Experiences with an Integrated Building Design Software

Expériences avec un logiciel de conception intégrée en construction

Erfahrungen mit Integrierter Software im konstruktiven Ingenieurbau

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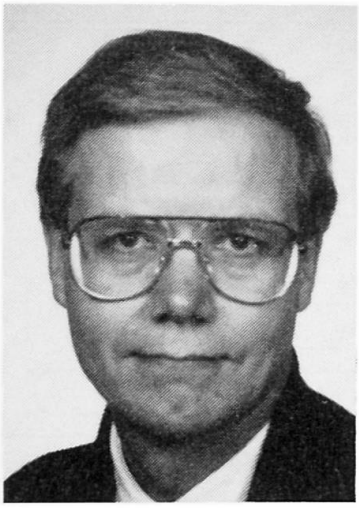


Risto Sajaniemi, born 1940, received his engineering degree at the Technical University of Helsinki, Finland. For twenty-three years he has been involved with computer applications in structural engineering. Now he is a manager in the leading Finnish engineering software company, Tekla Oy.

SUMMARY
A strategic long term concept will be presented for the integrated information processes in civil engineering and urban planning. This includes also some basic but very important guidelines. The integrated building design software package developed during 1984–1987 will be presented. Experiences achieved and the future of integrated building design will be discussed.

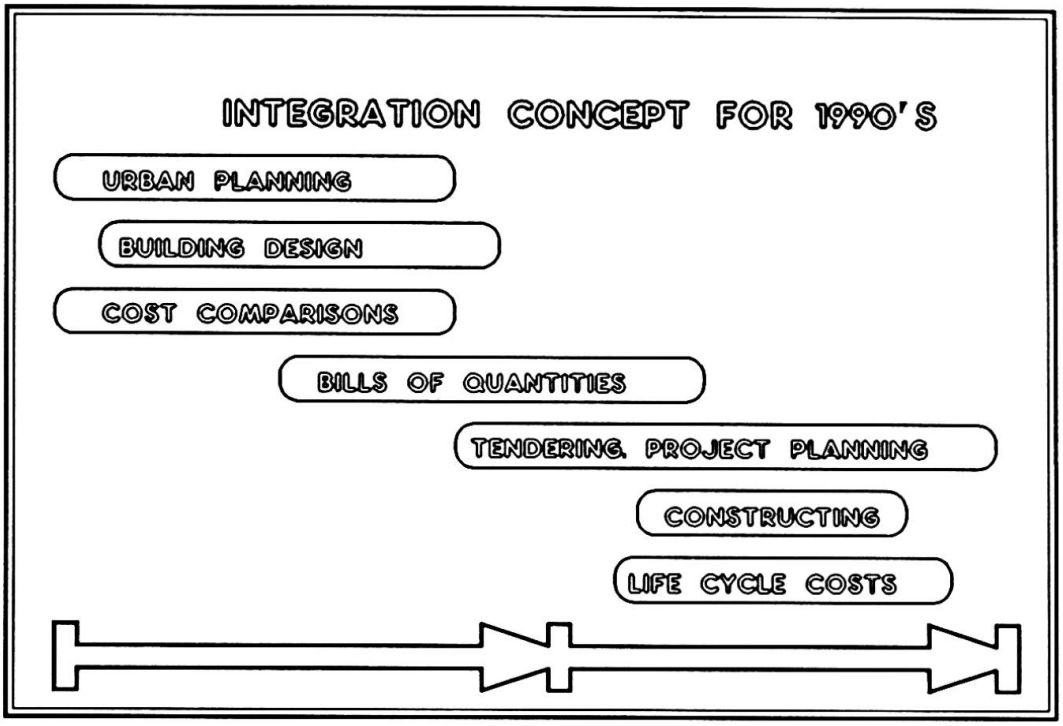
RÉSUMÉ
Une stratégie à long terme est proposée pour l'intégration de processus informatiques dans la conception de projets urbanistiques et dans le génie civil. Elle est constituée de lignes de conduite fondamentales mais néanmoins essentielles. Un progiciel de conception intégrée en construction a été développé de 1984 a 1987. La dernière partie montrera des réalisations terminées et ouvrira des perspectives sur la conception intégrée en construction.

