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Multidisciplinary conventions in CAD drawings

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Abstract

This paper discusses the CAD Conventions developed in the Netherlands for architectural design and building practice. These conventions are initiated by CAD users which stress the usability in practice. They are being adopted by a growing number of CAD applications focusing on building industry. Also manufacturers tend to conform their product information to these conventions.

Recently the second edition of these conventions has been published.

1 History

In the product-life-cycle of a building many disciplines are cooperating and exchange information on several levels. The Dutch Society for Integrated Architecture consists of organisations and companies who are active in this branche and who have common interests on the field of Computer Aided Architectural Design/Drafting.

One of the results of this cooperation has been the development of a successful application for creating architectural drawings. Also applications have been developed for Urban-design, Electrical and Mechanical engineering.

Traditionally the communication in the architectural design and building process uses paper as a medium. The introduction of the computer as a drawing aid created possibilities for discriminating drawing information, thereby enhancing the efficiency of the drawingprocess and the readability of drawings. Dealing with multiple disciplines and a common need for standardisation, the Society of Integrated Architecture, has initiated research on CAD Conventions by forming a working group.

Other conventions, among which the British Standard BS1192, have been subject of study. One of the conclusions is that the BS1192 focusses mainly on AEC and has limitations in the classification of general drawing symbols.

In the resulting conventions, the working group has adopted the element-classification of the SfB system (CI/SfB Construction index manual, RIBA), by conforming to the Dutch version [STAGG BNA 1983, SBK 1991].

For Urban planning and design, the basis has been formed by the classifications on landsurveying [BOCO 1991] and the classification resulting from a recent study of the Dutch Society of Urban planners [BNS, 1991].

2 Scope of the CAD Conventions

Originating from a multidisciplinary society, the CAD Conventions consist of conventions for each of the disciplines concerned individually and, at a more general level, of conventions which apply to all of these disciplines.

Basis					
Urban design	Arch. design	Arch. drawing	Electr. Engineering	Mech. Engineering	Construction

fig. 1. Multiple disciplines and a common basis.

Computerapplications in building design are developing from aids for draughtsmen towards sophisticated design tools. The CAD Conventions are mainly intended for structuring the information in technical drawings and geometrical models. The conventions concern the nomenclature and classification of data created by CAD applications that are being used in to-day's practice of urban designers, architects, architectural draughtsmen, installation technicians etc.

Essentially, the CAD Conventions are independent of the CAD system to be used. However the Society of Integrated Architecture is developing AutoCAD application modules for the distinct disciplines, these developments concur with the development of the CAD Conventions.

3 Principles

One of the basic conditions for an optimal exchange of information between actors in a designproces is that the actors understand each other, use the same words, definitions and notions. In CAD this implies that conventions are made on the nomenclature and classifications of aspects of the CAD document.

Two important aspects in the practice of computer aided drafting and design are layers and blocks, being two means for grouping information in a CAD document. The classifications of layers and blocks are defined in the CAD Conventions by classifying their names. The structure of the classification is the same for all disciplines and consists of the distinction of fields in the name of a layer or block.

Other subjects described in the CAD Convention imply the use of a character table, which is based on the PC 8 Symbol Set, and the definition of a standard set of linetypes in metrical form.

The convention defines the classification format which deals with 4 notions:
1. The originating discipline.
2. The kind of graphical information.
3. The classification of elements, dependent of the discipline.
4. Optional descriptions.

These notions are formalised into 4 fields which define the layernames and blocknames.

<field1><field2><field3><field4>

<field 1> One of the basic conventions is that for each object in a CAD document, e.g. drawing or model, the discipline that created the object can be identified. This makes it possible to distinguish the responsibilities and products of the different parties in the design and building proces.

<field2> indicates the derived class of drawing entities. This class identifies the kind of graphical information. Dealing with layer names one could identify text-entities or dimension information. With symbols or blocks this field describes the projection method and detail. The classification tables used in this section apply for all disciplines.

<field 3> contains the discipline dependent classification section. In this field multiple classification tables can be used.

<field 4> is reserved to explain what kind of information is coded. It is optional and must start with the '_' (underscore) character.

4 Classifications

Layers

For layers these fields are defined as described in the table below.

Field #	Contents	Length
1	Discipline	1 character
2	Entity-class	1 character
3	Classificationtable	discipline dependent
4	Description	discipline dependent

table 1. Classification of layernames.

The first field of a layername represents the discipline that created the layer: Urban design, Architectural design, Construction, Electrical engineering, etc. For each discipline a unique character is reserved. 'B' is reserved for Basis to indicate that the layer is used for multidisciplinary purposes.

