CAAD in the Future Perfect
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The history of CAAD research is largely one of generic computing techniques grafted on to existing design practices. The motivation behind such research, on different occasions, has been to automate some or all of the design process, to provide design assistance, to check designs for compliance against some predefined criteria, or more recently to enable people to experience designs as realistically as possible before they are built. But these goals remain unexamined, and their fulfilment is assumed to be a self-evident benefit. In the worst cases, they are examples of barely concealed technology-push. Few researchers have stated in detail what they want computers to do for architectural design, most choosing instead to focus on what computers can do, rather than what is needed.

This paper considers what we want CAAD systems to do for us. However, this will be a modest effort, a beginning, a mere sketch of possible directions for CAAD. But it should open channels for criticism and serious debate about the role of CAAD in the changing professional, social and cultural contexts of its eventual use in education and practice. The paper, therefore, is not so concerned to arrive at a single ‘right’ vision for future CAAD systems as concerned by the lack of any cogent vision for CAAD.

**Keywords:** History, CAAD research, Future trends

The vision thing

CAAD opens with Negroponte’s bold vision of intelligent design machines which will generate designs with minimal human intervention, interpret sketches and diagrams and, eventually, modify occupied environments (Negroponte, 1975). It closes the millennium, after nearly thirty years of research and development, with AutoCAD as the most widely used ‘design’ software in architectural practice. In between, CAAD researchers have investigated a wide range of design tools. The emphasis, however, has remained firmly on how techniques from computer science and artificial intelligence can be applied to design rather than on what designers seek from computers. Detailed statements about the motivation behind CAAD research (beyond a banal desire to help architects design in less time, with less effort, or with fewer mistakes), and its ramifications for the profession, are rare. In the worst cases, CAAD research is blatant technology push—we’ve got a bunch of techniques and we’re gonna use them, somehow—with no sustained critique of how it will benefit architecture. We may argue about how CAAD can aid design, but we all agree that it can. As architects, we need to ask, what do we want computers to do for us?

The purpose of this short paper, therefore, is to consider what we want computers to do for architecture, to begin to develop a view of what a
‘perfect’ CAAD system might look like to different people, and to reflect on some of the goals that have been and still are being addressed in CAAD research.

**Integrated CAAD systems**

The integrated CAAD systems, developed around the same time as Negroponte was publishing his work, provide the best examples of ambitious systems that found actual use in real organisations on a daily basis. In the 1970s, purpose-built integrated CAAD systems were developed for the Oxford Regional Health Authority—the OXSYS system (Hoskins, 1977)—and the Scottish Special Housing Association (SSHA). Bijl (1989) provides one of the best accounts of what happens when academic researchers meet the so-called real world. The SSHA had its own property development, professional services, management and maintenance departments and employed architects, quantity surveyors and engineers. It already had very effective formal procedures in place for managing its library of dwelling designs and construction details. It sought to improve the management of these through the use of a CAAD system. Inevitably, once a specification had been agreed for the system, new features were requested as its potential became clearer. It was not, therefore, a matter of trying to specify in advance every last detail of the final CAAD system. The fact that the system was a research project allowed greater flexibility. But the system was abandoned after about ten years because it could not adjust to evolving working practices in the SSHA, a problem that was exacerbated by the tight fit the researchers had achieved between systems and users.

Development of these integrated systems was made possible by a unique set of circumstances. As Richens (1992) notes:

- these bodies designed buildings for their own occupation and use and so they were prepared (at least in principle) to spend more on design and construction in order to reduce cost in use;
- they were interested in using computers as part of a much broader programme aimed at improving the efficiency of building design, construction and use
- prefabrication, system building, dimensional co-ordination and serial tendering were all part of the programme, and considerably affected the kind of software that was written.

**The retreat to description**

The difficulties of maintaining software to meet the escalating expectations of end-user organisations brought an end to university-based large-scale CAAD development. Commercial software developers concentrated their efforts on systems that were significantly less ambitious and more generic, to attract a wider audience than architects, as a way of spreading development and upgrade costs. AutoCAD is a prime example.

Today, goals for CAAD are often absorbed within a broader agenda for the construction industry as a whole. A recent survey of UK academics’ views of the challenges facing the construction industry identifies two main priorities for research in construction IT: closer integration in design and construction through better management of design information; and better tools for visualisation (Luck et al, 1997). Similar visions of progress are expounded in the recently published Construction Industry Board (CIB) report *Construction—a 2020 Vision.* (Anon, 1999, 87). The key difference, however, between these and the earlier visions for the technology is that now they are usually proposed by bodies representing the end-users rather than the software developers of researchers.

