Internet based support for architectural planning processes

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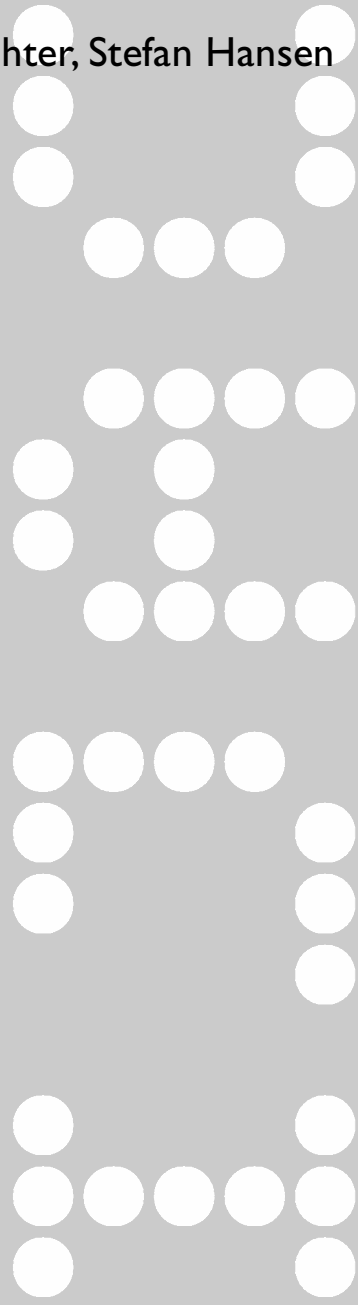

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As building projects become increasingly more complex, the number of project participants grows as does their spatial distribution. An effective decentralised work process and co-operation is of increasing importance. The global computer network, the internet, has great potential and recent times have seen the development of a variety of techniques in this field. The project described here is based upon this approach and also takes it a step further. A specific analysis of the topic and the subsequent identification of potential approaches formed the basis for an architectural application that brings the architect in contact with other project participants using the internet as a powerful yet simple and easy to use medium.

1. Introduction

As building requirements increase, the planning task becomes ever more complex. This applies both to new building as well as to renovation and conversion works which, due to the number of unknown variables, represent a particularly complex planning task. The professional uses digital systems and tools to help master the individual tasks. Corresponding planning systems for the planner, are either insufficient or do not exist.

The digital support of the planning process is the focus of current research at the InfAR chair for Computer Science in Architecture at the Bauhaus-University Weimar. Since 1998 the project has been integrated into the DFG (Deutsche Forschungsgemeinschaft) special research topic 524 "Tools and constructions for building renovation" with its own section (D2). The establishment of a junior professorship for Computer Science in Architecture in 2002 increases the breadth and depth of our research.

1.1. Motivation

As building projects become increasingly more complex, the number of project participants grows as does their spatial distribution. Planning projects themselves require a higher degree of planning coordination, organisation and communication than ever before.

To cope with the increasing complexity and requirements, it will become necessary for architects and planners to work together in flexible service networks. The technical basis is already available in the form of global networks: the Internet.

The approaches to solving the various problems are wide and varied and in the past few years a veritable flood of different applications have appeared for the internet, each based upon different technical backgrounds and academic approaches.

1.2. A closer look at internet-based project management systems

Common to all systems is a vision of an optimised planning process, simplified communication and better time management with the broad intention of saving time and money.

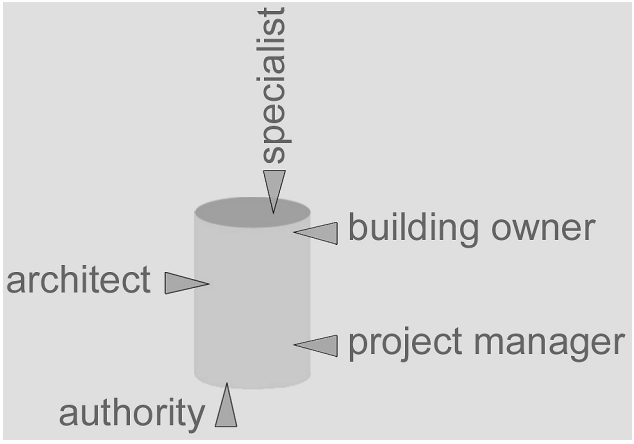
Currently available systems focus on different aspects. They can be roughly grouped in three categories, though the basic functionality of the simpler systems is further expanded by the more advanced systems:

1.2.1. Internet based data management systems

If we consider the conventional exchange of information during the planning of a project, it is very often characterised by an unstructured exchange of information: Faxes, letters, meeting protocols, as well as plans both in digital and paper form. Each project participant stores this information in their

own archive with their own ordering structure. The information cannot be seen by other participants without them actually passing it on to them. Digitally drawn plans are plotted and sent by post to the specialist who then incorporates the changes into his or her own set of plans. Plans are increasingly being sent via Email and the data quantities are often considerable. Once again, interchanged information is stored according to different methods by the various different project participants which does not help communication.

