# The meaning of CAAD in architectural education
# A brief historical analysis followed by some possible future scenarios

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## Abstract

The influence of CAD – nowadays more correctly stated with CAAD meaning architectural CAD – has been more and more evident in the university level architectural education. The development process of architectural CAD-courses and wider CAD-curriculums could, at least in Scandinavian countries, be described and simplified with a couple of development steps analyzed here, to give the starting point.

And since the process of educational evolution will naturally keep on developing in the future also, some possible future paths concerning both CAD-equipment, CAAD-education and more traditional architectural curriculumns, are described here after the historical analysis.

Following commonly used futures studies methods, my intent is not to predict the future, but to give several probable future choices, of which some might come true, and some might not. Some of the paths are evident, some are ideal and some may cause also negative effects. The future of architectural education and CAAD as part of it will certainly appear somehow, very possibly somewhere in the middle of these presented paths.

The aim of this presentation is to give the architectural education community – the schools and faculty – a wide perspective view to analyze and plan their local course structures also for the future. The future possibilities are presented here, so that the schools can prepare for the forecoming future changes in their workin environment. Finally, the future will appear the way we will create it.

## Short historical evolution of CAAD-education

In the historical analysis I divide CAD's influence to architectural education to two major periods. Naturally all schools don't fit into this simplified schema, and the history is just not so black and white, but the reason to simplify is to describe a clear evolutionary path.

### *I Traditional architectural curriculums – …1950 – 1980…*

Typical professor-driven departments or other divisions in architectural schools have during several decades been giving architectural education, for example in:

- architectural design principles
- constructions and materials
- public buildings
- housing
- architectural history
- urban planning
- plus additional support courses in arts, languages, mathematics & physics, CAD

CAD-education – whether it has yet been established at all – has been in the format of small support CAD-courses, or it has been embedded in other design oriented courses. The influence of CAD-education has been very dependent of the teachers' personalities. Pioneering teachers have typically worked as individuals, sometimes regarded as odd computer nerds.

I would like to call this period the era of CAD-tools, since the computing technology and ”keyboard tricks” seemed often characterize the first years in teaching computing. Learning programming languages seems also to be a good identifier of the era. The concentrating on computing tools' technical details or programming derives often the architectural schools' status

and profile. To be a part in a technical university naturally tends to emphasize more technical features in teaching, whereas an art school naturally concentrates more on creative art, painting, traditional plastic modelling and graphics.

*II Additional CAD-courses to traditional curriculums – …1985 – 1995…*

When the appearance of computers in the architectural practise was recognized to be somewhat remarkable factor in the mid 1980's, the evolution of CAD-education proceeded so, that some architectural schools established specialized CAD-curriculums – divisions of departments, which gave CAD-specialized courses. This has happened around 1990.

Naturally some pioneering schools, such as the MIT in Boston for instance, have recognized the importance of architectural computing a lot, even decades earlier, but generally speaking the computers became common in the end of 1980's and in the beginning 1990's.

A typical CAD-curriculum in a typical architectural department could consist of computing oriented courses such as:

- The basics of architectral computing
- Drawing with CAD
- Modelling with CAD
- CAD-based design projects

Characteristic to this era, and a factor that differs a school from a 1.st phase schools, is the concentration into CAD as an architectural media (CAAD). Rather than just a general computing machine, CAD is regarded an architectural tool. The big difference between CAD and CAAD empasizes architect's professional needs in architectural design, not just computing or computer engineering.

The personell of this evolution stage schools has typically grown to a CAAD-team, a group of CAAD-teachers and professionals.

CAD-oriented research and development activities have also played an important role in several architectural CAAD-departments. R&D has been helpful to CAAD-education, as a working connection to commercial business-life (consultancy), providing solid financial basis and also allowing high-end knowhow and sometimes "high-tech status" to more traditional education.

The so-called "high-tech character" which is often connected to computing technology and CAD, is often used by people who really don't know what high-tech is. One Finnish forest industry supervisor sees high-tech equivalent to good table manners – it is just natural to use the best modern equipment whatever you do, if you are intended to do your job seriously.

*Current situation*

Let's end the historical analysis with some conclusions from our present state:

- New digital tools such as CAD, are here to stay. The critcal mass of architectural CAD-users is already large enough in most developed countries (≈ 40–70 % of users, ≈ 20–50 % of work done). We have passed the point of no return.
- CAD has been mainly a technical concept for some decades, but it has finally been understood to be also a useful professional tool (CAAD) – by some scenarios even the major future tool.
- The recent technical changes emphasize that we shouldn't just see CAD, but wider architectural information technology (IT) and the whole new media concept, when developing the modern architectural education.

