Learning from the (in)visible city

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Abstract:
This paper focuses on results and findings of an educational project, in which the participating students had to develop a design strategy for an urban plan by using and combining endoscopic and computational design visualisation techniques.
This educational experiment attempted to create a link between the Media research programme titled 'Dynamic Perspective' and an educational exercise in design composition.
It was conceived as a pilot study, aimed at the investigation of emerging applications and possible combinations of different imaging techniques which might be of benefit in architectural and urban design education and potentially for the (future) design practice. The aim of this study was also to explore the relationship between spatial perception and design simulation.
The point of departure for the student exercise was an urban masterplan which the Dynamic Perspective research team prepared for the workshop 'the (in)visible city' as part of the 1995 European Architectural Endoscopy Association Conference in Vienna, Austria.
The students taking part in the exercise were asked to develop, discuss and evaluate proposals for a given part of this masterplan by creating images through different model configurations using optical and computer aided visualisation techniques besides more traditional design media .
The results of this project indicate that an active and combined use of visualisation media at a design level, may facilitate communication and lead to a greater understanding of design choices, thus creating insights and contributing to design decision-making both for the designers and for the other participants in the design process.

Concerning Design

The activity of architectural design is aimed at creating a *synthesis* of material and space.
Different aspects need to be taken into consideration when creating an architectural composition. These may be functional, structural, technical or financial in nature, but also *aesthetic*.
A range of possibilities, wishes, demands and limitations define the departing point for the design process. A determining factor may be the ‘setting’ for the design: the shape and size, qualities and restrictions of the *site.*

The end result should be more than a sum of sub-solutions for the specific problems which together define the overall task for the design. The designer strives towards a product which is economical, sound *and* elegant and is preferably not seen as being standardised and predictable, but which in its own way formulates an original, yet fitting solution.
As such designing is not a 'scientific' process, in the sense that in design there can be no question of a single 'correct' outcome (although designs generally incorporate a number of technological and material solutions which through experience or scientific testing have been proven to be reliable).
Designers as well as their clients tend to have specific ambitions concerning a design in progress, which will often lead to novel, unexpected solutions.

The ways in which formal aspects such as size, proportion and rhythm are treated plus the way in which different colours, materials and details are integrated within the overall concept will determine the perception of the end result and may lead to an experience of appreciation or even of beauty...
Architectural expression is a question both of recurring formal themes which can be related to design *precedents* and of the evolvement of *new* forms.
The late twentieth century architectural 'landscape' offers both the familiar and the innovative - often in combination. There appears to be a range of constantly shifting, underlying architectural themes, but at the same time there is no generally accepted architectural style, no standard set of *rules*.
Unlike in Renaissance architecture, which was characterised by variations within a clearly defined grammatical framework and a strict set of rules, or the Eclectic architecture of the eighteenth century in which architects might choose the appropriate stylistic constraints for a specific commission, in Contemporary architecture there is a tendency not to adhere to any predetermined, binding theme, but rather to make choices within a design *Concept* (amounting to a framework of plan-specific design rules) developed *per project*.

Choice is an important aspect in all forms of composition (Breen, 1994).[1] The process of development and decision-making in architectural design is generally not a simple linear route, but more often a painstaking process in which choices might be made rationally, but can also be the result of more unpredictable inspirations. The progress is often marked by intermediate deadlines, which form moments for presentation, communication, reflection and evaluation and milestones for decision making. Such an *iterative* process can theoretically be viewed as a series of design 'loops' in which a step forward is taken by evaluating the state of the design in relation to the comparable point of choice on the previous loop and determining the course of action to be taken towards the next (Zeisel, 1984).[2]
An important step in such a model is the 'decision to build', at which point certain design decisions become *irreversible*.

The Design of Urban Ensembles

The shaping of urban cityscapes for the future poses a major design challenge.
Projects may concern the development and realisation of completely new urban concepts, but often will be involved with reshaping the existing urban fabric. The changes taking place in the industrial and urban landscapes of the twentieth century fin de siècle, lead to increasingly

complex sites and programmes. At the same time more and more people with different backgrounds are involved in the design process and in decision-making.