This kind of information exchange and communication is costly both in terms of personal time and money, whereas time delays and in some cases information loss (working with different versions of the same plan) are almost pre-programmed.



◀ Figure 1. Internet based data management systems

The provision of an uniform central database for all project participants ensures that at any point in time during the project development the information is always up-to-date and relevant. Redundancy of information and data can be eliminated. The idea is that this central database, comparable to a dedicated hard disk in a network, can be viewed by all participants according to a series of access rights which determine their ability to view and amend the data per download and upload. Typically the plans can be viewed from the internet browser. A necessary prerequisite is that all participants take part in a disciplined manner. Data must be kept up-to-date and participants must inform the others of changes and additions to the data available.

Advanced systems also offer workflow functions for description and process modelling.

The aim is to use automated systems to simplify complex notification and communication processes and improve team and project coordination.

1.2.2. Project communication systems

Project communication systems provide support for specific manual as well as automated communications in the form of E-mail and SMS (SMS stands

for Short Message Service). The entire project communication over and above data management employs these systems. When documents are added to the data pool, all participants are informed automatically per E-mail.

The implementation of such systems necessitates a degree of preparation by the project co-ordinator. He or she must ensure that contact data concerning all participants in the process as well as their roles and inter-relationships in the planning process are known.

Additional features can include: appointment book, web cam, conferencing software, automatic plot and copy ordering, a viewer or discussion forum etc.

1.2.3. Project oriented systems

Project oriented systems go beyond data management and project communication. This also simulate and support the entire project development with a view to provide complete and continuous project management and steering via the internet. The purpose of such systems is to predict and plan for upcoming stages in the project development and to ensure that necessary stages are not left out. This would require that the entire planning process is modelled in advance but that it could be modified if necessary. Despite positive approaches developed in research and the industry, no available systems currently cover the entire planning process by providing supporting tools and information for the different planning phases from design to final project documentation.

Depending upon the background of the different developers, different systems have different foci, for example specification and tendering, CAD and plan representation, procurement, etc.

1.3. Defining the problem

At present the architect has a more or less ambivalent point of view in regards to Internet-Based-Project-Management Systems (IBPM). The idea behind IBPM systems is comprehensible and can offer an immediately measurable benefit.

On the other hand there are a variety of aspects which hinder the unconstrained implementation of such systems:

- Most IBPM – Systems are oriented towards dedicated project managers, general contractors, large building companies etc. and less so to the small to medium sized architectural office working through the planning process phase by phase, from design to construction.
- The systems are often viewed with personal scepticism by participants. Insufficiently informed they worry about personal security (“My data on my computer!”)
- A particularly remarkable problem, which became evident from our

investigations in the field and in practice, is the lack of an overview of what different systems are available and what they can do as well as their compatibility to existing tools and methods used in the office.
- number of risks and uncertainties arise due to the slowly changing structure and consolidation within the building branch and corresponding resentments and antipathies in the field. [2]
- The data-technical project development does not (yet) correspond to the traditional process of everyday planning in the office.
- There is still a large discrepancy between the "offline" and the "online world" during the planning process.

2. Data Exchange at a Document Level Compared to Format-Related Data Exchange

For the most part IBPM systems are used for the efficient exchange and storage of documents (using a central document server) rather than for the exchange of actual information. The format and content of the documents are not considered. Text, tables and graphical information are handled identically. This is a deficit of all currently available systems: Graphical data is not sufficiently supported although it is the primary information basis in the planning process.

This is the starting point for research and development project at the InfAR chair in Weimar.

2.1. Viewing and amending plans in the internet

The problem is not a new one. The potential for increased efficiency through more effective cooperation and interaction is too great to be ignored and different CAD manufacturers have attempted to address through their own systems.

Autodesk made the first initiative in 1997 with the DWF format together with the WHIP! plug-in for viewing it with internet browsers. It provides compact files sizes in a CAD-like environment: besides viewing pure vector data it is possibly to view layers and views. The DWF format can be exported directly from supporting CAD programs.

