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Planning-oriented building surveying

Modules in the computer aided architectural planning process of existing buildings

PETZOLD, Frank; THUROW, Torsten; RICHTER, Katharina; DONATH, Dirk
Bauhaus-Universität Weimar, Germany
http://www.uni-weimar.de/iar

Activities in the building industry in Germany concentrate increasingly on a combination of renovation and new-build. A prerequisite for computer-aided planning in the context of existing buildings is both the use of on-site computer aided surveying techniques and the integration of all professional disciplines in an integrated information and communication system. Current approaches to these issues are unsatisfactory. Methods and techniques in renovation work are being investigated as part of ongoing research at the Bauhaus-Universität Weimar (SFB524 - "Collaborative research center 524 „Materials and Structure in Revitalization of Buildings"). A sub-group (SFB524 - D2 „Planning-Relevant Digital Building Surveying and Information System") is currently investigating the possibilities of computer-aided building surveying and of joint communcation platforms for engineering disciplines (www.uni-weimar.de/sfb: May 2001). The objective is the development of a general approach for the renovation of buildings.
The paper discusses concepts and requirements for a computer-aided system supporting the entire surveying process from the initial site visit to its use in a CAD system.
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***Keywords**: surveying, CAAD Systems, computer aided planning process, building model*

Context

Since the beginning of the 1990's the focus of planning activities has shifted ever more away from new building to renovation and building within existing contexts.

Reliable and informative documentation is an essential pre-requisite for planning with existing buildings. If documentation is not available, then building surveying, despite its cost, presents a real alternative for providing accurate plan information. The building must therefore be measured-up, either in its entirety, in part or for verification.

A look at current computer aided surveying systems reveals a serious lack of IT-support for surveying and the preparation of the collected information for further use in later planning stages.

A particular problem when it comes to surveying existing buildings is that no conceptual models exists for the description of building stock, its condition and life-cycle properties.

Planning-relevant building surveying - a part of CAAD

The building survey provides the basis for all further planning in an existing context and can be seen as a part of CAAD-aided design and planning processes [FIGURE 1].

Add appropriate input devices such as hand-held distance measurer [FIGURE 2] and Totalstation to the existing hardware configuration and supplement it with

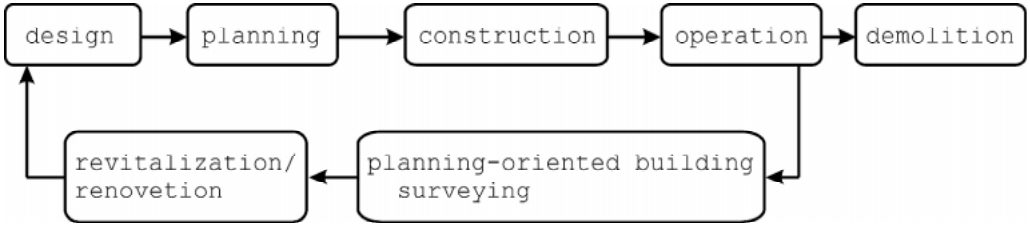


Figure 1. Classification of the planning-relevant building survey within the life-cycle of a building