ZUSAMMENFASSUNG
Es wird ein strategisches Langzeit-Konzept auf dem Gebiet der integrierten Informationsverarbeitung im Bauwesen und der Stadtplanung vorgestellt. Hierin eingeschlossen sind wesentliche Grundgedanken und wichtige Richtlinien. Anschliessend wird die integrierte Software für diese Anwendungen erläutert, die seit 1984 entwickelt wurde. Die gewonnenen Erfahrungen werden veranschaulicht und Zukunftsperspektiven des integrierten Entwerfens, Berechnens und Konstruierens aufgezeigt.

1. THE TOTAL CONCEPT

1.1 Civil Engineering and Urban Planning

The firm Tekla is creating an integrated CAD/CAM system for the area of civil and building design and construction (fig. 1). Every "bubble" - a part project - forms an integrated system. Each program has been developed by using consistent basic software, which secures the possibility to make further integration in the future.



1.2 The Basic Components

As a basis of this system Tekla has used ready made basic software:

- Design Office Graphics System - DOGS (PAFEC LTD., ENGLAND) for **graphics applications**
- Relational Data Base - RDB (DIGITAL EQUIPMENT CORP.) for **data base** applications

By basing the system on these, Tekla was able to concentrate on design and calculation applications, to achieve an easy user interface and to complete data management. Thus the resources are not wasted in reinventing of basic draughting and data base software.

One of the application systems called ALVISR, according to its Finnish initials of the corresponding design disciplines, is aimed at **building design**: architectural, structural, HVAC and electrical desing. The system consists of calculation, design and graphic programs, all of which use common data bases and the same data communication techniques. The application modules can be used separately, some even in PC micro computers, or as an integrated system in a computer network.

1.3 The Only Valid CAD Concept

The economic benefits are not achieved by automating only the drawing part of an engineer's work. The CAD system has to be intelligent, to know the contents and relations in a drawing. This means that the design object has not only to be drawn but rather to be modelled. This model, which is created using interactive graphics and application programs, is stored to data base. The drawing is merely one visual view of the model.

To achieve economic results all the three following components:

- interactive graphics
- engineering application programs
- data base management

have to be included in the CAD system and they have to run simultaneously in real time (fig.2). With modern software and hardware this is possible.

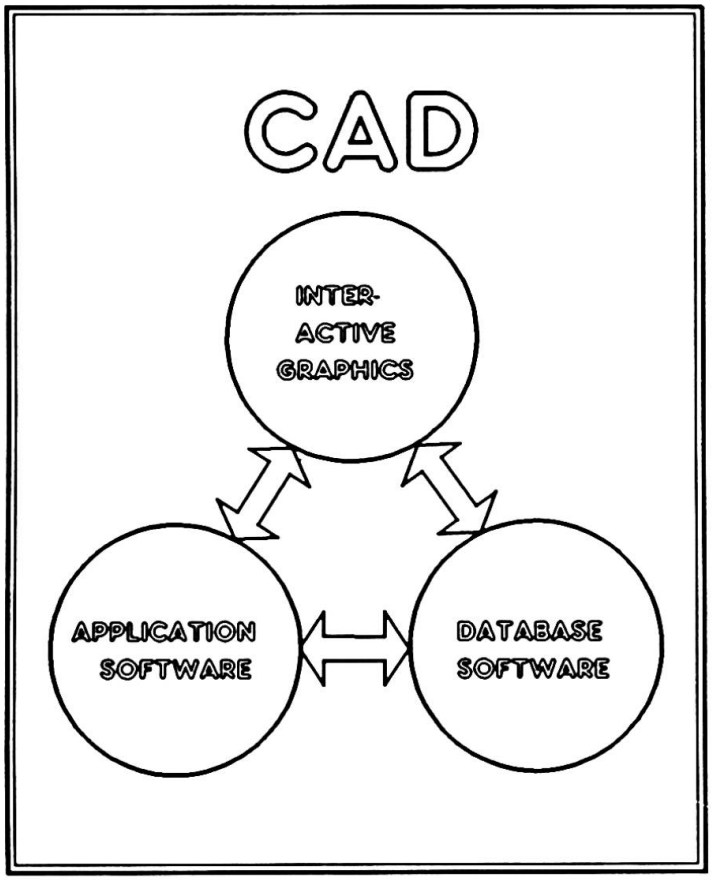


Fig.2 Computer aided design is an entity, of which computer aided draughting is only a part

Tekla is already prepared for the next phase of integration: the electronic information processing and transfer in the whole urban planning, civil engineering and construction environment.