Bentley, producers of the CAD program MicroStation took a more comprehensive approach independent of particular formats with their product "Viecon Publisher". A "model server" concept allows the user to access MicroStation files (DGN) and other formats, for instance the AutoCAD DWG format. The Viecon Publisher dynamically produces an image of the latest version of the file in a format of the user's choice, for instance as a JPEG file. The viewer does not need a particular plug-in but the advantages of CAD formats such as interactive zooming and shifting position are lost. The concept differs from other approaches by providing a concept for supporting the planning process.

The "Project Publisher", which is an integral part of the GraphiSoft application ArchiCAD from version 7 onwards, provides support for the

DWF format. It allows different plan information to be published in internet, whether vector data, text, images or HTML-pages. The publishing function makes use of a JAVA-applet to present the data in the internet browser. The viewer can make annotations use red-line functions. The information is then sent back to the originator via E-mail.

In addition there are a number of plug-ins available for the most common CAD file formats to allow them to be viewed via the internet. However, none of these formats are particularly internet-friendly. They are either insufficiently compressed or do not support internet-typical functionality.

2.2. Open Standards

Given the less than happy situation that most large CAD manufacturers have attempted to use their market leverage to establish their own proprietary format as quasi-standard, there have been long-running independent attempts to develop and establish open and manufacturer-independent formats as a general standard. The exchange of information is after all a central aspect of the internet, and this is best achieved on the basis of open and neutral standards.

Open standards include:

SVF (Simple Vector Format) from SoftSource, WebCGM and developed under sponsorship from the W3C. It is based upon the CGM (Computer Graphics Metafile) format.

The format favoured most by the W3C at present is SVG (Scalable Vector Graphics). It fulfils many requirements for the internet-friendly representation of plan data, the most important of which include:

- Viewing with a freely available plug-in directly in the internet browser. Future browser generations should incorporate this as standard.
- Data transfer quantities are low
- Interactive viewing and editing

2.2.1. SVG

The most important differences to previously mentioned formats include:

- Developed and specified by a W3C consortium, it is manufacturer-independent
- It has wide support in the industry. Many large software houses have been involved in the specification process including Adobe Systems, AOL/Netscape, Apple, Autodesk, Canon, Corel, Eastman Kodak, Ericsson, Hewlett-Packard, IBM, Macromedia, Microsoft, Nokia, Quark, Sun Microsystems, Visio, Xerox.

- The integration of SVG-viewing technology in future browser generations has the potential to make viewing vector data as straightforward as viewing pixel-based formats.
- SVG can also include text and images in addition to vector data. Text can be referenced and searched. [3]

SVG files cannot yet be generated by any of the commonly available CAD programs. Autodesk have announced that future versions of AutoCAD will support the SVG format and it will only be a matter of time before other software houses follow. In comparison almost all Adobe products as well as those from Corel already support SVG. [4]

An overview of internet vector formats would not be complete without mentioning the widely used Flash format from Macromedia. Apart from the fact that it is manufacture-dependent, it is less suitable for planning purposes as there are no export or conversion possibilities for typical CAD-formats. The concept of SVG goes much further than that of Flash, enabling it to be integrated into automated batch processing due to its XML compatibility. A functional comparison between Flash and SVG can be found in [5].

3. Architectural Content Systems – ACS

A project at the InfAR Chair for Computer Science in Architecture at the Bauhaus-Universität Weimar investigated the potential of ACS.

Based upon a concrete and in-depth analysis of the planning process, the investigation of potential development possibilities available with existing systems and a detailed examination of new internet technologies, an application was developed that is oriented around architectural practice. The aim was to use the internet as more than a presentation medium or means of communication. Rather, the goal was to use it as an interactive interface for all those involved in the design and planning process.

3.1. An interactive interface in the internet

The concept of an interactive interface differs from project communication systems in that it integrates presentation from information and communication without using external services such as E-mail. An interface in Internet creates a location in the net in which information is provided and also received, and moreover can present this differently depending upon who is viewing or using it.

In contrast to the static presentation of information, a dynamic and communicative tool results. Its content is no longer document-bound – and therefore difficult to reference and integrate – but is instead stored in a flexible database. The data can be served up dynamically according to the demands and interests of the respective users.

This concept goes beyond the original concept of the internet, and far beyond the idea of connected documents. It departs from the document-

bound understanding of the early days of the internet, where the representation of content and the content itself were contained in the same document. [6]

3.2. The application

The core of the application is the presentation and communication of design and planning progress. This occurs digitally as plan information stored on a central server in SVG format.

The application is based upon the 2D abstraction, the plan, as central model (information carrier), as this is still the most typical means of communicating architectural information in planning practice.

