

Building Classification for BIM

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Reconsidering the ISO Framework

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Contextual information

- The reported work is part of the Interreg IV A project "Integration of sustainable construction processes" (<http://www.oresund.org/baerebyg>).
- Partners are the Denmark Technical University, DTU, och Lund University, with the objective to contribute to creating an Öresund regional market where private and public actors can act across national borders.
- The work has been coordinated with the "BIMInfo" project financed by Formas-BIC which includes an analysis of the structure of the Swedish BSAB 96 system with regard to requirements from BIM.
- Additionally, the work is based on an investigation of the Danish DBK classification system commissioned by the Danish Enterprise and Construction Authority (EBST) to the present authors.
- The reported work has been done by Professor Anders Ekholm and civ. ing. Lars Häggström, at the Division of Design Methodology, Department of Construction Sciences, Lund University, Faculty of Engineering.

BIM and ISO 12006-2

- A Building Information Model, BIM, contains information about constructions of e.g. a building.
- Besides relations of specialization a building model consists of classes related by composition, from the building as a whole, through its technical systems and larger elements down to its smallest components.
- The ISO 12006-2 standard does not clarify how its classes may be applied in BIM, e.g. whether there could be a compositional relation between Element and Work result, although this is assumed in certain applications like e.g. cost calculation.
- The standard lacks a theoretical foundation that describes how the built environment can be seen as a system composed of parts in different levels, i.e. a compositional structure.

Proposed development of ISO 12006-2

- Applications of ISO 12006-2, e.g. BSAB 96, show that the definition of Element is not applied strictly in development of classification tables. Besides technical function, also other criteria are used like position in the building and geometrical shape.
- We propose that the primary subdivision criterion for Element classes is in fact not function but composition, i.e. intrinsic properties.
- In our analysis we recommend that the ISO 12006-2 standard is enhanced with a conceptual model expressing a compositional view on the built environment.
- Accordingly, the definitions should be adjusted so as to better represent the classes developed in existing classification systems, and guide the mapping between classes from different systems.
- The reference classes developed in the report on mapping between BSAB 96 and DBK, presented here, verifies the possibility to develop a compositionally based table for constructions, i.e. Construction entity and Construction entity parts.



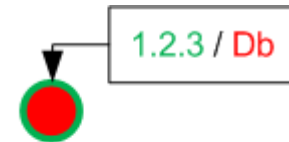
Contents

- A short introduction to DBK
- Mapping between DBK and BSAB 96 and a conceptual model based on a compositional view on the built environment
- Analysis of the development of the concept building element in BSAB 96, and a questioning of the definition of Element in ISO 12006-2
- Development of a new conceptual model based on a compositional view to support further development of ISO 12006-2.



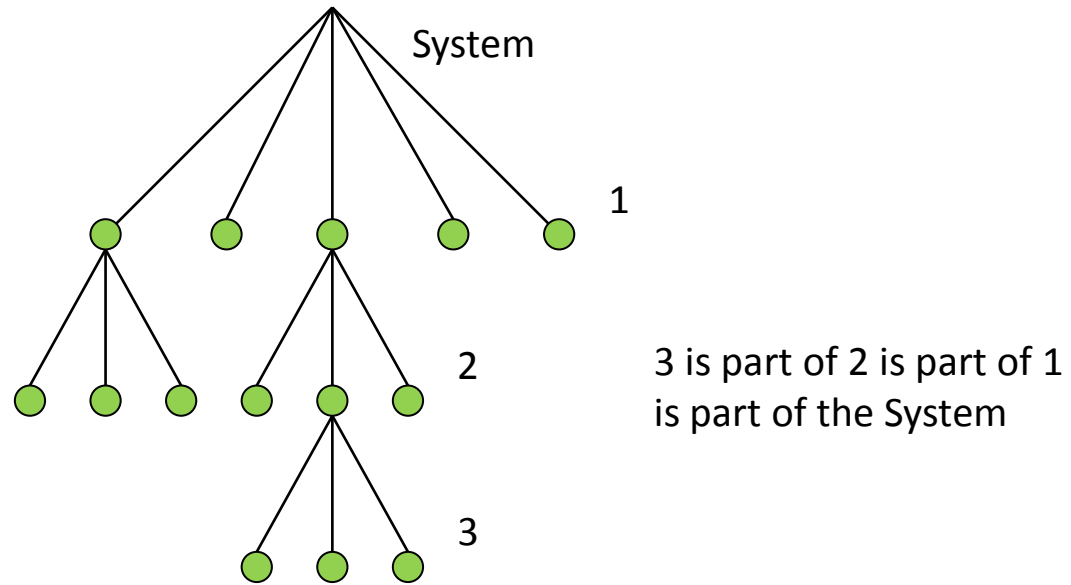
DBK

- DBK, the Danish Building Classification System is a combined classification and identification system, which includes traditional classification based on "kind-of" relations and identification of systems and subsystems in a construction entity based on the "part-of" relation.
- DBK is based on the ISO 12006-2 classification framework standard
- DBK also adheres to the standard for reference systematics, DS/EN 81346
- The reference systematic is to be used to unambiguously identify classes and occurrences in an information system