Code	Discipline
B	Basis
S	Urban design
O	Architecture / Design
A	Architecture / Technical drawings
E	Electrical engineering
W	Mechanical engineering
K	Construction

table 2. Reserved codes for disciplines

The second field allows distinction between different types of entities in a CAD document, e.g. geometric entities, texts, dimensions, attributes, hatchings, etc.

Code	Entity-class
A	Hatchings
B	Attributes
I	Notes
L	Geometric entities
M	Dimensions
T	Text

table 3. Entity-classes

The classificationtable that fills the third field of the layername, is discipline dependent. Some types of drawing information are shared by all disciplines and have been classified in the Basis conventions: grids, graduations, border lines, title box, etc.

Code	Information type
$1A, $1B, ...	General
$2A, $2B, ...	Border line
$3A, $3B, ...	Viewports
$4A, $4B, ...	Title box
$5A, $5B, ...	North arrow
$6A, $6B, ...	Graduation
$7A, $7B, ...	Grid
$8A, $8B, ...	Temporary lines
$9A, $9B, ...	Legenda

table 4. Basis classificationtable for common drawing information

In addition, the disciplines use their own method of classification for the third field of layernames. For instance for Urban design, the classificationtable Codes is used. For Architectural drawings the SfB classification is used, as well as for Electrical engineering, where the latter uses a subset with more details. Examples of layernames are:

Architecture	AL63---_LIGHTING	
	A	discipline
	L	entity-class
	63---	classificationtable
	_LIGHTING	description

This layer contains geometric entities concerning architectural symbols for electrical provisions.

Electrical Eng.	ET6320-_EMERGENCY	
	E	discipline
	T	entity-class
	6320-	classificationtable
	_EMERGENCY	description

This layer contains text on emergency information.

Urban desgin	SMB-V12000V--_PARKING	
	S	discipline
	M	entity-class
	B-V12000V--	classificationtable
	_PARKING	description

This layer contains dimensioning for parking in an occupationplan.

Blocks

The fieldlength for blocknames is restricted by the 8 character limit imposed by requirements of compatibility to DOS.

The first field describes the discipline, table 2. The second field classifies the level of detail and method of representation. The level of detail is derived from the scale of the entities being represented. This scale is discipline dependent.

Level	Hor. Section	Ver. Section	Elev.	Neutral	3D	Symbol
0	N	O	P	Q	0	S
1	H	V	A	K	1	S
2	W	X	Y	L	2	S
3	D	E	F	M	3	S

table 5. Classification for level of detail and method of representation

Level	Range of scale	
0	N/A	N/A
1	N/A	1: > 20
2	1:10	1:20
3	1: < 10	N/A

table 6. Example of the range of scale for the different levels of detail in architectural drawings.

Architecture	AD31BK12	
	A	discipline
	D	representation
	31BK12	classificationtable

This block contains a horizontal jamb detail on scale 1:5 with subcode BK12.

5 Prospects

These conventions have been developed respecting the applications developed for AutoCAD by the Society for Integrated Architecture. Expectations however are that other CAD systems will also be adopting these conventions in their applications.

Research is started in newly formed working groups on the development of similar conventions for the following disciplines:

- facility management
- civil engineering
- construction

The growing interest of manufacturers for supplying product information in the form of digital data urges the need for standardisation of product identification and linking product information to CAD documents. Research is done on applying the international conventions for EAN code systems (e.g. barcodes).

Applications are being developed for linking CAD documents to software for numeric analysis. The classification of special entities for this purpose and methods for structuring embedded attributes will be part of future conventions.

6 Discussion

As mentioned the CAD Conventions focus on data-exchange at the drawing level and have no intention yet to describe the coherence of the data defining the product. One could say the CAD Conventions stress the data-interchange between equivalent CAD systems. De Vries [De Vries, 1991] describes this concept as the local model. Most CAD systems and applications optimize their datamodel at the level of the local model.

Data-interchange on a view independent level is described as the exchange model. This model stresses data-interchange at the product level. Most promissing at the moment is the ISO-STEP development.

In a combination of these concepts, prototypes are built that link the local model, derived from a CAD document, to an intermediate exchange model to be used in evalutation applications.

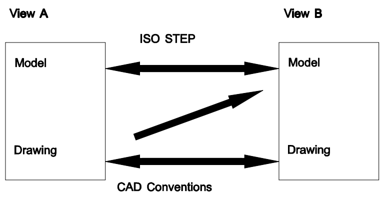

fig. 2. Processing a local model to an exchange model.

This method of data-exchange is called the process model [De Vries, 1991] and uses two different techniques for analysing the drawing model. On the semantic level, the layer-convention is used to derive the meaning of drawing entities. On the level of coherence, topological analysis is used to derive the geometrical properties of the proposed product. The intermediate model follows the ISO-STEP protocol.

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