B-processor

Building Information Design and Management

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The B-processor is a redesign of the digital building information modelling/managing concept: Addressing the whole building industry participants and all phases in the building process. Offering a new “standard” for digital building information structure with generic modelling and evaluation tools in the B-model kernel. Plug-in structure for free extension of the B-processor system by the Building Industry. Kernel prototyped in Java to be downloaded for free – open source.

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Architectural key competences

Orthographic projection has for a long period been one of the key competences for architects. The design process and the building process has relayed strongly on the architects – as well as other building industry actors – ability to express and read the 3D nature of an architectural project out of a set of 2D drawings enhanced with symbols, labels, measurements – indeed a very internal language.

This is changing.

The new key competence will be the skill to design and model the building digitally – not to say that sketching, physical scale modeling not still are important tools. Modeling poses a challenge to of the professions as well as to developers of the software. The basics of modeling is geometrically forming the objects of the building on the screen and classifying them to know one object from another.

Geometric and parametric relations between building objects are another important part of modeling – allowing for a dynamic and generative development of the building project.

Detailing is yet another important issue. Detailing in steps from not detailed to full, with no lack of integration from one step to the next during the process, should be possible. Following a natural design process from the concept phase forward to modeling the building finally, as it is to be constructed.

Scripting will be part of the new key competence, as scripting allow for extending the software to match the needs of a specific building project.

So digitally modeling is about building information integrated in a single model – conceptually
a building database, where information can be accessed, visualized and manipulated.

The building information database is replacing the traditional 2D drawing set and specifications, and will offer a much more comprehensive and dynamic building information language – in B-processor the interface for this communication with building information is implemented as a database view – D-view, an attribute view – A-view, and a geometry view – G-view.

The B-processor addresses this new key competence – digital building information modeling – by developing the necessary software tools to support this radical new way of working in the industry.

### Structure and the dynamic modeling process

A building is a set of interrelated “Spaces” containing building objects: Functional Spaces and Constructional Spaces. A Surface is a division and a relation between two Spaces. This outset for a building model structure – the B-model – contrasts with the (normal) concept, that a building is a set of building elements, where the elements are forming the rooms.

The Spaces where we live and work and the Spaces taken up by the constructions for sheltering and bearing are treated equally as complementary building objects in the B-model structure, and the Spaces are related to each other through their common Surfaces.

A Space can be detailed into a set of Elements – element spaces – and each Element can be further detailed into a set of Parts – part spaces. The Space-Element-Part relations are forming a “Chinese box system”, where changes in for example Space level are reflected down to Element and Part level. This dynamic behavior is caused by the three levels existing inside each other – although a lower level only
has to be modeled if it is necessary for the level of detail needed.

The choice of exactly three levels could be changed, adding Subparts or even SubsubParts. But it seems like three levels are sufficient for a building model, whereas the building component producer could need more levels in his product model.

The last structural object is the Union. A Union is a group of Spaces, Elements or Parts. Unions are meant to be copied or repeated, as a library object.

Spaces-Elements-Parts are classified. B-processor uses the new Danish building classification standard DBK – Dansk Bygnings Klassifikation. In DBK the classification concept for building elements is hierarchical following the principle of “portion of entirety”, and therefore fitting well with the “Chinese box system”. The use of a classification system, secure a uniform decomposition of the building into building objects.

Surfaces are created with the Pencil tool – Edge by Edge – or with the Extrude tool. In this process every new Point and Edge are fitted into the existing geometry, and a surface surrounded by another surface is registered as a Hole. Every new Surface has to be assigned to the two building objects – Spaces, Elements or Parts – it divides and relates. Thereby a surface model with building objects attached is established. And this model structure tends to be highly integrated and therefore flexible and dynamic.

In the assignment process new building objects are created and classified when needed. The building objects can have a free geometrical form. Changing the geometry for example moving – Move tool – a geometric entity will keep the topology of the geometry intact.

The “Chinese box” strategy for detailing secure that details are integrated in the 3D model and thereby the flexibility and dynamics of the model. Also the B-model with its richness of relations between building object is very well suited for evaluation – e.g. static's analysis, fire analysis etc.