Informationsobjekt med
referencebetegnelse
Röd: klasse
Grön: ID

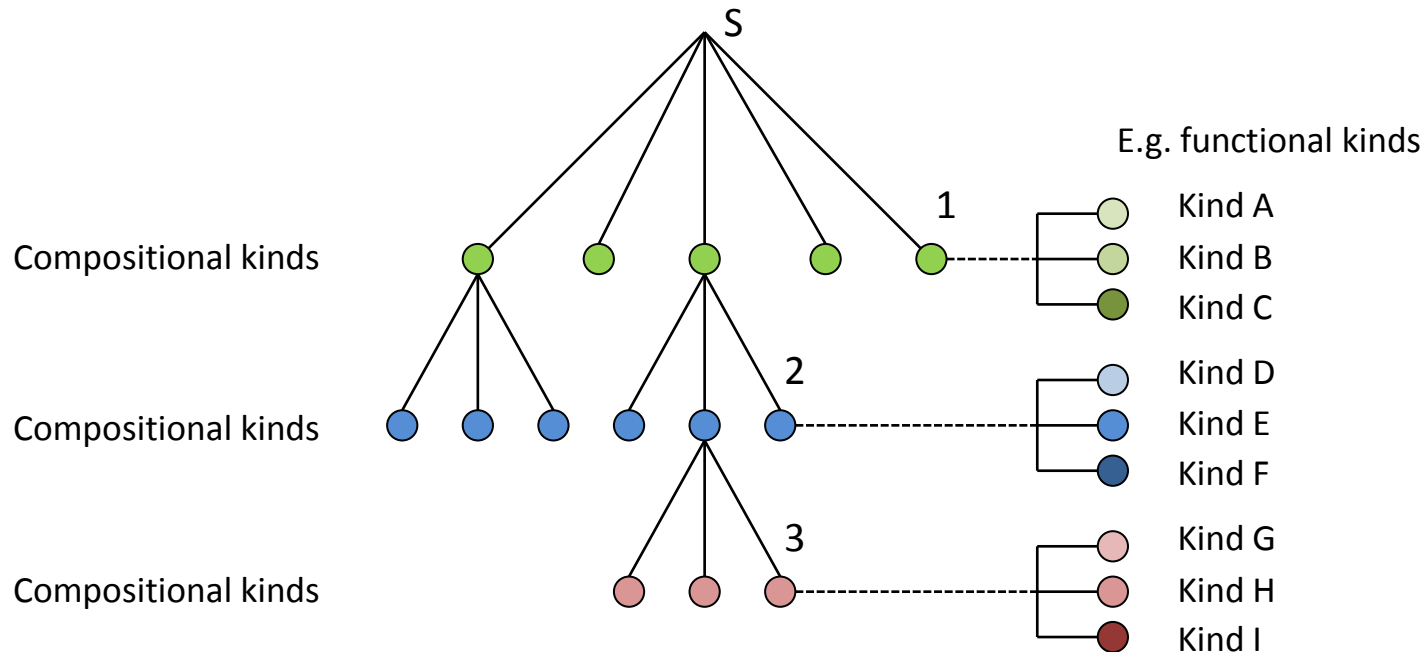
Structuring according to DS/EN 81346



Structuring according to DS/EN 81346 is to identify parts of a system from different aspects:

- The Function aspect: Parts with functional relations
- The Product aspect: Parts with compositional relations
- The Location aspect: Parts with spatial relations, etc.