## Future scenarios for CAAD-education

The following futurologial game is based on a few simple ideas. First, the development in digital technology, CAD and CAAD seems to happen as an evolution kind of causal process, where

changes motivate other changes. These changes are used here as hypotheses. Consequently, the changes end up causing recognized effects – either good of bad.

I generally try to create three possible future paths for these evident changes :

**neutral** a possible and normal evolution path with very probable changes, this happens when and if things are just ”taken as granted” – a laissez-faire -path

**positive +** an ideal evolution path, when changes in the future are the most desired ones

**negative –** threats or dangers in evolution, when consequences for changes may cause negative or non-wanted effects in the future

And finally, all these possibilities and scenarios are presented here for us to prepare for all of those possible changes. The way we will face the future, has probably some of these presented features, but it will quite certainly also have something surprising, some features or changes that nobody can foretell – this is why futures researchers don't predict, but just present possibilities.

The following scenarios are presented for different kind readers :

- for **a single architect,** who wants to widen his single-CAD-tool perspective
- for **CAAD-teachers** as an educational group to plan their future education
- for **architectural teachers** generally to maintain their education modern enough
- for **architectural schools** to create a better combination with so-called traditional architectural education and the new design tools

## The dilemma between architectural education and CAD

As the first hypothesis, the differences between so called traditional architectural education and the new CAD-based education is evaluated, because it often seems to be one problematic area within traditional schools – at least from the CAD point of view.

*Neutral development path*

Without any changes in our surrounding society we would be teaching architecture with traditional aspects still for decades, the way we have been doing it during this century. Materials, structures, history etc. are the cornerstones forming the ”everlasting architectural principles”, for instance venustas, firmitas and utilitas, such as Vitruvius formulated it. New architects learn our old profession slowly in design studios, lectures and above all, by doing it themselves. The good old master and novice -method is still efficient in delivering experience-based information. In fact, traditional architectural education has not changed very much during several decades before CAD.

Compared with the long history of the profession, just for a short time so far, a few additional computing courses have been educating students how to use a drastically new working tool – the computer. Understandably, it may seem even ridiculous how enthusiastic some teachers can be about a new pencil, if one evaluates it along the history. Still, it may seem even more confusing, when the architects have finally started to recognise how vast role these CAD-tools in fact have gained during the last 10 years.

And the confusion continues. Architecture hasn't hardly ever been a subject for rapid changes.

*Positive aspects*

As typically human, part of the confusion is ignorance. It is easy to pass the things that are new or unknown, one can even neglet them totally. New computer-based tools and methods are not familiar to our traditional teachers, and so they simply can't cope with them.

Co-operation with the ”older generation” is simply one important keyword. First, make a short introduction to the new tool. Second, show some simple and valuable tools that give advantage for the newcomer. And finally, you have probably made him understand what the CAD-teaching is all about.

Teaching CAD without an architectural value is useless. And the value has to be found in traditional architectural context – definately not from CAD itself, nor from efficiency or rationality. These are good features of a practical tool in the work, but not so good in education phase, when a student should first learn the architectural essence of things.

The phase we have found computer-based approach most fruitful in Tampere department, is the last studying years. Writing, calculating and simple drawing should naturally be available already for younger students, but more powerful CAD-use seems to come later, not before a student has spent some years with the architectural principles – computer is a suitable ”production phase tool”.

In developing the educationally wide and sensible use of a computing within architectural discipline, one good approach has been via the use of simple low-cost tools – compared with heavy CAD use. With low-cost I mean delivering several kinds of ”semifinished products” to our traditional colleagues:

- writing templates (idiot simple, maybe yes, but powerfull also)
- calculating templates (for students' credit points, for simple wooden beam tension, for architectural design cost evaluation etc.)
- drawing templates (including just drawing frames and logos etc.)
- narrow field computing-assistants (for evaluating site area, floor area and site efficiency in urban planning, for evaluating building costs, for evaluating energy consumption, etc.)

In Tampere approach, the use of CAD in design courses comes after a student has learned the essential facts about design itself, and after he has learned how to technically manage a CAD-system – which in fact should be regarded as a heavy architectural tool in complex design context. CAD is a tool for a professional.

*Negative aspects*

The way some ”computing scientists” still introduce their digital world to ”normal people” is sometimes frightening: they often start with history of programming and continue with theory of bits and bytes – a method from the 1960's. This will quite certainly make an architect turn his back to the machine. Architects are pragmatic and sometimes even fanatic in trying to see everything through ”architecturally pink” eyeglasses.

Old fashioned architect teachers claim often that CAD requires too much resources – resources which do not profit architectural education. Honestly, following the rapid digital development requires constantly new resources, which in turn has not been very common within the architectural education – paper and pencils have never been significant investmets.