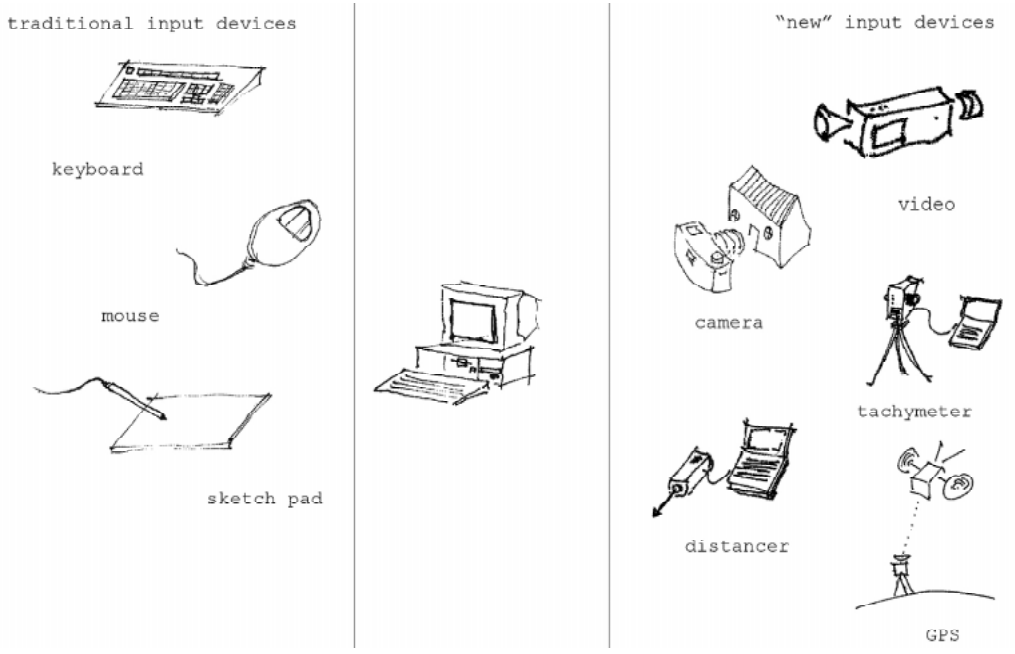


Figure 2. " new " CA(A)D input devices

the relevant necessary functionality, then the building survey can then also be seen as a module of a CAAD system - a CAAD programme for the measuring and surveying of existing building stock.

Planning-relevant building surveying includes not only the measuring of the building's geometry, but also any further information relevant for planning such as qualitative information, multimedial information and structural interconnections (Donath and Petzold, 1997). More often than not the measured or collected data is characteristically of vague and incomplete nature.

Based upon an empirical examination of existing computer-assisted planning software and IT-solutions as well as geodetic tools, the following requirements for planning-relevant building surveying have been identified:

- Support for the entire building surveying processes, the measuring of the building in different levels of abstraction (models), and the transformation of the model (i.e. from on-site 'sketch' to 3D-model),
- On-site survey-model building together with plausability checking,

- The combined collection and surveying of different forms of information, such as formal data (descriptive), informal data (multimedial information) nnd stuctured data,
- Immediate support for the creation and modification of ordering structures (structured building systems),
- The import of ordering structures (basis structures),
- The possibility to adjust the geometric representation,
- The flexibility to allow the use of various surveying systems, such as tachymetry, photogrammetry, vectorisation etc. ,
- Preparation of the collected data in an information system,
- Presentation of the data in different presentation forms.

From sketch to architectural model - a concept for computer-aided building surveying

The concept comprises a set of tools for the computer-aided architectural surveying of buildings. The individual tools form a continuous, evolutionary and flexible system providing support from the initial site visit to the appropriate presentation of the data for further use. The system is intended to support the professional surveyor with a structured surveying method, the post-processing and the analysis of the data. Each of the tools covers a different aspect of the surveying process [FIGURE 3]

The surveyor can create ordering systems (structures), adjust them and import or export as basis-structures. Pre-defined ordering systems can therefore be created for particular building types.

The following modules have been conceived to support the entire building surveying process:

The module **Initial Site Visit** involves the initial creation of the building model and the definition of a spatial structure. Primary functionality concentrates on the approximate representation of the principal spatial and constructional elements in sketch form.

The **survey** module encompasses the local non-destructive/minimum-disturbance collection of geometric and further planning-relevant data. Surveying methods supported include the use of reflectorless tachymeters and/or reflectorless motorised tachymeters with additional measuring by hand as well as photogrammetry.