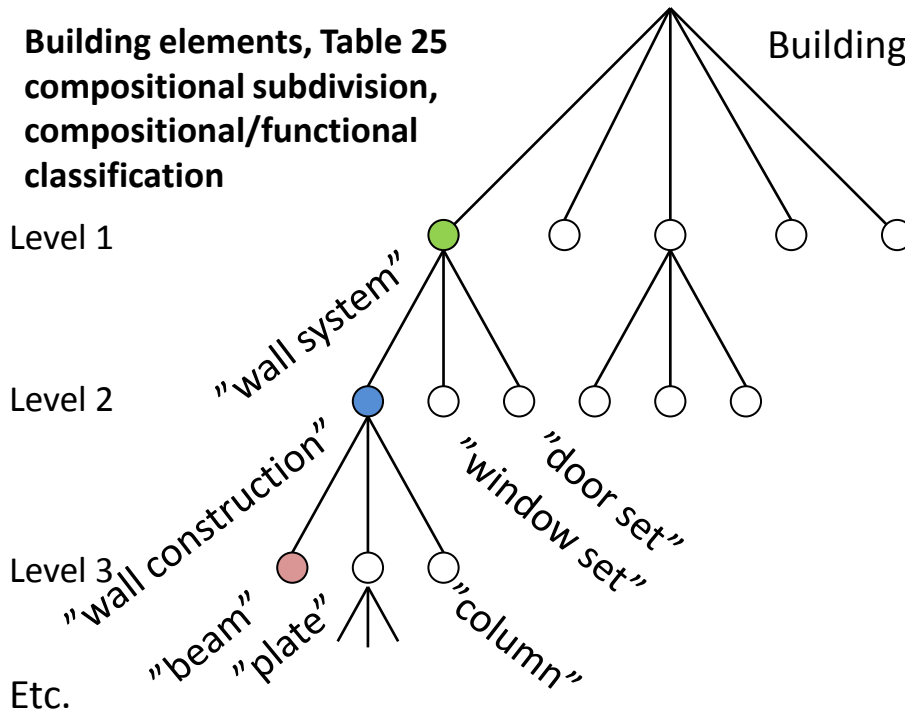
Classification according to DS/EN 81346



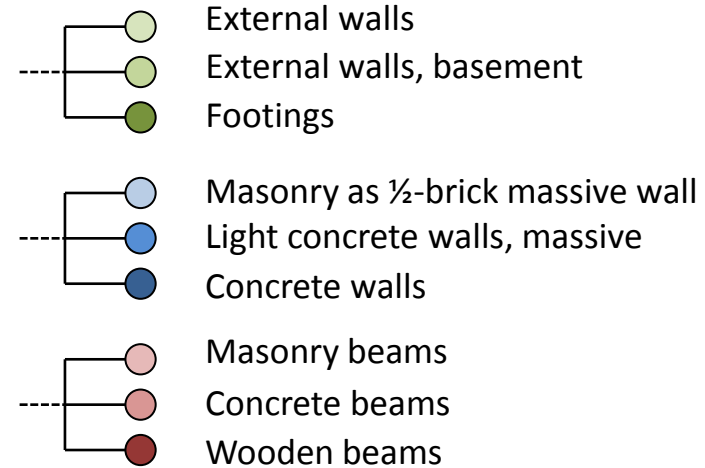
DS/EN 81346 uses composition as a primary subdivision criterion and other characteristics, e.g. function as a secondary subdivision criterion for classification of system parts.

DBK building elements

Building elements, Table 25
compositional subdivision,
compositional/functional
classification



Designed building elements,
Table 25 a, different
subdivision criteria



- "Building elements" are defined as Element in ISO 12006-2: "Construction entity part which, in itself or in combination with other such parts, fulfils a predominating function of the construction entity"
- In ISO 12006-2, "Designed element" is defined as "Element for which the work result(s) have been defined",
- The DBK definition may be translated as "the material composition of a building element, or the way it is composed".

Work results in DBK



- DBK has no table for Work result.
- The class "Building element" covers all parts from technical systems to the smallest components.
- Some Work results in e.g. BSAB 96 appear as subsystems in DBK (Table 25a Designed elements), however only on a course level.
- Additionally, Work results that are not part of a construction entity are missing, e.g. external scaffolding.

Mapping between BSAB 96 and DBK

- The Swedish BSAB 96 and the Danish DBK are both developed according to ISO 12006-2.
- In spite of the common roots there are large differences, especially in the view on parts of construction entities.
- DBK:s structure deviates from other applications of ISO 12006-2 through the influence from the aspect concept in the reference systematic standard DS/EN 81346.
- The objective of the present work has been to investigate the possibilities to map between classes in BSAB 96 and DBK.

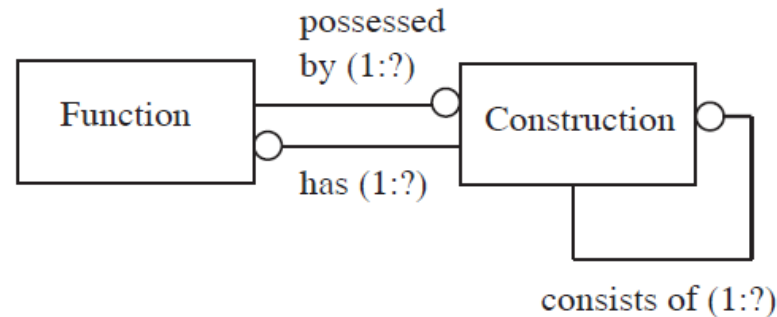


Basis for analysis and comparison

- As a basis for analysis and comparison of the systems, a conceptual model based on a compositional view of the built environment has been developed.
- DBK is based on a compositional view, called a "product" view.
- DBK:s table for construction entity parts is based on a compositional subdivision criterion, with other properties as a secondary specialization criterion, amongst others function.
- BSAB 96 has two tables for parts of construction entities: Elements (Byggdelar) have function as subdivision criterion, while Work results (Produktionsresultat) have composition and intrinsic structure as subdivision criterion.
- Difficulties arise when mapping between classes with different subdivision criteria is tried.