One of the problematic aspects of urban design is that such plans are notoriously difficult to 'read' and communicate. This is the case especially for non-professional participants, but is also often a problem for different professional 'actors' involved in the design process.
Certain information, such as the impression of the actual buildings that will eventually make up the plan is not yet known. At the same time relatively abstract drawings and models composed of unarticulated volumes, create insufficient images for proper understanding and communication concerning a plan in development. In the past this has often lead to disappointed reactions by those involved, once the plans had actually been realised.

Because of the scope and complexity of urban planning, it is customary that plans are worked out in teams in order to integrate different disciplines and responsibilities.
Such a process is generally both complex and iterative. The creative group process relies to a large extent on *visual* information as a medium of notation and communication. Design options need to be visualised so their merits can be evaluated (a process which Zeisel has dubbed *Imaging*).

In recent years there has been a renewed interest in the design for the public realm. Inspired by regional developments, notably in Barcelona, many European cities have recently been paying considerably more attention to spatial quality and furnishing of urban spaces, both in existing neighbourhoods and in newly developing (sub)urban areas. Compared to the large scale town planning of previous decennia, the perspective of planners and decision-makers has gradually but steadily shifted from taking a birds-eye view of the *overall plan* towards an appreciation of 'the architecture of the city' on a pedestrian level, in the form of *urban ensembles*. In the Netherlands, design and planning of such ensembles is increasingly in the hands of multi-disciplinary teams including artists and architects (often in the role of Supervisor). One of the reasons for the growing role of architects may lie in their ability to translate ideas into visual information that is indicative of the kind of experience one might be able to expect. Active utilisation of imaging techniques within such heterogeneous teams is of importance as this might be expected to lead to a greater understanding by the different participants of where the planning process is heading and whether this is the right direction. It means that effects of such plans can be discussed more openly - and altered if necessary - *before* the 'decision to build' has been made.

Perception and Design Simulation

In creating compositions for urban environments designers define a certain 'dialogue' between the built forms *and* their spatial counterparts: the resulting public and semi-public spaces.
An aspect which needs to be taken into consideration in spatial design is the phenomenon that we do not experience architectural or urban compositions *as a whole* but rather in sequence, a *dynamic perception* through a series of changing, selective views, focusing both on the totality and on relevant and 'eye-catching' details. One could compare this to a continually changing

filmistic combination composed of ‘pans’ and ‘stills’, zooming in on meaningful elements within the totality, whilst a mental image of the whole and the orientation of the perceiver is ‘constructed’ simultaneously in the brain.
Authors like Lynch, Cullen, Ashihara and Bacon have in the past emphasised the importance of a ‘scenographic’ approach to the design of public spaces.

The impression of such environments is influenced not only by the designer’s 'primary' spatial characteristics (such as the specific size and proportions or the relationship between object and space) but also to a large extent by 'secondary' factors. Some examples of these are (on the level of the buildings:) scale, plasticity, facade patterns and material expression and (on the level of the urban space:) visual aspects such as differences in surface treatment, trees, streetlights, signs etc. These aspects have to be taken into consideration when attempting to simulate urban concepts.
These aspects can in principle be isolated and considered in their own right, but in ‘reality’ we perceive them as simultaneously present, though *selectively* appreciated. Aldo van Eyck has argued for an appreciation of *place and occasion* rather than space and time (van Eyck/ Strauven, 1994)[3] and recently Steven Holl has described the fusing of these different aspects as an ‘intertwining continuum’ (Holl, 1995, see quote).[4]

Environmental simulation differs from most other forms of simulation in so far as it does not present an outcome for a specific condition. It is rather a method of creating images which in one way or another foreshadow the perception of the composition in realised form. The results of such an ‘imaging’ process may be used for the evaluation of the plan, leading to decision-making concerning alterations, and subsequently in creating a consensus amongst involved parties. The process of creating the simulated images is not a ‘black box’ situation but an active process which can in itself lead to new insights and design ideas. Compared to traditional forms of planning communication, such simulations are *dynamic and interactive* (Kwartler, 1996).[5] Rather than simply (re)presenting (aspects of) a design, simulation creates a condition for communication and presupposes a potential for *testing different options* (and potentially discovering new ones).