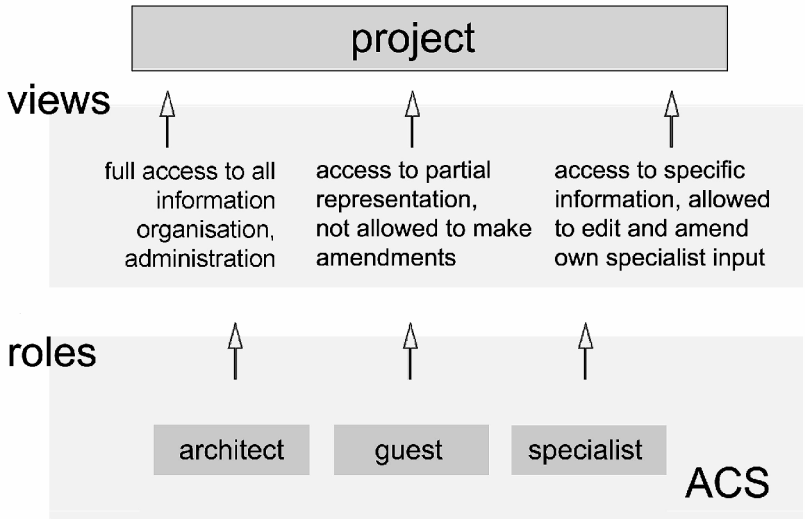
The project is based upon several functional and formal aspects:

The hub of the application is the notion of a *central database*.

3.2.1. Roles

Through a user-based administration system, the different participants are assigned specific roles (for instance internal: project coordinator, architect, and external: guest). These roles determine the way and extent of information that can be viewed and accessed (i.e., view limits and amendment restrictions, access rights etc.). These views are dependent upon the role used.

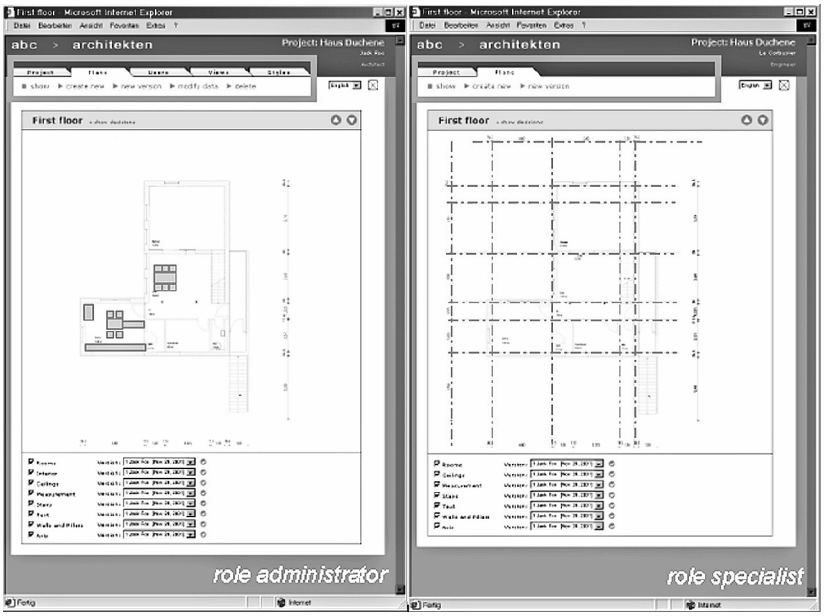
► Figure 2. Roles, views and access rights in ACS



3.2.2. Views

The concept of views is based upon the roles and is the core of the design in terms of its functionality. Views take into account a well known phenomenon of everyday practice: A single building or a design can be viewed from different standpoints each with their own context and

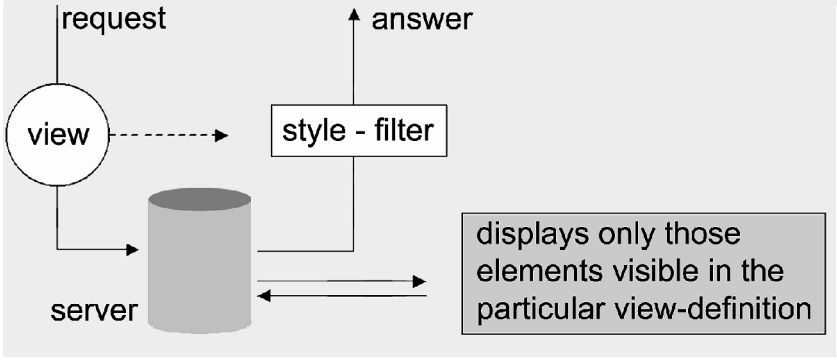
language. A view therefore does not only define rules about which section of information from the total information available is accessible but also how this information is to be presented.