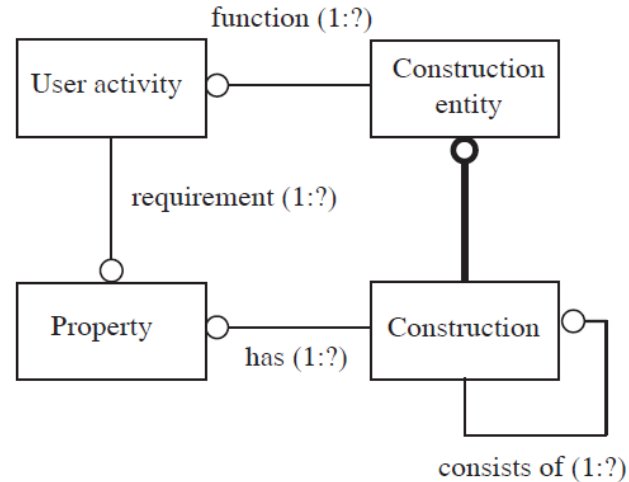


The relation construction - function



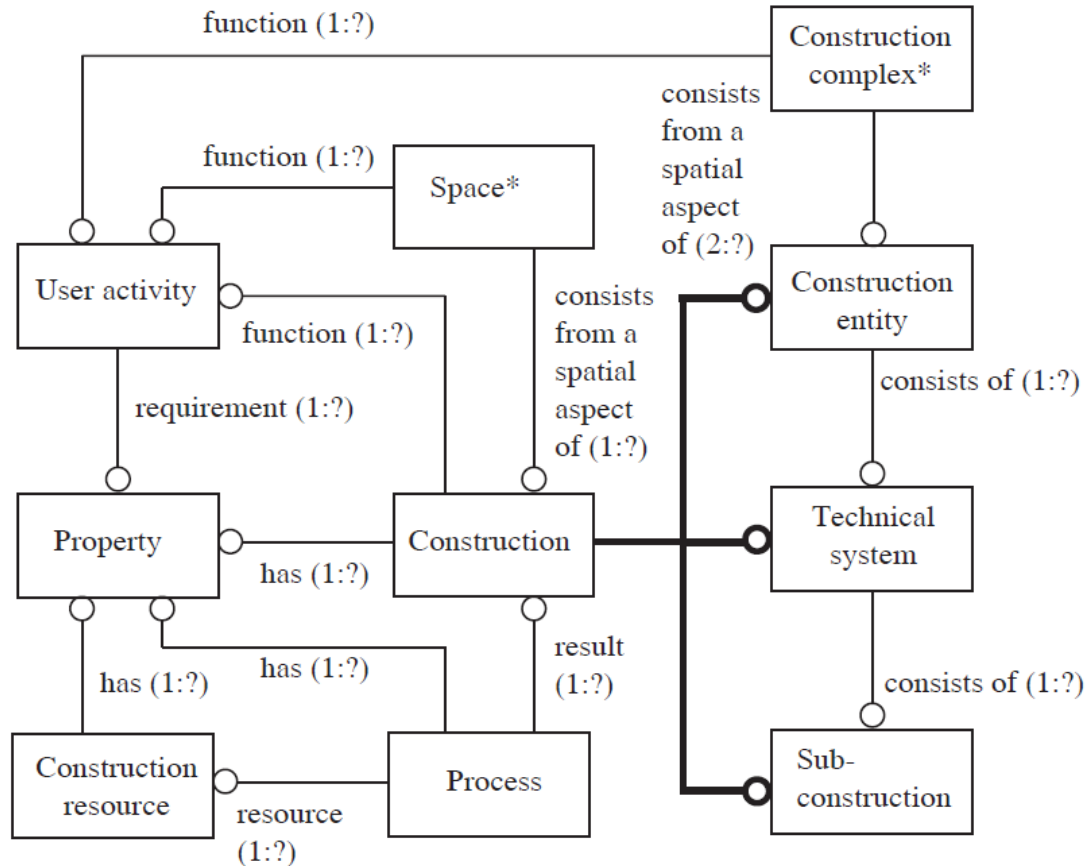
- The built environment consists of manufactured and assembled products, here called constructions.
- A construction is designed for one or many purposes i.e. its properties are basic for at least one function.
- A specific function can be realized by one or many constructions and a specific construction has one or many functions.
- The relation between functions and constructions in a design process are many to many.

Construction entities as constructions



- A Construction entity a complex of constructions that together fulfils the requirements on a built environment for an activity.
- A common criterion is that at least one of these constructions is a permanent ground construction.
- Construction entities are often named according to the most characteristic construction type, such as house (construction), road (construction), mast (construction), quay (construction), and bridge (construction).

