A digital way of planning based on information surveying

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The aim of this project is to develop a software system for generating complex digital models of existing buildings and structures, i.e. in the broadest sense a computer-supported surveying and management system for existing buildings.
The built environment is registered by surveying a series of geometrical and building-relevant information broken down into different levels of abstraction. The recorded data consists of a variety of geometric, multimedia and verbal - less structured - pieces of information.
The starting point for developing such a system is both an analysis and reworking of the methods used in architectural surveying, and the evaluation and use of current techniques and tools in the field of computer applications.

1 Starting point

A large part of current architectural and building practice is concerned with the field of restoration, modernisation and reconstruction of existing built structures, in particular the conservation, renovation and documentation of listed buildings and monuments.
Around 70% of current planning activity in the former East German states, and over 50% of building work in West Germany are work on existing buildings. Over 200 billion DM are spent yearly on the conservation of existing buildings.
A detailed building analysis and survey is an essential part of these planning activities. The statistics demonstrate the importance and relevance that the computer-supported surveying and management of existing buildings has.
The starting-point with which the architect or engineer is confronted is often the same.
Before the actual planning task can begin, a comprehensive consideration of the existing built situation has to be undertaken. This requires an intensive and detailed exploration and explanation of the existing situation, a survey of all building-relevant information necessary to describe and understand the task at hand.
The geometry of a structure is documented as a series of abstracted single 'views' - plan, section, elevation, detail. Further documentation, in the form of analyses, log books, statistical information, project descriptions, photographs or expert reports,

follow or are produced alongside the graphical survey. These are invariably detached from the graphical views, connected at most through cross references.

Our aim, therefore, is the conception of an integrated building information system, combined with a digitally-supported survey.

2 Building information system - GEBIS (GEBäudeInformationsSystem)

The aim of this research project is twofold: to design a practice-relevant software concept (GEBIS); and to develop a prototype system (GEBISexp), for a structured way of capturing and organising building-related information about existing buildings in digital form. The research is principally oriented towards existing buildings, in particular residential, office and commercial buildings.

2.1 THE REQUIREMENTS FOR A BUILDING INFORMATION SYSTEM BASED ON AN INTEGRATED SURVEYING SYSTEM

Practical experience in the field of digital architectural surveying has revealed clear deficiencies, in particular the absence of a systematic approach and its respective support in the software systems.
The deficiencies were identified, sorted and evaluated according to their importance. Ways of reducing the effort involved and factors influencing exactness were identified. The following requirements for a computer-based building and surveying system were formulated as a result of our investigations:

- the development of a 'universal solution' based upon 'more intelligent' building models & interfaces, in order to enable a better interchange of data between the different planning phases.
- the integration of different technical and technological surveying procedures
- the capability to combine different recording techniques - hand measurements (the inch rule), exact measurements, photogrammetry, tachymetry, ...
- universal application in all fields, as well as in the field of conservation
- an efficient and cost-effective survey

2.2 RESEARCH - PRINCIPAL AREAS OF FOCUS

The research and development progressed as follows:

a) Basic principles in architectural surveying and of information technology.

b) Specification and development of a prototype system (GEBISexp)
elementary functionality for computer-based capture and organisation of data in a practice-relevant environment.

c) Evaluation of responses

d) The results will form the basis of a detailed specification.

3 Selected research aims

A prototype system (GEBISexp) was designed based upon the multitude of requirements.
'GEBISexp' only considers specific objects of room and element structure. It attempts only to demonstrate the principle approach of a computer-supported surveying and information system.
In the following section selected aspects of the prototype system will be described in more detail.

3.1 DERIVING A ROOM AND BUILDING ELEMENT STRUCTURE FOR OBJECT-ORIENTED BUILDING-SURVEYING

Principal emphasis is laid on the systematisation of the built structure of a building, and the establishment of relevant planning and use-related information. Taken into account are the planning methods of architects working in the field of building restoration and reconstruction.
A typical problem when surveying existing buildings is that a large amount of information is recorded without an overview of the overall situation. The tendency is to concentrate on details, whereby simpler structural connections within the building go overlooked. These problems can be countered through the use of an ordering system that is used right from the start.

There are two primary ordering principles:

(A) Room structure - the spatial subdivision of the building
building complexes can be arranged both as entire buildings or individual rooms (i.e. building, floor level , room),

and

(B) Element structure - the hierarchy of built elements in the building
that which defines space and from which the geometry of the building is measured (i.e. wall, opening, window).