◀ Figure 3. Viewing and access rights; e.g.: administrator, specialist etc. in ACS – Screenshot

3.2.3. Styles

Styles define the graphical representation of the data. For the purposes of presentation, line thicknesses, stroke and colour can be defined differently for the same object for each role.



◀ Figure 4. Views and style filters

3.2.4. Plans

Plans are the central information carrier for the application. They are not only for viewing, they are the basis upon which the project participants interact with one another. Project participants contribute new plan information to the interface.

3.2.5. Versions

A central aspect of working together using an ACS interface is the concept of versions based upon stringent and consistent plan structuring in layers defined in advance by the project coordinator. Different versions of different layers in a single plan can be viewed and the responsible participant can then decide which version should be the currently valid version which other team members can view and access.

3.3. Extensibility

The technology used allows the application to be extended as required. For instance the integration of "geometry-based interactivity" such as a history protocol and a red-line function are two functions that are relatively straightforward to implement. The direct manipulation of geometry data is in principle also possible, but is dependent upon better export filters from existing CAAD-systems.

Whether such a system should continue to work with object-oriented data formats (linking of geometry data with alphanumeric data) in an internet environment is for the moment still open to discussion. The usefulness and practical relevance of 3D or 2D-based planning data is, as we speak, still a matter of hot professional debate.

Functionality already provided by IBPM systems have not been recreated or implemented for the time being. The focus lies on working with graphical planning information and verbal annotation. The ACS application could quite feasibly be integrated as a module of an IBPM system and would be possible in terms of technologies used.

Alternatively, another approach not dependent upon other IBPM – systems would also be possible. The application can be extended and developed itself. Current development has focussed upon the plan as a central architectural means of expression and communication. The concept could be extended to include information groups linked to the plan data which could include not only text but also pictures, video or GIS information. This information network could 'dock onto' other networks, and thus form an extended network going out from the geometric information of the plans as central information nodes. Using this approach, planning and design processes could be stored, organised, processed and accessed directly in an internet-oriented format, without having to fall back on IBPM system metaphors such as project space, folder, etc.

3.4. Technical implementation

For the technical implementation, the aim was to build a generic and modular extensible application architecture, that is,

- To use an open source and internationally W3C accepted web standard for geometry data SVG (Scalable Vector Graphics).

SVG was developed from the outset with interactivity in mind as well as the representation of planning processes and planning data in the internet. This means that drawings can in principle be worked upon directly.

Further development included the following features:

- Avoidance of script languages,
- Implementation with server side Java (J2EE-standard),
- XML-based date exchange and editing,
- A clear differentiation between data, business logic and representation,
- No hard-coded HTML, and instead XSLT use.

These properties make it possible to change the appearance of the application completely without having to delve into the program source code. This also allows adaptable viewing on any combination of viewing device and personal role according to their own specific requirements. The principle of different representations of the same information can be used both ways. The chosen representation may be defined and kept the way one wants it whereas the information (XML data) may be revised and renewed. Internationalisation is therefore very easy. By quite simply translating the interface texts in the representations, new languages can be added without the need for any programming skills.

- The server infrastructure is realised only with Open-Source projects.
- Use of a framework.

A basis program (framework) is used to provide additional functions such as authentication, security, database linkage, internationalisation, transformation of XML to other formats, error handling and configuration. The design of the interface builds upon this by providing functions for displaying plan, views and administration depending upon visibility as determined by the framework.

3.5. Overcoming system limitations

The potential offered by internet-based applications for steering the architectural planning process is enormous. The implementation focuses on architectural-practice oriented demands.

The ACS application uses the SVG format as primary data storage format not only because of its explicit suitability for the internet, but also because it promises to become a further important data exchange format. SVG is not at present a standard export format for CAD programs. This

system limitation would be best overcome with a built-in conversion routine as part of the interface. Given the current level of technical implementation, this would improve the everyday usability of the designed system significantly and bring it a step nearer to the vision of a consistent and integrated computer aided planning management system for everyday architectural planning.

4. Future Prospects

As with all the other technical developments that have significantly changed the way we go about things, architecture will eventually have to confront the potential offered by the internet. The impression seems to be that architecture, at least as far as making use of the possibilities offered by new information technology is concerned, is falling considerably behind the times. One would hope that this would evoke a positive response.

The ACS project at the InfAR Chair for Computer Science in Architecture will make a contribution to this response when, through its use, the planning process and the understanding of planning begins to adapt to new working possibilities.

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