Compositional conceptual model for the built environment



- The asterisks indicate that Construction complex and Space are defined by spatial relations



Mapping through reference classes

- In order to map between systems with different structure it is necessary to use a theoretical model which includes the concepts in question.
- The compositional conceptual model fulfils these requirements
- Reference classes based on the compositional conceptual model has been developed in order to enable comparison and mapping between BSAB 96 and DBK.
- The result of the mapping of the classes is only guiding for how such a mapping can be done.



Subdivision criteria for Elements

Reference classification	ISO 12006-2	BSAB 96	DBK
Technical systems and sub-constructions, compositionally	-	-	Bygningsdele (DBK Element)
Technical systems and sub-constructions, functionally	Element	Byggdel (BSAB Element)	-
Technical systems and sub-constructions, functionally with compositional specialization	Designed element	Byggdelstyp (BSAB Designed element)	-
Technical systems and sub-constructions, compositionally with functional specialization	-	-	Bygningsdelstyper (DBK Designed element)

- The table shows that the reference classification includes the different subdivision criteria in DBK and BSAB 96, and that the applied criteria are different in these systems.
- Accordingly, DBK and BSAB 96 are not directly compatible but the reference classes are links for compatibility.

DBK building elements compared to BSAB/OCCS

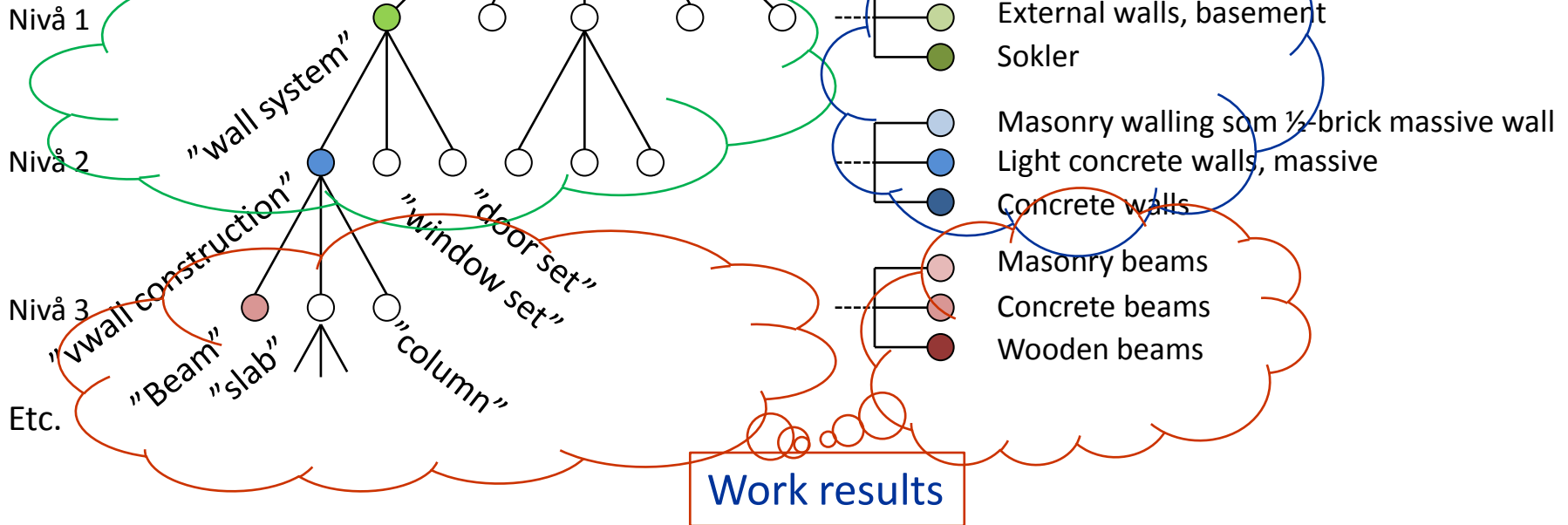
Elements

Designed elements

Building elements, Table 25
compositional subdivision,
compositional/functional
classification

Building

Designed building elements,
Table 25 a different
subdivision criteria



- Larger building parts in DBK resemble Elements
- Smaller building parts in DBK resemble Work results
- DBK Designed elements resemble those in ISO 12006-2

Conclusions of the mapping study

- The result points at possibilities and difficulties to translate between DBK and BSAB 96.
- The mapping study shows that DBK at large conforms to the compositional conceptual model.
- For those classes in BSAB 96 that concern parts of buildings, the conformance is good.
- A conclusion of the study is that ISO 12006-2 should be enhanced by a compositional conceptual model for the built environment, and that the recommendations for development of tables in ISO 12006-2 should be revised with this model as a starting point.
- Another reflection is that perhaps the BSAB 96 system Elements do not strictly apply the ISO 12006-2 definition of Element as function, but rather is similar to the idea in DBK that Elements are constructions identified by compositional properties?