On-site surveying can only measure the visible surfaces of the building. The captured data is therefore incomplete. These can be supplemented by suppositions which then require subsequent verification. For example, from the consideration of the visible surfaces the location of constructional elements buried within them can be inferred.

The **structuring** module describes the building in terms of its material elements and their possible inter-connections. Tools are provided for transferring the surveyed building surfaces into constructional elements.

These structural elements can be assigned to higher ordering systems, e.g. building phases.

In addition to surveying geometric data, each module also supports the collection of further planning-relevant data (formal, informal and structural data) in a structured form, and can be assigned to spatial and/or constructional elements.

Two modules cover the evaluation and preparation of the collected data:

- documentation and presentation (for example the creation of room and building logs)
- information module (information system in the Internet)

The development and transformation of the survey-model in this concept and its transfer into a model appropriate to the different specialised planners (structural engineer, energy consultant, building material laboratory) are conceived according to a linkage-based approach (Willenbacher and Hübler, 2000; Petzold et al, 2000).

Figure 3. Subsystems and their relations

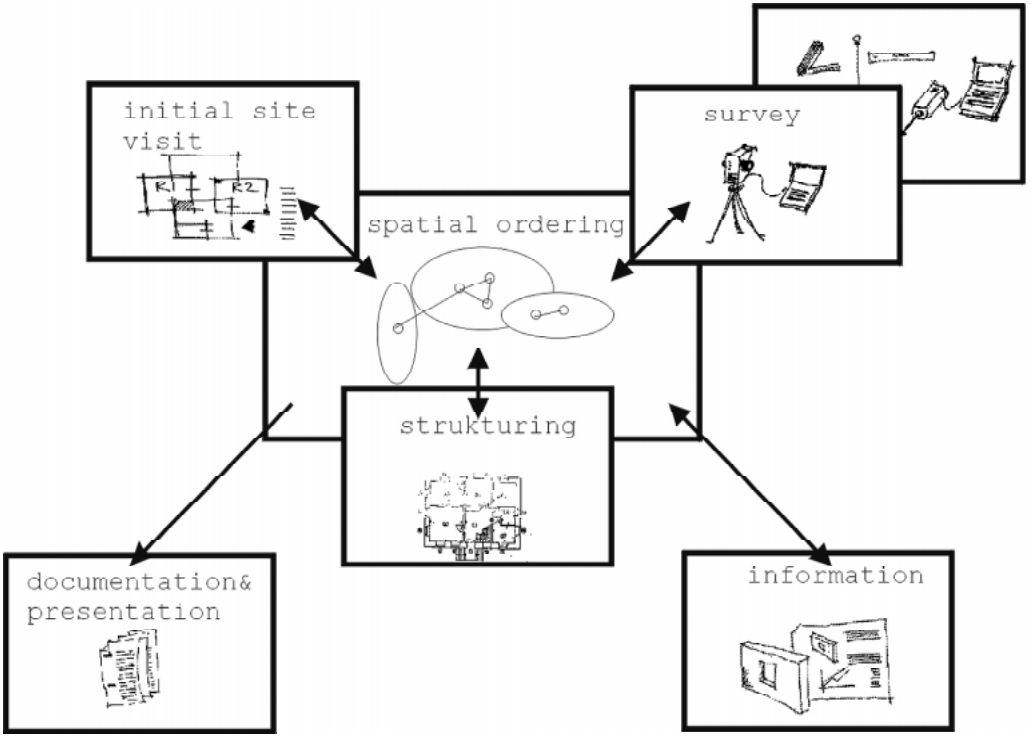
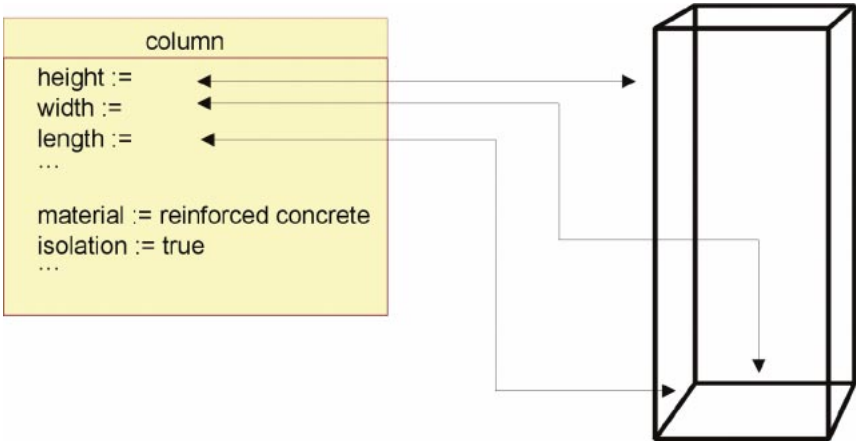


