

# **Computers for Architects Only a Tool?**

**Dipl.Ing.Arch. Hartmut Ayrle**

Institut für Industrielle Bauproduktion

Prof. Fritz Haller/Karlsruhe/Germany

## Abstract

*The paper states that, as a result of the schism between architecture as art and engineering as rationalism, the architectural community underestimates the computer as tool with a potential to substantially enlarge the possibilities of building design. It is claimed that the computer could serve as coordination tool for the ruptured design process, as a virtual workbench where all design disciplines sit together and develop their designs in enhanced conscience of what the whole design demands.*

*The paper then concludes, that to develop such software fools, architects must participate in the development of software and may no longer be restricted to the role of applicants, especially during their university instruction. The corresponding research and training facilities at the University of Karlsruhe, Faculty of Architecture are described.*

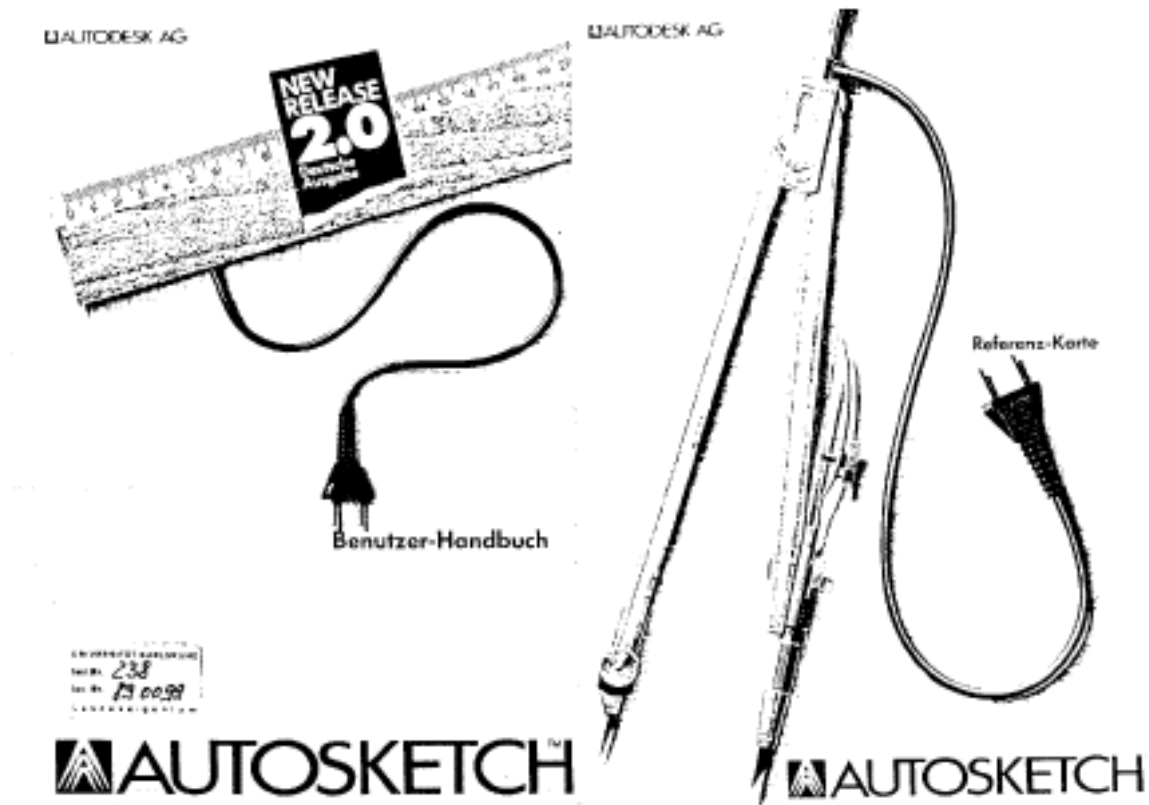
## Architects' problems with computers

Since the separation of civil engineering from architecture in the 18th Century, architects do underestimate rational methods and techniques for building and construction design.