Building parts in SfB and BSAB 72

- The 1950 version of the SfB-system encompassed a relatively small number of building elements or parts (54 classes sorted under 9 headings) and was used in ByggAMA 1950 (ByggAMA 1950). Characteristic features were position in the building and construction type, e.g. “external walls” and “flat roofs”.
- In ByggAMA 1965, also smaller details of a building were considered building parts since a “construction commodity when assembled or mounted in a building is transformed into a building part” .
- In the first BSAB, 1972, building parts were divided into two kinds, each represented in a separate Product table.
 - Product table 2 of “larger parts”, defined as “physically material parts, distinguished by their primary technical properties in the finished product”, rather similar to the SfB-parts from 1950, and
 - Product table 1 concerning “assemblies and mounted apparatus”, defined as “physical material parts distinguished by similarity in composition or significant effort of resources like commodities or work needed for their creation”.



Building part in BSAB 83 and 96

- The building parts in BSAB 72 were “technical product parts” of the building.
- In BSAB 83, building parts were defined as “planned or real result of construction activities at the building site”. The parts in Product table 2 were subdivided using “technical function as main subdivision criteria”. There was no principal difference between the two versions concerning the nature of building parts.
- BSAB 96 marked a definite change with respect to the view on building parts, now understood as identified from two different views on the building’s composition, both views giving a complete account of parts.
 - “Elements” are defined by function, as a “part of a building that fulfils a main function in the building”, and
 - “Work results” are defined by compositional properties, e.g. resources like material and labour.



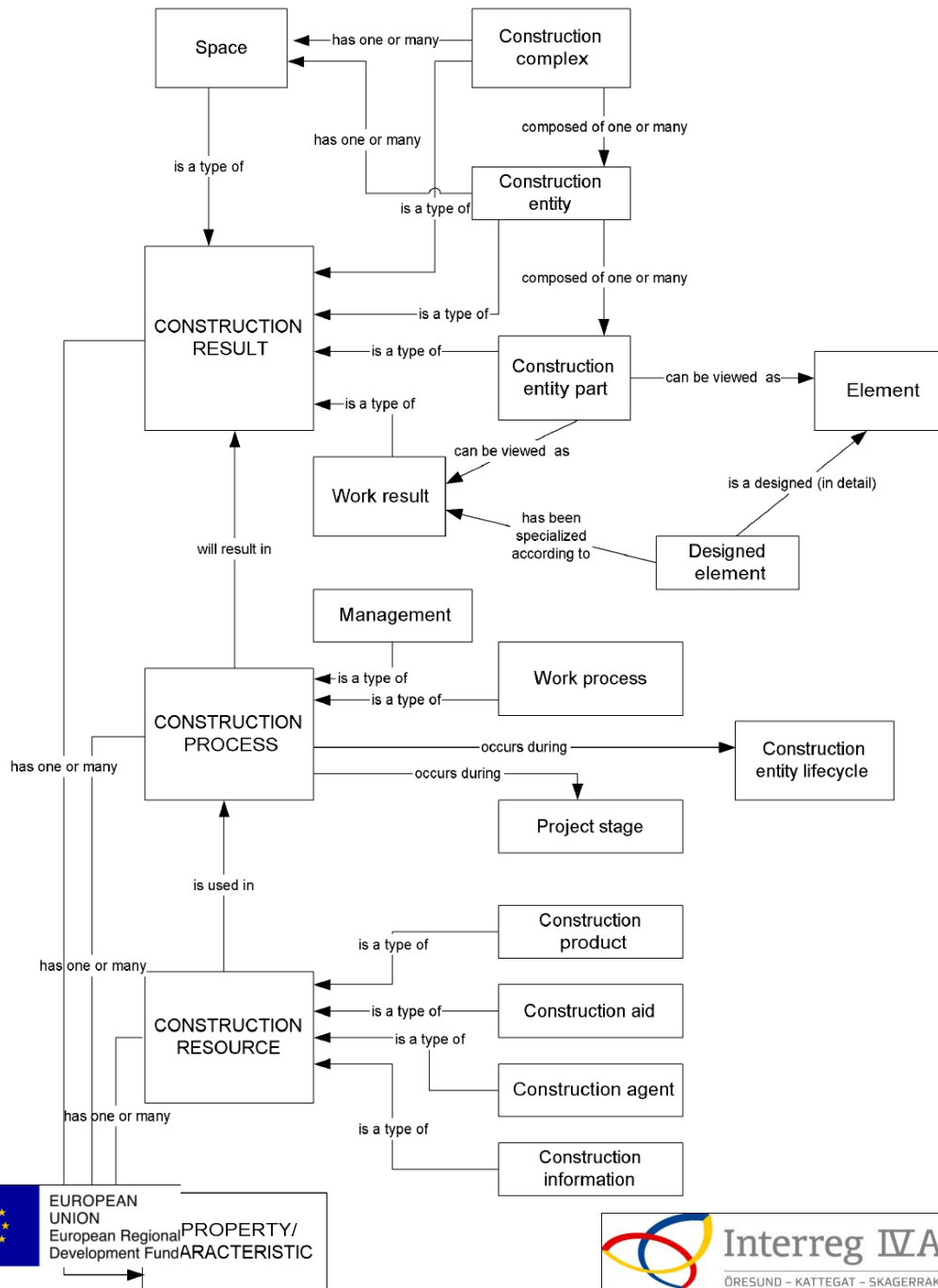
Are Elements identified by function only?