If the digital technology becomes too dominant in architectural education, the time devoted to architectural design skills and understanding of construction process naturally decreases. The so-called good architectural tradition and good design skills versus modern CAD-skills don't always meet, since ”old experience” and ”new technological talent” are often features of different personalities. If not observed, this gap can become even a major dilemma in the near future. It is a real challenge to teach an architecturally skillfull CAD-specialist – both features provide natural talent and also some 5–10 years of practise.

## The character of architects' tools changes

The character of the architectural profession has met vast changes during the micro-computer revolution. Suddenly everything should be created and managed with some kind of immaterial bits and bytes. Architects are said to ”think on the table with paper and a pencil”. How do we do thinking ”inside the computer” then?

*A neutral path*

One of the biggest material changes we have met recently, has probably been the quick revolution of digital technology and all new tools which came with it. Computers are here to stay, they are not the other choice anymore, but digital world is a self-evident truth.

Most of the architects' general tools – new CAD-pencils, linears, calculators and cardboard models in 3D – will quite soon be driven by the all-unifying digital media. Not only architects' traditional drawing tools, but also the Internet-based digital communication ”multi-media-big-bang” followed by digital video and TV will in the near future be written with bits also. By the way, 70% of a local telephone company's income come from digital data transfer already some years ago – and telephones are supposed to be for talking.

Even though the software-based tools may change drastically within some months, and the working methods change slightly in each software version, the essential contents of the architectural design work doesn't change that dramatically. This should emphasize the importance of solid architectural basis in architectural education.

*Positive aspects*

First of all, the technical properties of architectural tools nor minor details in CAD-systems should not be the essential thing in education, but the way an architect uses and manages his tools in his design work.

Some new e-mail and netwok-based tools in communication are even newer than CAD, the professional main tool. Digital networks have capabilities and chances that haven't even been created yet. When the net-evolution continues, the architecturally most valuable and useful new tools will appear somewhere in the net – hopefully someone will recognize them in the overwhelming flood of entertainment and useless rubbish.

Despite the network structure or new tools, architectural departments should also concentrate in teaching more modern communication skills and traditional architectural team-work these days. Even now the network offers possibilities for distant work or team-work in some kinds of projects and, for instance in the form of simple data transfer.

Some promising signs about new simple-enough team-work tools could be seen in Internet's IRC, ”the multi-user simultaneous word-based discussion forum” – from architectural point of view it could though be more graphic. Another example or future chances may be the multi-user virtual surroundings (VRML) and games based on it. When the games surroundings start resembling architecturally interesting milieus and functionality of the built environment, these could be useful in several kinds of simulation tasks, for instance.

*Negative aspects*

Architects' digital tools develop rapidly and it requires constant re-evaluation of the technical evolution, it is also tedious to follow the trends in CAD and computing development. A dilemma in high-end CAD-work is the constantly accelerating pace of evolution. Too often a CAD-architect finds out that 80% of his time is devoted to solving technical problems or changing the systems' settings – it means 80% less time to architectural proflems and 80% less time to teaching.

The dilemma of constantly growing computing problems may become even worse in the future, when most of our new tools will be digital by their nature.

Another possible threat in working with software tools concerns maintenance. CAD-education should not be too strongly based on certain single software platforms. Important though, schools should have some continuity in maintaining their software platforms, which in turn should not be too narrow – this may sound inconsistent, and it is so.

Especially CAD is regarded to be resource-intensive since CAD-equipment has also to be maintained constantly. Without resources you will fall off the pace within just some years (minimum maintenance cycle for software is practically 1–2 years, for hardware 3–5 years). When the architectural education resources are cut, CAD-resources are quite often the first to be cut, since it is easier to cut from the machines than human resources.

An evident net-threat is the growing commercial character in about everything. If the multinational entertainmet corporations will grab the Internet, it can be even harder to find something useful – and cheap – from the net in the future. Finding something essential can be hard enough even in the current situation. Another drawback in the free public network is the increasing

amount of ”untalented nonesense” or even digital kind terror. Hope that the netikett of active users will decrease the irrelevant net-use if it develops too inappropriate.

## Architectural practise is also business

A normal and typical architectural practise in Finland has been a rather small studio-kind of office with a few workers – an average is these days 4–6 persons. Commercial thinking and financial understanding about business basics hasn't been architectural virtues, even though money has been a basis for also our activities. Business principles have never been taught in our national architect schools, the skills have been learned in practise, often via the hard way.

*Positive aspects*

In teaching the students a necessary architectural ”business survival package” we in Tampere have tried to lower the gap between studying and working. It has been even more important in a current situation of high unemployment (among architects ≈30–40% in the early 1990's).

When advertising architectural services students learn how to manage in competition about jobs and money. The commercial courses should be aimed especially for recently graduated architects and small offices, since small jobs will most often be the first ones.

