integration of total different information areas (cost- and CAD- information) becomes possible and the linkage of already existing, isolated software is with this approach probable. On the next steps the group has to evaluate, if the proposed approach really covers different national regulations according to BoQ.

In the near future the integration of time oriented systems (scheduling software) has to be also integrated in this above mentioned progress. Also new web service technology makes the transition from the older pure document-oriented approach to a more service-oriented business possible. This innovative relation of technologies opens an enormous potential for the software integration of the future in the building and construction industry.

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