**Technology pull**

The flip side of technology-push is technology pull, which rather crudely identifies the other side of the asymmetrical relationship between CAAD technology and its users. Though we have concentrated on architectural practice as the primary domain, there
are many spheres of interest surrounding the development and deployment of CAAD systems. Education is probably the most significant application domain after practice. The vast majority of academic CAAD research has been directed towards applications which are expected to operate in one or both of these domains. If we accept that CAAD has an impact on architecture, then we must also consider the needs of any group which has an interest in architecture, so embracing non-architectural members of the design team, clients and developers, builders, building users, the general public, government and, in a peculiarly recursive move, CAAD researchers and developers as well. All of these could have an interest in the capabilities of future systems, and few are likely to coincide. Putting aside technological possibilities and the goals of past and present systems, we can consider a few of these groups.

**Architectural students**

Architectural education is about learning to see in a particular way, brought about through a slow and often painful appropriation of a tradition complete with its own language, practices and values (Tweed, 1999). The heterogeneity of the architectural community ensures that healthy debate continues. The tensions this creates are most keenly felt between education and practice, in which CAAD is often a highly contentious issue.

The needs of education and practice are different, a point underlined by Hanna et al:

“The way in which the computer helped students translate their design concepts from 2D to 3D was quicker and easier than conventional media. The notion of shifting to and working in 3D proved very useful as students were able to investigate and explore the relationship between form and space and understand their spatial implications” (Hanna et al, 1997).

CAAD in education can help the fledgling architect appreciate the spatial qualities of the plans they produce. Students have to learn what conventional orthographic projections ‘mean’ in terms of three-dimensional space. New technologies question the authority of the plan such that we begin to wonder why it is necessary to continue to design in this way.

The perfect CAAD system for education would facilitate the leap of understanding students must make if they are to relate their imaginings to the physical realisation of a building. Such a system would need to be capable of demonstrating the full breadth of experience a design proposal might yield, not just its visual appearance.

**Practitioners**

Architecture is a broad church, which makes it difficult to talk about any sector without reverting to crude stereotypes. However, all privately run architectural practices, regardless of their architectural ideals, must succeed as businesses in which design, though a major part, is not the only ingredient. As Pringle points out:

“Analysis of how architects actually spend their time in the process of running a building contract has produced the sobering statistic that only about 30% is spent on the prime activity of drawing.” (Pringle, 1992, 78)

Within commercial constraints, each practice needs to resolve competing aspirations for each and every project. Some will jettison high-minded goals of producing architecture with a capital ‘A’ (as some of our colleagues refer to it) to maximise profits, while others will resign themselves to near penury to suffer for their art. And there are infinite gradations between. The result is that different practices have different expectations of CAAD. Some will justify the lack of 3d modelling on the basis that that clients will not pay for it; others will routinely produce 3d models as part of the design process, because they believe it improves the quality of the design as well as their
efficiency. An attitude to CAAD is coterminous with an attitude to architecture.

**Clients**

“Give the client what he wants: better products, for free.” (email signature line)

Clients present an even greater range of dispositions, values and attitudes than the community of architects. There is no ‘community’ of clients with a ground of shared values. Little can be said about clients’ needs beyond the crass observation that most want value for money. As CAAD researchers we need to be sensitive to the needs of different types of client, from developers through to the individual wishing to extend his or her home. Do these clients have the same needs? Does the same CAAD system satisfy both?

**CAAD researchers and developers**

We would be remiss in the extreme if we were to skate over the thorniest issue in developing systems—the needs of CAAD researchers and developers. In truth, it warrants lengthy separate treatment to do it justice. Suffice to say that CAAD researchers and developers have a vested interest in the continuing application of ever more advanced systems. However, there are signs that the architectural profession is already approaching saturation point even at the relatively modest levels of investment today. In 1992 the problem facing the CAAD industry was

“...one of trying to find ways of meeting the aspirations of users who, having already derived benefit from certain aspects of computing, are keen to see both the systems they use and their own knowledge develop at a steady pace.” (Hare, 1992, 68).

Today, it is to convince end-users (and research sponsors) that CAAD can continue to develop those benefits.

**Key CAAD goals**

The needs of interested parties alone will not decide the future of CAAD; they merely suggest possible directions for future research. It is the interaction between these needs and emerging technologies which will determine the directions CAAD research and development will take. This section examines some of the applications for CAAD which have been, and are, suggested by researchers and try to measure these against the outline of interests presented above.

**Automated design generation**

Why would architects want computers to take over the most pleasurable part of practising architecture? More pertinently, with the profession fighting a rearguard action against incursions by other construction professionals, design has become the main weapon in the architect’s armoury. Although design is only part of what architects do, it is the profession’s distinguishing feature. Other professionals could quite easily do the non-design tasks. From their perspective, therefore, machine-based design generators under their control would seem attractive.