Architects in the 18th and 19th Century did hardly realize how the application of new scientific methods to construction problems brought forward a flood of new materials and calculation methods. These new possibilities rapidly devaluated the experience and knowledge of the craftsmen architects relied on up to then. In the flood of new developments in construction and form, architects lost the overview of all the details and dependencies in a building design process and had to invite specialized engineers, who did just optimize their sub-tasks. Architects retreated to aesthetical design questions and could less and lesser steer the design process towards quality of the whole product.

As the name "Ecole des Beaux Arts" suggests, architectural design was more and more understood as an aesthetical task, which brings forward cultural works. In the core of the architect's work is said to stand the creative idea, that comes from intuition and has no obvious relations to rational or scientific considerations. To the contrary, rational examination of a problem is thought to be contra-creative or at least culturally unworthy, as it is directed by restrictions for design that stem from objective laws of nature and not from free human intuition. Even classical Modernism did not overcome this schism between ratio and intuition but continued to treat design, this time as functional "machine design", as an aesthetical formalism.

In consequence, the use of technologies for architectural design-tasks is regarded as an unimportant and secondary theme. The importance and the influences of tools on the work to be done is denied. Today many of us do not realize how much their intuition depends on the possibilities offered by such physical or mental tools as mathematics, standardizations, building construction machines and industrial semi-products.



Thus architects treat the application of computers to architectural problems as a temporary problem, that will disappear as soon as computers will have adapted themselves to the architectural working process quasi "naturally".

As computers can no longer be overseen, architects accept them in their offices as electronical substitutions for well-known physical tools: computers are understood as "big slide-rulers" for business calculations, as "electronical drawing-boards" for worksheet-drawing or as "electronical workshops" for three-dimensional models (see illustration).

But the first experiences with the new tool normally make it obvious, that despite all promises the computer and its software do not really fit to the architect's working process. Obviously there were no architects involved in the design of software for architects. So the average bureau buys just those programs, that are really nothing else but electronical substitutes for small subtasks out of the entire design-process and waits for further development of information technology, that is expected to adapt sooner or later to the architect's needs.

Meanwhile other disciplines understand that the computer actually is an under-determined tool and seize the chance of specifying it for problems that could not be solved earlier.

With such background, architectural education in computer technology can only focus on the preparation of students for this interim time in the bureau - they are trained in CAD application and "future" 3D-Animation

For the trainer of computer technology at a faculty for architecture it is only consequent to transform the frustrating experiences from practice to a training program, that focuses on preparing the students for the hard times to stand until finally the programs will really fit to the architect's work.

Subsequently there is a tendency to orientate CAAD-courses towards the urgencies of architectural practice which in turn is only reacting to the moves of computer developers. Students are trained as good CAD-users or, as an advanced version, they learn how to force some 3D-animations from poorly equipped hard- and software. In most cases they are strictly kept in the state of computer users, scarcely able to look behind the "objective limitations" of computer components.

Even though the usage of such a rigid tool as a computer with its software is indeed a good training for students of architecture, it would be more fruitful if they were confronted with programming tasks, as they often convey design- and problem-solving processes in great clarity.

## **A more promising perception of computers as tools**

We think that the architectural community heavily underestimates the influences, that the new (hardware- and software-) tools will have on the architect's work, especially as long as those tools are made by non-architects.

The tools we use to work out a product have always restricted its form and content. This will also be true for computers in architecture.

The programs that we use do support or substitute certain sub-processes of design and thus change the way we engage ourselves in a design task. There is a substantial difference between working out a building project without any effective possibility of cost-control (as it is true for Germany at least up to now), and working it out with a cost-control software in the background, that reliably cross-checks all decisions made. There is a difference between working with or without a climate- simulation program right from the start of design. The results of the design-process are heavily influenced by software tools in both cases.