Figure 4 Separation of building-specific semantic data and geometry



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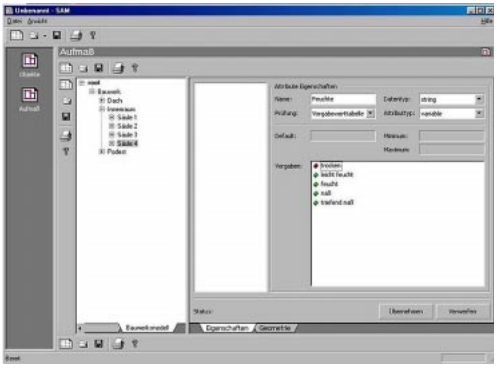


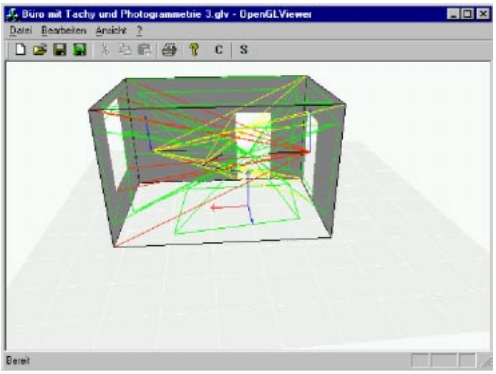


Figure 5 (left). Definition of user classes - prototype SAM

Figure 6 (right). survey module - prototype Freak2000

The survey module - concept and prototypes

The survey module addresses the construction of a digital geometrical representation of the building to be surveyed. The representational accuracy of the survey depends largely upon its subsequent usage as well as from the effort possible or permissable during the surveying itself. The representational accuracy is therefore dependent upon the degree of abstraction, detail and dimensional accuracy.

The concept envisages an approach whereby the building geometry is approximated as realistically as possible. This means that a building element is represented according to how it was found on site, not how it would be geometrically represented, resulting in differences in degree of detail, topology and geometric values. The support of differing degrees of representational abstraction according to the respective requirements adds further layers of difference to a single element. For this reason the geometrical information and the element itself are linked to one another but not merged together in the element's definition. This results in a separation of the building-specific semantic (spatial and building element data including formal, informal and structural data) from the geometric form [FIGURE 4].

Two tools are available for the creation, extension and modification of the ordering structures:

- the structure generator (creation of spatial and element data)
- the geometry generator

The structure generator provides various tools for adapting existing ordering systems or for the development of new ordering systems without the need for special programming knowledge.