**Parametric and generative design, the Modellor**

The “natural” Surface relations in the B-model are not sufficient to express every relation of relevance for dynamic modeling, and evaluation analysis. And
parametric configuration can only be supported by adding more model features. That is the Constructor and the Constraint.

The Constructor – B-point, B-line, B-plane, B-system or the B-net – is model objects that support the modeling process by acting as reference geometry or by being part of a Constraint. The Constructor acts as a handle for changing the Constraint parameter G-view by direct manipulation.

The B-net consist of Nodes, Lines and Fields, that can be edit, added to and can have a type, and thus be the outset for generating for example a façade, a bath cabin plan, a landscape etc.

The Constraint is a Relation between a Constructor and a geometric entity in the B-model. So far the Relation in a Constraint can be of the type Offset or Angle.

A Constructor is created by the Constructor tool in the G-view, but the parameters of the Constructor can be altered in the A-view.

A Constraint can be created with the Relation tool, and a move of a related geometric entity is done by moving the Constructor as a handle or by changing the parameters – offset distance or angle – in the A-view.

All Parameters can be calculated values from expressions using Global variables. Thereby for example constrained wall thickness can be set globally.

Constructors and Constraints are not meant only as a facility for the graphic modeling work. Their prime task is their use in scripted or Java-programmed Modellors, as a mean to facilitate graphically parameter setting.

A Modellor is a plug-in facilitating the configuration and modeling of a building object or a building object system. A Modellor represent the building object in the B-model in a dynamic way, listening to the surrounding objects, and intelligently adjusting to changes. Modellors can be applied on all levels – i.e. Union, Space, Element, or Part.

In the B-processor prototype a “Bath cabin Union Modellor”, “Façade system Element Modellor”, and an “Inner wall component Part Modellor” is realized, as examples.

Product neutral Modellors are meant to be standard for a branch of producers in the industry. Product Specific Modellors are meant to be specific for the special product of a producer and the Modellor should ideally take a neutral configuration as input. Product specific Modellors are B-processor plug-ins accessible through a “Digital Product Catalog” and thereby represent a direct digital line between designer and producer – component manufacturer.

Library parts in the B-processor fall in three categories: 1. Unions – non parametric and non dynamic. 2. Static Modellors – parametric but non dynamic. 3. Dynamic Modellors – parametric and dynamic, with some of the parameter settings in a graphical way.

Modellor plug-in development – on the basis of the open source standardized B-model kernel
– comprises the strategy for the Industry implementation and growth of the B-processor.

**Evaluation, simulation, the Evalor**

The classified building objects, the “natural” Surface to Spaces-Elements-Parts relations and the Constraints all facilitate evaluation software plug-ins – Evalors.

For every Surface, the area with holes subtracted is calculated and shown in the A-view on selection. The Edge has its length calculated, and the Point shows its coordinates in an editable form. Volumes of building objects will be calculated.

The quantities are the basis for estimations – and for managing and constructing the building.

The classification codes are a placeholder for default values of the properties of building objects. That is for constructional building objects: U-value, construction cost, construction duration, running cost, specific gravity, specific heat, sound transmission, acoustics properties etc. For Functional building objects the defaults are: Temperature, sound, acoustics, humidity, population etc. Not all defaults are of relevance for all classification codes.

The B-processor prototype will have plug-in Evalors for Energy loss estimation, Static’s estimation, Construction cost estimation and Running cost estimation, all based on the Space detail level. The Element and Part detail levels will contain information sufficient for much more accurate and detailed evaluation and simulation. Evalor plug-in development on the basis of the open source standardized B-model kernel comprises another strategy for the Industry implementation and growth of the B-processor.

**Information management**

In Architecture the process of developing the design, constructing the design result and managing and maintaining the build result is characterized with a large content of information management. This is not a new situation.

The new conditions are that the information is on digital form and therefore can be managed by processes that are secured against conflicting information, and processes that allow for usage of the same information for multiple purposes. The communication between actors in the building process is based on views – visualizations – and various reports directly created from the building information database.