But as long as architects do not understand the development of their (computer-) tools as a prominent task, they will have to adapt their working process to the possibilities of a given software, developed by non-architects - or to completely renounce the abilities the computer could offer them. In the first case, architects will have to accept a lot of unrequested impacts of the software on their working-process and -outcome, in the second case they will have to leave things undone they might have done with the help of the computer.

Computers are under-determined tools, that can be specified for special purposes. We think that architects should seize the chance to make the computer a tool, that reintroduces the generalist to the planning process.

Since the appearance of empirical science and the subsequent loss of building-constructive certainty the architect lost more and more the ability to oversee and steer the design-process towards total quality of a building. Instead, he redrew to the partial task of surface design and invited other engineers to the design -process. In the meantime it has become impossible for an architect to realize all the dependencies between the different design -disciplines for a building. The task of coordinating the individual efforts of those planning-agents and to ensure the quality of their cooperative work is only superficially done by the architect.

We believe, that one of the great chances of computer tools for architecture is to use it as a coordination tool for the different design-disciplines.

The computer could be the platform and medium that is able to contain and to convey the lots of facts,

dependencies and decisions of a modern building design process. We do not think, that the computer should be specified to be a problem-solver but rather to be a problem-handler: an architectural design process comprises always formalisable knowledge, that can be handled by the computer. but as well unformalisable knowledge, that is necessarily left to the human designer, no matter which discipline we talk about.

We imagine that computer tools can coordinate the design process (and afterwards the operation of a building) by

- allowing all involved planners to build their differing planning worlds in parallel
- assisting them to represent the dependencies between their different planning worlds
- assisting them to represent the important design-steps of their disciplines
- uncovering design- conflicts (inconsistent decisions) to all involved planners
- keeping available typical solutions (algorithmic or heuristic) for problems (inconsistencies).

The human planners will go on using their rational and intuitive capacities for working on the design process represented in the computer. Only if the solution of a specific problem can be formalised, it may be handed to automatic treatment by the computer.

With such programs, the architect would be given a tool that allows him to oversee and steer the building design process again. We state that the task of the generalist to ensure an overall quality (instead of only punctual optimisations) could then probably be fulfilled by the architect again.

To envisage this, architects will have to adopt an aesthetical theory, that does no longer discriminate rational planning compared to intuition.

Rather they have to understand that both human abilities condition each other and are indispensable elements of cultural work.

Under such preconditions it will no longer be possible to construct a contradiction between rational and intuitive work, because the one can not be done without the other. The borderline between them is nothing but the possibility to express and formalize the knowledge used. Such an aesthetical concept will also help to overcome the animosities between so-called -engineers- and "artists", between -theorists- and -practitioners- and other useless discriminations.

## **Consequences for Architectural Research and Education at the University of Karlsruhe**

Research and education in computer technology for architects cannot be delegated to specialized institutes.

This was common ground at the Faculty of Architecture at Karlsruhe right from the introduction of EDP-research and -education in 1978.

That year Fritz Haller took on his professoral chair in order to find out how the computer could help solving

architectural problems. The first courses in "Programming for Architects" were held in parallel for interested highschool teachers and students and soon several other institutes engaged themselves in computer technology for their special interests. Some of the typical design teachers however remained reserved towards the new tool. Today all institutes use computers for their paperwork and all of them have made their start at least into application of computer technology for architects.

We think that the best way to introduce the computer as a tool for architecture is to bring all the disciplines represented at a Faculty to work with the computer, to make their own experiences and developments and to enhance the exchange between them. The institutes may start at different times, but it is important, that a broad front of different approaches to computer technology is formed - which may of course be preceded by some more advanced institutes. If the computer shall become a commonly used tool for architects and if the design of software-tools for coordination of architectural disciplines is accepted as a task, then the whole range of disciplines must take part in this process. If especially the traditional design teachers refuse this possibility, computers will become just another brick in the wall that separates architects from their engineer colleagues.