In simulating the real life, we have been utilising project management software plus simple pre-defined calculation templates. The aim in simulating design in practise is to teach ”architects information management” where outlining and calculation tools help in organizing the architectural information in data format. The information consists of numerous fragments of text, agreements, facts, phone calls, faxes, etc. The tools help in managing this heterogenious flood of information.

It is also important to widen a common understanding of architectural services, which could cover much more than just plain ”architectural design”. An architect should also pack his services to understandable and down-to-earth products. It is much easier to buy a can of milk than buy architectural consultancy – though, why should it be so difficult? Some new fields that architects could try to conquer, are for instance:

- visualization and presentation services (with CAD and good lay-out skills)
- construction project management services
- quantity surveying – an architect can his own quantities (often a CAD-system's by-product)
- building use and maintenance services (facilities management)

*Negative aspects*

Teaching commercial business facts in an architectural school should not become the main factor, but it could best be done in small supporting courses and with elderly students, who already have the motivation towards work. Here we may face the same problem than with CAD – don't spend all your architectural energy into secondary support courses, or money or technology. Architects should teach each others architecture.

## The amount of architectural work decreases

As the last hypothesis a few words about unemployment. A global economical depression in several European countries has caused wide construction field unemployment during the late 1980's and 1990's. Within the architectural community also architectural education has faced the local economical changes.

*A neutral path*

The architects' high unemployment seems to lead towards tight architectural competition about design prices, but also about architectural design quality and services provided. The specalization and fragmentation of the architectural field seems also to be one of the causal effects of unemployment – you have better chances to work more efficiently in certain narrow fields, such as just housing or just renovation or just CAD.

Some unemployed architects will naturally change their profession totally. Some loosely CAD-related fields such as graphic design, computing consultancy, and even programming seem to give rather good chances to maintain the employment.

*Positive aspects*

As one reaction to the lack of work, architectural CAD-skills seem to give possibilities to offer customers better service. CAD-skills seem also to be an advantage in getting a job. This has been one driving force and mental resource in developing CAAD-eduction in Tampere architectural department during the last few years – despite our zero-budget for CAD-equipment, we have maintained our educational staff.

Another educational reaction to the severe unemployment, is to strengthen architects' capabilities in understanding the design and construction process, and act in it as a main designer. Practical courses to maintain architects' traditional leading role in a design process have been given in Tampere by ass. prof. Matti Seppänen (Architect as a main designer) and by myself (Architects' information management). The courses have been rather succesfull both to older architectural students and also to graduated architects' re-education.

If the employment scenario changes any better, the need of new designers equipped with CAD-skills and modern understanding of current communication seem to grow rather rapidly. The schools should naturally react to this already during the depression.

*Negative aspects*

If architectural education managers don't react to the evolution of architectural profession and new media, and don't add more architectural information technology and CAAD-courses to the curriculumns, someone else will finally take advantage of this field. The first pioneering architectural CAD-systems in Finland, for instance, had some drawbacks in the beginning in the mid 1980's, and the drawbacks caused a 5 year prejudice against CAD among the majority of Finnish architects. All CAD-development was done by civil engineers in Finland during the delay in architectural computing.

If architects' unemployment figures grow even worse in the near future, the more one should concentrate in developing CAAD-education, since CAD gives efficiency an rationality in the severe competition. Though, it should be kept in mind that too rational and too efficient ”heavy CAD use” has also negative impacts – less design time means evidently less design quality. Too narrow-minded concentration on just project time or money or technology only, seems often to make a person blind to architect's traditional morale and virtue: to be neutral and equal to everyone and everything.

## Some facts about Finnish architectural-CAD

Currently some ≈50-70% of all the architectural practising offices are using architectural-CAD, the actual volume of CAD-produced documents is ≈30-50%. Of all the users, some 60-80% are PC/AutoCAD-based systems (3 separate architectural applications) and ≈15-20% are Mac/ArchiCAD-based systems.

Tampere school of architecture (≈30 new students/year), is the only school of the three Finnish architectural schools, which has maintained and increased the CAAD-education resources during the 1990's, despite a severe financial construction field depression. The other two schools, Helsinki (≈50 new students/year) and Oulu (≈30 new students/year), have both decreased their CAD-resources, either due to financial or strategic decisions.

## Facts about the writer

Hannu Penttilä is a Finnish architect, who started his CAAD-career in the University of Technology (TKK), department of architecture, Helsinki in 1982, teaching the basics of CAAD for architects for several years. Late 1980's he graduated and joined the research team of object-oriented building product data models at the Technical Research Center of Finland (VTT). Early 1990's he started to teach CAAD in Tampere University of Technology (TTKK), department of architecture at the same time with his own architectural practise. Penttilä has been developing CAAD-education in Tampere within the team of Arto Kiviniemi, Petri Siitonen, Ilkka Alavalkama and Mikko Kuutti.