Tools are available for the generation of the following [Figure 5]

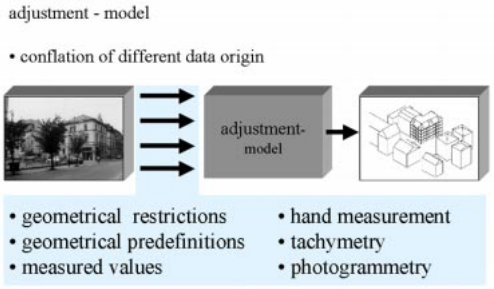
- spatial and building element classes
- evaluable alphanumeric properties
- multimedial properties

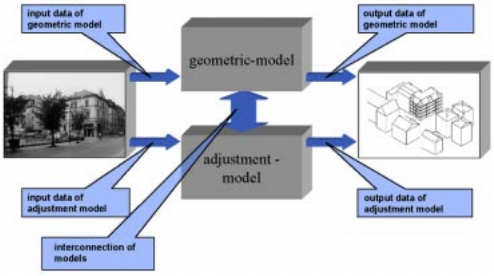
The geometry generator uses a sketch-based three-dimensional geometry construction method. Geometries can be saved to a catalogue and re-used. This approach enables the creation and assembly of a kind of 3D-sketch of the geometrical situation, which is then adapted to the actual situation by taking measurements at the level of accuracy desired. This procedure is assisted by the use of building element catalogues, in which geometrical properties or restrictions such as parallelism or orthogonality are defined and to which the measured information can be assigned [FIGURE 6].

In order to maintain a free choice and flexible combination of surveying techniques for the user, the

Figure 7 (left). Combination of different surveying methods

Figure 8 (right). Connection between adjustment and geometrical model.





techniques have been linked to one another with the help of geodetic algorithms used in surveying, for example different for adjustment methods (Donath et al, 2000b) [FIGURE 7]. As a result, the values required for the digital geometrical image are indirectly determined, supporting both the deliberate use of verification using several methods to ensure higher accuracy, as well as an estimate of the representational accuracy [FIGURE 8].

Outlook

The long-term objective is the development of an easy to use IT-system that adapts information from the actual built situation to planning needs. A superimposition of real and mapped images could be realised through the combination of surveying and AR/VR-techniques. This would assist the detection and correction of errors. Future developments in computer engineering with respect to miniaturisation open up new possibilities. The current research and development reults will therefore be integrated and modified according to the changing demands of digital surveying. The project focuses not only on the technical presentation and on problem solutions but also on the surveying procedure itself.

References

Donath, D. and Petzold, F.: 1997, A digital way of planning based on information surveying, in R. Junge (ed.), CAAD futures '97, Springer-Verlag, München, pp. 183-187

Donath, D.; Lömker, T.M. and Petzold, F.: 2000, New approaches in computer aided project planning - Towards the use of a modular building information system based on digital survey in the revitalisation process of existing building, in J.R.Kós, A.S. Barbosa and R.C. (edrs.), SIGRADI 2000, Gràfica Onida Ltda., Rio de Janeiro, pp. 212-215.

Donath, D.; Liedtke, M.; Petzold, F.and Thurow, T.: 2000, Gemetrierfassung und - abbildung in der Bestandsaufnahme .in J. Hanff, E. Kasparek, M. Ruess and G. Schutte, G. (edrs.), Forum Bauinformatik 2000 - Junge Wissenschaftler forschen, Fortschr.-Ber. VDI Reihe 4 Nr. 163, VDI Verlag, Düsseldorf, pp. 68-76.

Petzold, F; Willenbacher, H, Willenbacher, S. and Bubner, A.: 2000, Relationen-orientierter Daten- und Informationsaustausch - Basis eines flexiblen digitalen Bauwerksmodells, in J. Hanff, E. Kasparek, M. Ruess and G. Schutte, G. (edrs.), Forum Bauinformatik 2000 - Junge Wissenschaftler forschen, Fortschr.-Ber. VDI Reihe 4 Nr. 163, VDI Verlag, Düsseldorf, pp. 25-33.

Willenbacher, H. and Hübler, R.: 2000, Relationen zwischen Domänenmodellen - Ansatz zur Schaffung einer integrierten computergestützten Bauplanungsumgebung, in L. Hempel (ed), IKM 2000, Weimar, CD-ROM.