If the subject is delegated to only one institute, the following problems must be feared:

- students and other teachers might be tied to only one approach to computer technology
- other institutes use the one engaged in computer technology as a pretext for continuing to avoid computers
- a kind of computer priesthood emerges, that avoids competence in computer technology to become wide-spread and socialized
  
- computer tools then again will be something separated from architecture, that will reduce the architect's competence instead of enlarging it.

At Karlsruhe, we offer today a broad range of research and educational activities that is formed out of the experience of multiple institutes. The rest of the paper describes this scene.

## **Research work to be done**

For the development of computer tools that support the cooperation of building disciplines during the design process, at least three major themes can be nominated as research tasks:

- a) development of computer aided design tools, also known as -intelligent CAD systems
- b) formulation and implementation of design knowledge and -methodologies from a multitude of disciplines for use in design tools
- c) formulation of a dynamically growing data-model serving as communication platform between the disciplines
- d) special support of teamwork design processes

Research in this direction at Karlsruhe comprises the following projects:

- Knowledge acquisition and development of a set of rules for systematic planning of technical

in buildings /ARMILLA - Haller, Gauchel, Mathis

- Computer Aided Design Tool for architectural design tasks on the basis of ARMILLA /A4 - Hovestadt, Hertkorn
- A knowledge editor for engineering tasks /Drach
- A software tool for the design of local area data networks /XNET - Raetz, Ayrle
- A software tool for the design of buildings with the USM MINI building block system /MINICAD -Ding, Bach
- A Computer Aided Design Tool for participatory planning processes /ProSAR II - Uhl
- Computer Simulation of dynamical climate processes in buildings /BLAST - Lehmann, Deng
- Computer Aided Urban Structure Analysis /Coenen, Van Gool

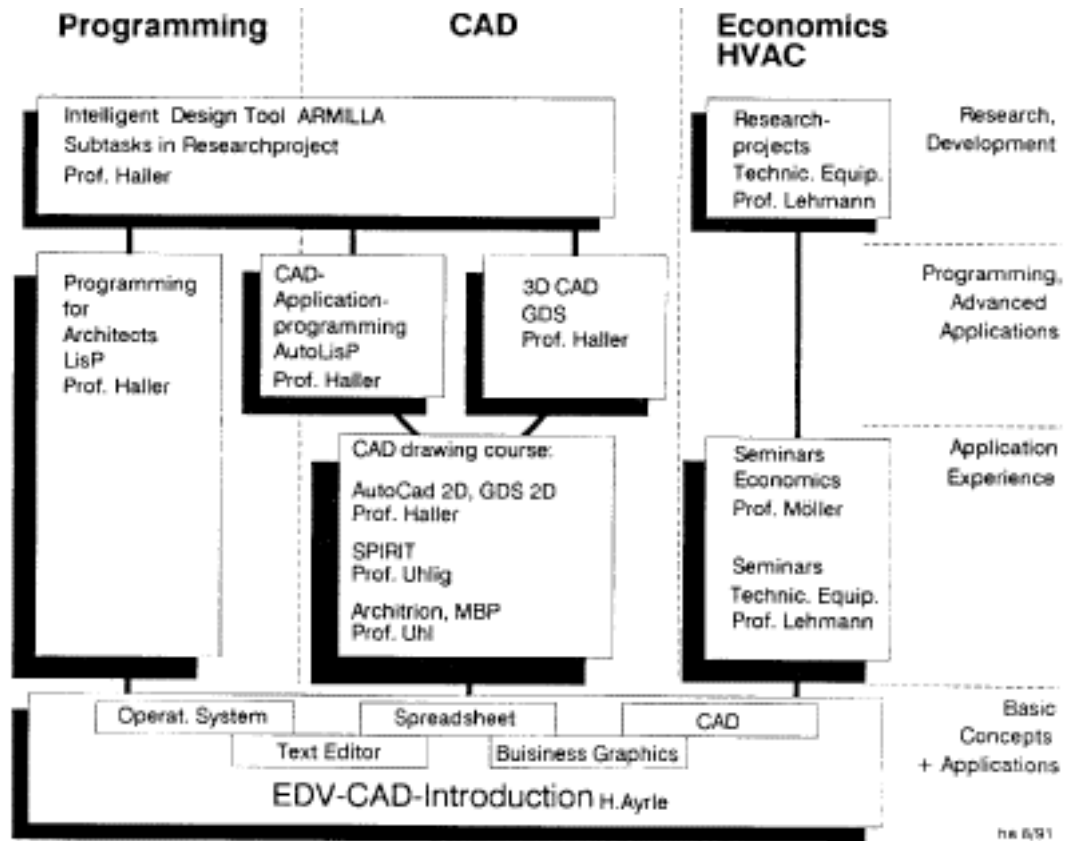
These projects are partially funded by the scarce financial resources of a traditional architectural faculty, partially by industrial partners or state research programmes.