The structuring principles for both room and element structure have been developed. They are not independent from one another.
Rooms are defined, at least in an architectural sense, by spatial events. The room is therefore described only by the shape of the rooms boundaries, its perceived surfaces (Figure 1.). Thickness is not necessarily identifiable. Building elements can be interpreted as 'material rooms' and described by their actual surfaces.

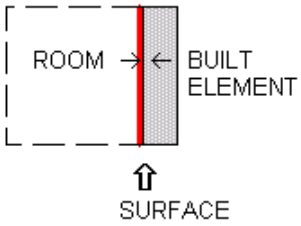


Figure 1. The relation between both structures

A geometric survey measures the building surfaces - wall, ceiling, floor etc. The connection between room structure (A) and element structure (B) are the building surfaces.

3.2 SPECIFIC PROPERTIES OF OBJECTS

The computer-supported building survey is not simply a geometric description of a building. It should also provide a multitude of features and characteristics relevant both to the buildings future use.
A series of attributes and their range of possibilities were identified, based upon practical experience in the field of architectural surveying.

The following are examples of object properties and characteristics relevant in working with existing buildings:

- method of construction, material, building damage
- constructional qualities
- thermal and technical details

The specific properties are descriptive qualities quantified as alphanumeric attributes with a range of possibilities (Figure 2). Defining these provides the architect or engineer with a consistent basis upon which to qualify his or her decisions.

When trying to define a 'static' attribute, it soon becomes clear that it is impossible to provide a comprehensive solution for all possibilities.
A 'variable attribute', however, allows the user to define custom attributes for the situation at hand. These can be defined and extended as required, both in terms of class and their evaluation methods.

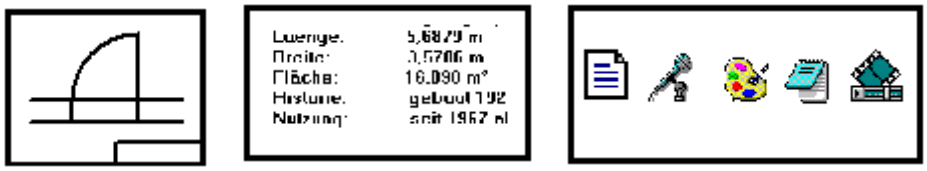
At present the following types of 'variable attribute' are catered for:

- notional attributes
- numeric attributes
- textual attributes

attribute group	attribute	range
geometry		
	type	foundation / wall / floor / roof / ...
	...	
construction		
	material	tiling / cork / wallpaper / textile / ... plaster / stucco / ... boarding / plasterboard /... panelling / wood (pine, oak ...)/ ... smooth / profiled / rough / ... Metal plate (lead, zinc ...) / Metal sandwich panel / ...
	finish	none / opaque / transparent / glossy / matt / satin / ... oil-based / lime-based / wax / stain / ...
	colour	white / black / green / ...
	...	
history		
	condition	good / smooth / cracked / dry / damaged / repaired / ...
	extent of damage	total / internal / framework / nogging / ...
	...	

Figure 2. Relevant properties of the object ”surface”

The integration of multimedia data into the building survey is of fundamental importance (Figure 3). It is an essential part of a comprehensive survey of any existing building.



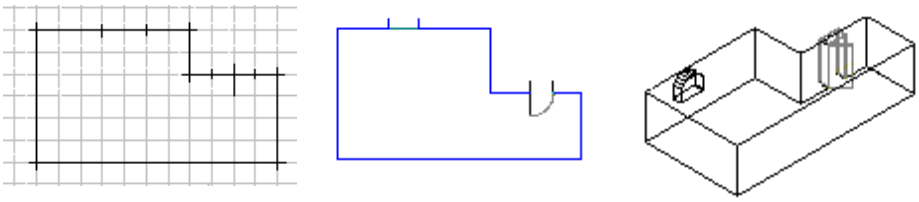
geometrical alpha-numerical multimedia description

Figure 3. Multimedia functionality

3.3 ABSTRACTION LEVELS

Nevertheless, the architectural survey tends to be communicated in its graphical form. We have developed three different levels of abstraction corresponding to the phases in architectural practice:

- sketch orientated — size and orientation
- 2D-plan orientated — 2D-representation
- 3D-model orientated — 3D-representation



sketch orientated 2D-plan orientated 3D-model orientated
Figure 4 Abstraction levels of geometrical views

The transfer between different levels of abstraction - sketch orientated, 2D-planing orientated, or 3D-model orientated is always possible as a result of the higher density of information carried within each object. The object remains the same, the level of scrutiny changes.

4 Acknowledgements

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