Environmental simulation is particularly effective in studying the effects of *combinations* of architectural objects and their spatial relationships from an observer’s viewpoint.
To create such insights it is necessary for the model, from which the pedestrian-level images are to be taken, to contain sufficient visual information, in order to approach an effect of ‘realism’. The need for surface information has to do with the phenomenon of Texture Perspective, for which J.J Gibson introduced the term ‘*texture gradient*’ (Gibson,1950)[6]. Surface textures or structures are instrumental in creating the correct sense of scale in perspective. It is therefore not sufficient for the information in a model to consist solely of ‘primary’ information (the abstract white blocks of traditional urban models). Instead, secondary, visual information such as facade patterns, trees and urban design elements should be incorporated. This can prove difficult, if such information is not yet available, but as Kwartler as indicated on the role of facade patterns in simulation, it is better to make use of ‘bland’ facade structures which at least convey an indication of size and scale, then to use none (EAEA presentation,1995).

Another aspect to consider is the way in which *serial vision* is used. Is it necessary to create visual sequences in flowing motion, or will a series of stills suffice? How interactive can - and indeed should - the visual sequences be, may the route be preconceived? No matter how detailed and technically advanced a production will be, it remains another, lesser kind of ‘reality’, as there will always be a distinct reduction compared to the sensory richness of real perception. This very often leads to a lack of a sense of *place* and difficulties in *orientation*.
Interactive movement is technically relatively complicated, whereas in more sophisticated, preconceived forms of Animation one ventures into the realm of motion picture production (Bridges,1993).[7]
Per case study decisions need to be made concerning the level of detail or abstraction of the model plus which techniques are appropriate.

Design Media

In creating compositions for new environments, designers make use of a range of *media* which can assist in translating their ideas. The designer is involved in developing models for thought and communication, through which a design concept may be captured so that it can be understood, evaluated, discussed, altered and documented and can subsequently be ‘realised’ in built form.

The best known of design media is the *drawing*, which is used throughout the design process. Drawing types that create a two-dimensional image are floor plans, elevations and cross sections. Using such basic drawing types requires for the designer to mentally construct images of how the design would be perceived spatially if it were to be built.
Three-dimensional representations such as *perspective drawings, isometric and axonometric projections* give a more realistic insight into the concept as a whole or into specific aspects.
Another medium which is often used both for the benefit of design thought and design communication is the three-dimensional *scale model.* Here the concept is realised in reduced form, both in scale and level of detailing. From models such as these, images can be made by simulating eyelevel perception using optical *Endoscopes.*
Endoscopes are instruments used to look into normally inaccessible, often small spaces.
An architectural endoscope (sometimes called 'urbanoscope') is an instrument which affords views into scale models, approaching 'real' perception. It is essentially a periscope and may be attached to a photographic or video camera.
Traditional Endoscopy makes use of optical apparatus, but computers have the potential of being used as *digital* Endoscopes (Stellingwerff and Breen, 1996).[8]
Another traditional technique which has gained prominence in creative design representation is the *collage*, which can be used to express varying design qualities such as composition and design references, material and spatial qualities or atmosphere. The collage technique frequently makes use of so called ‘ready-mades’.
The techniques mentioned can be used for *presenting* finished ideas, but also for *inquiry.* S*ketching* is often used as a swift and direct way of noting down options, for reflection and devising alternatives. Introducing changes or testing variations essentially means *re-drawing* (parts of) the concept.