- The concept of Element in the ISO-standard is ambiguous since its definition only mentions functional characteristics.
- “Elements sometimes seem to be structured on the basis of the composition of the construction entity instead of expressing the functional specification of the element. However, this is only due to lack of practical wordings for those complex functions” (The Swedish Building Centre 1999:31).
- However, in different applications Elements are given names that indicate other characteristics as well, e.g. position in the Construction entity, and geometrical shape. The BSAB 96 system has Element classes like “Loadbearing external wall” and “Surface layers on wall”.



ISO 12006-2

- Organisation of information about construction works
- Based on over 50 years of experience in practice
- Applied to the development of e.g. BSAB 96, UNI-CLASS, Omniclass and DBK
- Supports development of internationally common tables



The concept of Element in ISO 12006-2

- A “Construction Entity Part” defined as “a solid material part of a construction entity, having physically delineated boundaries”, is not represented in a table.
- Both Work result and Element are considered a view on a Construction entity part.
- The definition of the class Designed element, is defined as an “Element for which the Work result(s) have been defined”.
- This must be interpreted as Work results can be seen as parts of Elements.
- The latest Finnish building classification system Talo 2000 states that “building elements are divided into structural parts whenever several types of production work are required to produce a single building element” (Talo 2000 2006).



Part-of structure in BSAB 96 in cost calculation

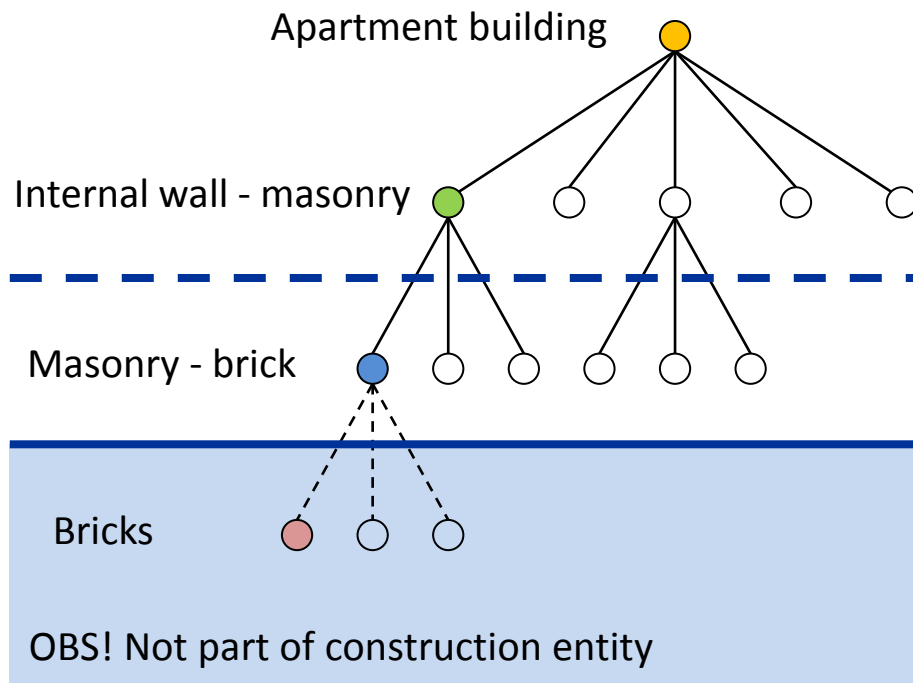
Tables in BSAB 96

Construction entity

Element-Designed element

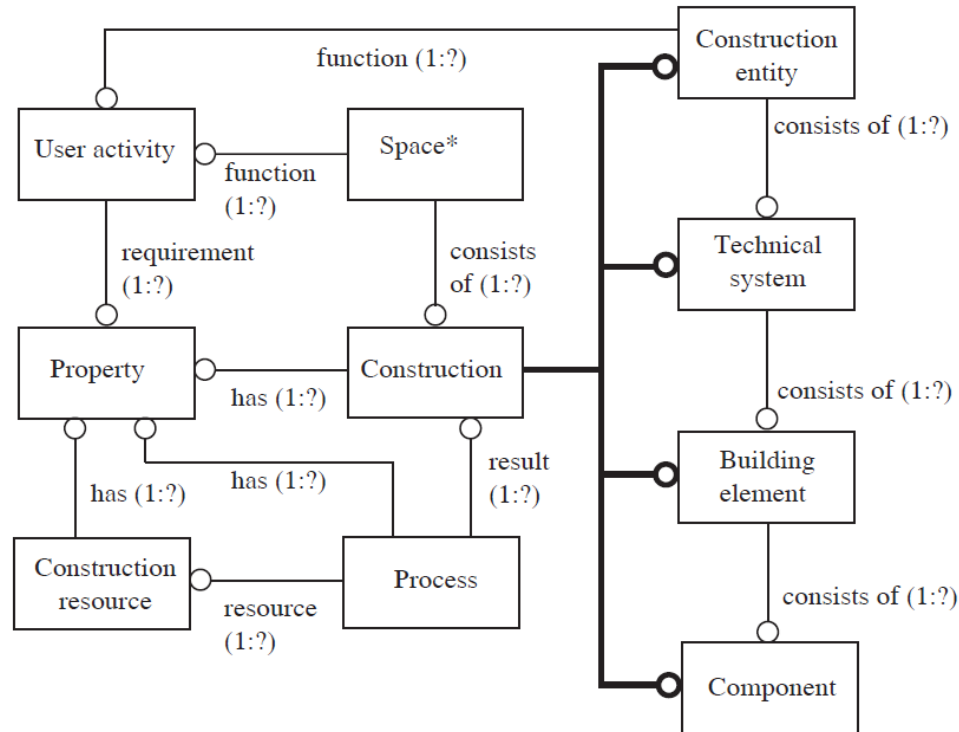
Work result

Construction product



- Practical application of BSAB 96 for cost calculation

Compositional conceptual model for the built environment



- The building parts of interest in this context are Technical system, Building element, and Component.
- The asterisc indicates that Space is defined by spatial relations



Components

- We propose that Components are the basic constituents of Building elements.
- They have similarities to Work results in the ISO standard.