It needs to be emphasised that we have deliberately held in abeyance questions about whether automated design generation is possible now or ever. But it is worth noting that the goalposts are shifting rapidly. As the class of objects we refer to as architecture begins to include buildings in which much of the design activity seems to consist in arranging manufactured components to form a pleasing whole, it is conceivable that some day a computer program might be written to produce feasible configurations with minimal human guidance.

**Design Assistance**

If total automation of design seems unpalatable and too difficult to achieve, what about automating part of the design process? Which parts would we automate? Elevational design? Structural design? Stair layouts? Machine-based design assistance could reverse the
fortunes of the architectural profession since it could eliminate the need for structural, mechanical & electrical engineers and cost consultants, providing all the assistance/expertise to allow the architect total control of the design process. In this scenario architects would regain their status as being in charge of the overall project with other members of the design team relegated to minor roles, as politically distasteful as this would be.

The reverse position would also hold, in which non-architects could be equipped with powerful tools for putting together building designs. Something along these lines took place in desktop publishing in the mid-eighties, which placed powerful design tools in the hands of those without design education. The results were not pretty.

**Virtual design studios**

In recent years, CAAD researchers have discovered the Internet, which rather strangely has exposed the myth within the CAAD community that buildings are the product of a single individual's efforts. The shift from the heroic conception of the architect, grappling with the complexities of design and armed with the most inadequate design tools, to the harmonious workings of the multi-disciplinary design team has been so swift that one wonders how design was possible before the Internet became widely accessible. Of course, once you can communicate information so rapidly across the globe, you must. Hence, virtual design studios.

Virtual design studios take two main forms. Either they are intended to facilitate communications between different members of a design team, providing a central repository of project information which is always up to date, or they offer support to design teams that are geographically remote from the site they are designing for. The former seems like a sensible use of the technology, though there are signs that it is trying to do too much by restricting the content of design descriptions to a standardised framework, for example, in the WISPER project. To use virtual design studios as a way of designing for remote sites flies in the face of most architectural wisdom—the importance of understanding cultural as well as physical context—and in extreme cases leads to a kind of wired neo-colonialism.

**Drawing**

This is where most architectural practices are now. It is also where many wish to stay. CAAD researchers, however, have not finished with drawings yet. In recent years the focus has once again swung round to the early design stages and, in particular, computer-aided support for sketching (Gross, 1996; Do, 1997; Macfadzean, 1999). As with all of the research topics discussed in this paper, computer-based sketching may well be a useful goal—intellectually, it offers great challenges—but again we must ask why it is needed.

There are credible reasons for wanting to contain the entire design process in a machine environment. If everything is machine-resident it is much easier to move between different stages of a project and to ensure some degree of consistency between all of the information relevant to a project. But from a human perspective it is difficult to see on this occasion what is gained by replacing the traditional with new media. Putting aside the technical possibilities of using computers to sketch, the act of sketching must be one of the most enjoyable aspects of designing.

**No computers**

For the sake of completeness, we should also consider the scenario in which the perfect CAAD system is no system. The complete absence of computers in the design process is ironically the most difficult scenario of all to imagine. Granted, there are still many practices who have yet to embrace the technology and admit it to the precious business of designing, but their number is diminishing. What makes this a realistic option is that the general public frequently cite “computers” as a source of problems which happen to them. It is not beyond the bounds of possibility that in a few years some practices might make a virtue out of their ‘backwardness’: “We don’t use computers—because we care.” This seemingly
flippant point highlights a crucial issue which should concern us: computers never care about what they are doing. Humans often may not care either, but at least they have the capacity to do so even if they chose not to exercise it.

**Where the future comes from**

It would be naïve to assume that all that needs to be done is to determine end-users’ real needs and then go about satisfying them through the design of systems. It is not that simple. People ‘discover’ needs when innovations are presented to them, which reinforces the need for continued technologically driven research. Our aim in highlighting the lack of thought given to the impact of CAAD systems on architecture is simply to flag this as a concern. Technological changes are creating new priorities for the construction industry that seem determined to make it converge with manufacturing industries. Buildings are increasingly conceived not as unique events marking the once-in-a-lifetime coalescence of site, prevailing culture and design team, but as collections of mass-produced components assembled by firms with specialised techniques that may be located far from the geographical locations they are designing for.

We have hinted at an ethical dimension to CAAD research. As CAAD developers, educators and users we have to ask ourselves: what role has CAD played in this transformation? Does the emphasis on modular construction necessarily follow from system building software which makes it relatively easy to design objects in terms of modular parts, which in turn have been designed using state-of-the-art CAD/CAM systems? Perhaps to suggest that some of the things we value in architecture may be compromised by an unquestioning pursuit of technological progress, and to hint that CAAD may be partly responsible, is to stretch the point too far. But as long as we subscribe to the unexamined goal of increasing efficiency in design and construction we run precisely that risk.

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