2. THE INTEGRATED BUILDING DESIGN SYSTEM - ALVISR

Tekla's Integrated Building Design System is divided into several logical subsystems (Fig.3).

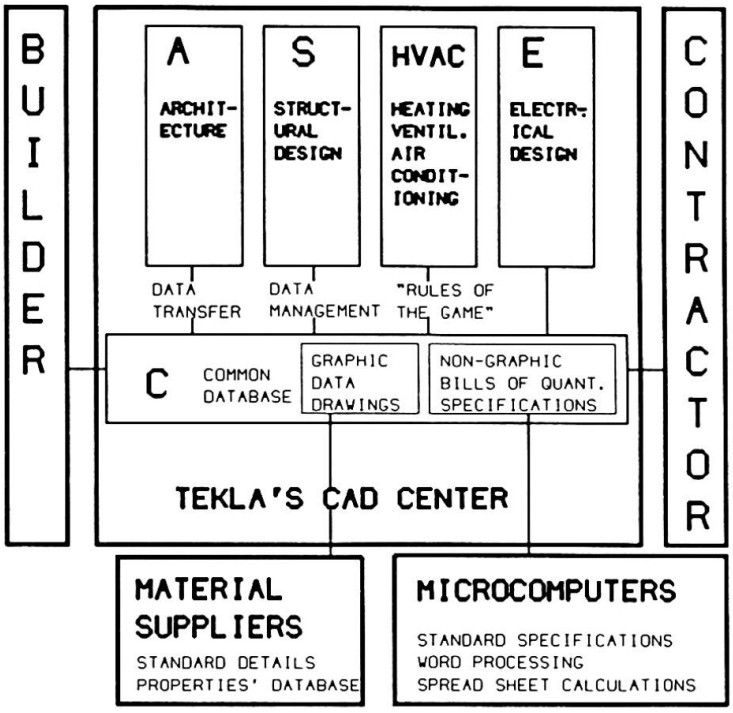


Fig. 3 Integrated use of CAD in building design

2.1 Common Data Base C

This consists of the management of the graphic and non-graphic common data base, data transfer options and instructions for integrated building design.

The instructions include recommended rules for an integrated design process such as the use of plot layers and password practices. With data transfer options it is possible to transfer picture files between different CAD systems (DOGS, INTERGRAPH, MEDUSA, AUTOCAD). There are also connections to material suppliers and PC micro applications, standard specifications, word processing and spreadsheet calculations.

Using this subsystem all designers can exchange information between each other.

2.2 Architect A

The creative design and drawing work of an architect is made easier by symbol libraries, both parametric and non-parametric, and many drawing options even for 3D axonometric and perspective visualisations. The bills of quantities are automatically generated simultaneously with the drawing process.

2.3 Structural S

This part consists of complete steel and concrete design program suites and many CAD applications, especially for steel structures and concrete element structures.

2.4 Heating, Ventilation and Air Conditioning HVAC

This subsystem is described in greater detail in chapter 3. It contains all necessary design and drawing applications, symbol libraries plus a total data base system for the modelling of HVAC networks. It also contains both graphic and non-graphic HVAC component data bases.

2.5 Electrical E

This subsystem is similar to the HVAC module and is as complete.

3. AN IMPLEMENTATION EXAMPLE FOR ONE DESIGN DISCIPLINE

Fig. 4 shows more detailed contents of this integrated building design system - ALVISR.