- Components consist of processed and assembled construction material, e.g. mounted wall studs, gypsum board, countertops, bathroom fixtures, diffusers, electrical cables, etc.
- Components each have a characteristic function in the construction entity.
- Components are often characterized by their dominant materials such as wood, concrete, steel etc. in different variations and combinations.

Building elements

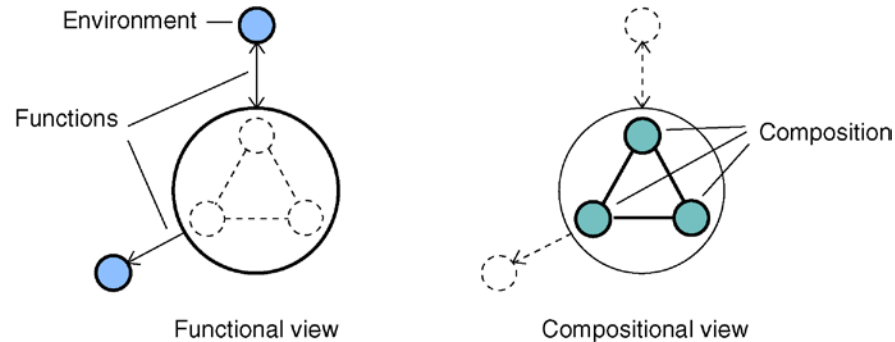
- Building elements are the immediate parts of technical systems
- Building elements have similarities to Elements in ISO 12006-2, but their definition includes, besides characteristic function, form or position relative to the technical system of which they are part.
- Building elements each have their compositional structure such as beam structures, floor structures, land surfaces and vegetation beds.
- The primary subdivision criterion is compositional rather than functional.
- It could be hypothesized that this is also tacitly recognized for Elements of the ISO-standard. In the BSAB 96 system, the Elements “Loadbearing external walls” or “Outdoor climate envelope in external walls” are obviously defined by form and position in the building.



Technical system

- Technical systems are the major constituents of Construction entities
- A technical system is an independent construction with a characteristic function in a construction entity.
- Technical systems may be classified according to compositional properties for example:
 - House constructions,
 - Mast constructions,
 - Quay constructions,
 - Road constructions,
 - Bridge constructions,
 - Tramway constructions,
 - HVAC-systems,
 - Electrical systems,
 - Tele communication systems and
 - Furnishing/fit-out systems.

Consequenses for classification



- A compositionally based classification system is stable over time, it reflects existing consturctions.
- In classification of constructions of the built environment , a compositional aspect should be used as the primary criterion for subdivision, other aspects, e.g. technical function or function for user activities can be used as secondary criteria.
- The compositional aspect is based on composition and intrinsic structure of the system, i.e. constituent parts and material, and their relations and other properties, e.g. processing and assembly work .

Thank you for your attention!