#### Education guidelines

With the proposed vision of computer tools for architects as a background, several claims can be made towards the conception of the educational courses in computer technology:

- a user- and a developer-level can be distinguished,
- for the users, a set of conceptual knowledge and a set of application-skill knowledge can be distinguished;
- to wide-spread computer technology, each student should at least acquire common conceptual knowledge on a theoretical level;
- to prepare students for practice, most of them should acquire some application experience as users of text- and graphical editors
- to further the development of software tools, some students should be given the possibility to step into software development and programming.

At Karlsruhe we offer a range of courses that fulfil these demands (see schema overside):



Structure of EDP/CAD-education at the Fac. Architecture, KA

*Basic skills: Concepts + Application Experience*

- we offer an Introduction to EDP/CAD, that gives an overview and basic concepts of computer technology for architects and takes the students to a level where they can use our pc-pool with its standard business software (operating system, text editors, spreadsheet, presentation graphics, 2D CAD) for their studying needs. Form: lectures and practica
- we offer basic training courses in CAD that concentrate on 2D drawing; each course comprises a regular design task that has to be worked out with the newly acquired tool. Form: 2-weeks crash course, design task

*Deeper skills: Programming +Advanced Applications, Development*

on this basis we offer several courses, that gradually take the students to the level of adapting or developing software for specific tasks:

as users:

- 3D-CAD for presentation needs; Form: 2-weeks crash course, design task
- CAD-application for participatory planning processes; Form: tutorial class
- Using CAD for building project groups; Form: 1 -week crash course, tutorial class



*as developers:*

- Adaptation of spreadsheet-programs to building economics' problems;
- Form: tutorial class<R>
- AutoLisP-Course for development of design-aids for architects; Form: 2-weeks crash-course. programming task
- Programming for Architects /The LisPCourse, as preparation for the ARMILLA project., Form: 2-weeks crash-course
- Specific programming tasks within the ARMILLA research project
- Specific programming tasks within the BLAST research project

These courses up to now are regular voluntary courses offered for senior students. We are just about to incorporate at least computer application (not development) into the junior students' architectural courses. Nevertheless we have already brought forth a group of students, who are now supporting research and educational work in Karlsruhe and elsewhere.

### ***History:***

Our computer courses started in 1979 with Programming for Architects in Fortran on a PDP-11; it was a 2weeks crash course that required no computer experience and took the students to programming of little application programs out of the field of structural calculation. We shifted to Turbo-Pascal on IBM-PCs in the 1980s and produced a nice series of programs for building economics and climate control. By 1989 we shifted to LisP, which had become the primary language of the ARMILLA project.

Around 1985 the first CAD-courses were offered on workstations with CADAM and later CATIA, on PCs with CAD-Pack; three student-tutors developed the courses and held them with great success over 4 years. We keep offering workstation-CAD and PC-CAD in parallel, as these are different qualities up to now, and we offer AutoCAD, Spirit, and Architron on PCs and GDS on workstations today.

The Introduction to EDP/CAD was first offered in 1987 and has since then developed to the best-attended voluntary course at the faculty.

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