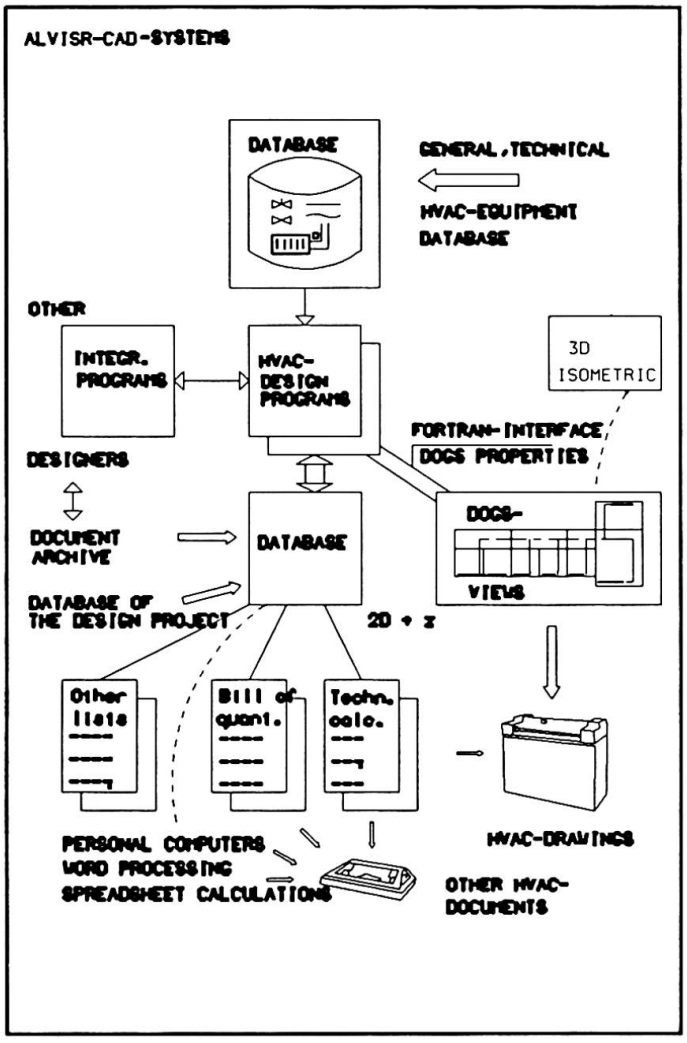


Fig. 4 HVAC design system

Uppermost in the picture are the HVAC component and equipment data bases. From these the designer may obtain the graphic and non-graphic information of selected items. These data bases are updated by material suppliers.

The middle of the picture shows the HVAC design programs: heating, water pipe and air conditioning networks. They are the nucleus of the whole subsystem. The designer communicates with these programs by using interactive graphics (DOGS). This essential interface has been done by using the unique DOGS/ FORTRAN interface which has been developed by Tekla Oy and is now accepted all over the world as a standard feature of DOGS.

All information that is created automatically during the drawing session is saved in the data base. This contains the x-, y- and z-coordinates, all attributes of pipes, lines, components, symbols etc. The drawing created during the session is only for visualisation. The design product itself is the model in the data base! With RDB data base it is possible to redraw the network, make logical checks, dimension the product, print bills of quantities and even draw 3D axonometries.

The bill of quantities can be transferred to a PC micro as shown in the lowest part of Fig. 4. A modern laser beam printer can combine text and pictures and print them on the same page. It also is a very useful hard copy device for printing drawings. The resolution of the laser beam printer is so good that no reduction of picture quality will follow even though the picture was enlarged to A2.

Via integration programs a designer can change information (drawings, messages) with other designers.

4. EXPERIENCES AND FUTURE TRENDS

CAD will affect design work in many ways. It affects even the making of design contracts and invoicing principles.
Are the builders interested in paying more, if they get a better and cheaper building? The usual answer is negative. So the benefits have to be achieved in direct design work, which will not get the best out of CAD's possibilities. The architect sees that his work is increased and other's decreased. This is due to the fact that an architect creates the drawings for the CAD system, while other designers can use these drawings directly without any redrawing.

Designer's work is affected by the fact that at the first stage, when inputting the design, there is almost no trace of increased efficiency. The possible copying features are the only positive options. At the second stage, when the logical checks, calculating, axonometric drawings, bills of quantities suddenly appear with "the press of a button", the efficiency factor is suddenly 10 - 100 ! To get all benefits the contractor should have a system for direct use of bills of quantities.

Thus Computer Aided Design cannot proceed very much further without the evolution of the design culture, or rather without the evolution of the building industry as whole!