In B-processor this is reflected in the direct access in the A-view to attributes of building objects, geometric entities etc. through selection in the D-view or the G-view – and not only access to see but access to set and manipulate attributes. B-processor does not support the working out of the traditional 2D working drawing set. Instead there are good facilities to navigate in the 3D model to find the building objects of interest, and then to visualize and to read specifications for construction or installation.

The B-processor prototype will not support directly rendering and SQL-database facilities. Rendering must in version 1 rely on moving a VRML formatted model to specialized rendering software. An SQL database facility will exist indirectly via XML transferring of the model to a database system supporting SQL.

Future versions will facilitate a server version supporting many users working simultaneous on the same model.

Turning the whole industry in the digital information management direction is a huge challenge for the coming years, because it changes every traditional process and way of organizing processes.

Only the architectural content of designing and building remains untouched and possibly even enriched by new digital ways of working.

**Industry implementation**

Implementing B-processor in the building industry is an even bigger challenge in that it implies an industry shift from existing software to B-processor. The richness of the B-processor model format is a
hindering for writing translators to and from the IFC model format, without a major loss of information. This do not mean that the B-processor prototype will be without a facility to write IFC, but it means that communication with other model formats will be on a low level.

It is possible in B-processor to read directly the format of L3D a Danish digital building surveying system, and thereby getting a model of an existing building into B-processor. The low level communication with older building industry software systems, imply that B-processor, to reach its full potential, should be used by all members of the building team – a strategy also used by Ghery Technology.

One next step for B-processor is to be used – as though out as possible – in a real building case, manned with actors working solely with B-processor.

This and more cases to follow will cause B-processor to be adjusted and developed further. Another next step is to use B-processor as a stand-alone product configurator in the Digital Product Catalog.

The B-processor kernel is open source software. Participants in the building industry can download B-processor and expand the system by developing new plug-ins. This is an important strategy, in that it for the first time gives the industry the possibility to control the speed and content of software development.

A long row of industry partners have participated in the B-processor prototype development, as specification partners in the various Modellor and Evalor subsystems, and as discussion partners in developing a business strategy for B-processor. The future development will be based on an Association of building industry partners. Members of the B-processor association, will through participation influence and secure continuing update and development of the B-processor kernel.

The realization of the first B-processor prototype is in its last phase, and many of the ideas that was the outset for starting the development has been implemented, but the prototype await to be tried out in a real world situation.

**Conclusion**

B-processor is a serious attempt to develop the next generation of software to support the new “information modeling” way of working in architecture and construction.

As a whole B-processor, by not supporting the traditional building documentation, takes the database
approach serious and shows a way to realize design and to build without this documentation. In detail B-processor does this by implementing a suit of new building modeling ideas.

The surface model, with classified building objects assigned to surfaces, facilitate 3D sketching of the architecture and also the evaluation of the proposals.

B-processor is attacking the problem of a fully detailed and still dynamic 3D model. The Space-Element-Part “Chinese box system” of 3D detailing comprises a natural design process by offering successive detailing, based on sketchy proposals.

The Modellor plug-in concept based on Constrains offers not only user developed B-processor extension, but also implement a strategy for dynamic, generative and parametric “building product system” modeling, representation and linking to the production industry, and comprising a Digital product Catalog basis.

The Evalor plug-in, supported by the surface model relations and assignments and by the constrains, facilitates the non detailed – and with the “Chinese box system” more and more detailed – evaluations of many different aspects of the architecture. Again the users can themselves expand the evaluation possibilities by implementing new Evalor plug-ins.

The final conclusions must await the real building project test of B-processor, and a wider implementation in architecture and the construction industry.

Acknowledgements


References

There are no references in the text. The following is references to inspirations and links.

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Links:
B-processor (daily up/down load), www.b-processor.dk.
Det digitale Byggeri (Dansk Bygge Klassifikation), www.detdigitalebyggeri.dk.
IAI forum DK (IFC), www.iai-forum.dk.
SourceForge (new versions up/down load), www.sourceforge.net/projects/bprocessor.