Although initially used primarily for drafting, *computers* offer a great number of possibilities by potentially encompassing different media techniques.
Computer Aided Architectural Design need not be limited to making separate drawings of a plan, but can be used to 'construct' the plan as a *model* which can be tested and altered, which can viewed in several ways, and from which different types of images can be taken.
Some advantages of the computer are their *precision* (essentially working 1:1 with a chosen scale for presentation), the possibility to work with *components*, the opportunities of working in different *layers* simultaneously or separately, the ease of generating three dimensional images, of working *simultaneously* in 2D and 3D formats and with distinguishing *colours*, the relative simplicity of making *alterations* (without the need to re-draw large plans of a plan) and of *storing* information in project libraries and data-bases, plus their tireless *energy.*
There are also shadow sides to design in a CAD 'environment'. Some of these are the lack of a sense of 'presence' and visual clarity caused by the interaction via a *screen* and a system of *commands*, the lack of overview and sense of *scale*, the danger of uncritically consumed *seductive* imagery and easy surrealism, the endless unpleasant *surprises* and the eternal craving for more *speed* and *power* by the impatient user.

An important difference with traditional media is that in CAD the design is not set down by guiding separate lines over paper but by positioning preconceived elements within a virtual framework, which makes it necessary to anticipate and work systematically (Bridges, 1993)[9] and makes repetition dangerously easy.
There is growing evidence that the computer is changing our perception of both the process of design and its products (Coyne, 1992, Mitchell and Mc Cullough, 1991).[10]
What should we expect from computers in the design practice and in education, what aspects and types of interfaces should we develop? Many expect an increasing influence of *artificial intelligence* on design. Should we desire *rational* forms of intelligent support with an emphasis on procedure, logic and precedent? There are many who would argue that something as complex and unpredictable as design cannot be captured via typologies and schemes developed for the *description* of design results and that such an approach might confine creativity, leading to excessive simplification and abstraction (Coyne and Snodgrass, 1993).[11] Should we expect *creative* intelligent input? It is important that the designer remains in charge, making the decisions *assisted* by the computer. The designer should be able to creatively challenge the potentials of the instrument, at the same time able to count on a reliable performance. In this light it is perhaps best to consider computers as multi-faceted *Instruments* for design.
As an instrument, CAAD is essentially a *choice based* medium.
One development which is to be expected is an increased, creative utilisation of *data bases* in design. As the number of possibilities and the structural complexity of such knowledge systems will increase, applications will need to be kept relatively simple and specific (Hennesey, 1993,)[12] In order to achieve a designer-responsive computer interface, both *desktop clarity* and *structural clarity* are of paramount importance (Breen and Stellingwerff, 1996).[13]

In the euphoria surrounding the influx of computers into architectural practice and education some years ago, many predicted that the computer would take over the tasks of existing media and render them obsolete. This has not proved to be the case. On the contrary, there appears to be a continuing evolution of *all* kinds of design-support media. There is growing interaction and inquisitive mixing of media by influential, creative designers. The potentials of using different media in combination - both the 'traditional' *and* the digital - may offer new perspectives for creative computer assisted design.

The (in)visible city Workshop

The Dynamic Perspective research programme of the Delft Media group is concerned with the study of composition and perception and of methods and effects relating to design visualisation and communication techniques, including Simulation Technology (Breen, 1996).[14]
In this particular study an attempt was made to explore the possibilities and boundaries of existing imaging techniques and, where possible, to attempt to shift the boundaries and find new methods for indicative design visualisation on the scale of the urban ensemble. The study explored the potentials of simulation techniques (which are generally implemented in the concluding phases of the design process) as creative tools in the *idea* phase of design.
The study aimed to include both optical endoscopic techniques *and* computer aided techniques. The ambition was to not only compare the two types of environmental simulation technologies, but where possible to attempt to employ them in combination, in a form of creative *Symbiosis*.

The study was prepared for the Workshop 'The (in)visible city', which was a part of the second conference of the European Architectural Endoscopy Association (EAEA) held in Vienna, Austria in September 1995. For this workshop a number of European universities, active in the field of architectural simulation, were invited to prepare contributions which would be presented and discussed at the conference (Martens, 1996).[15]
Starting point for the projects was a masterplan by the Viennese architect Rüdiger Lainer for a city extension on a former airfield at Aspern. A scale model scale 1:500 travelled around the participating universities.
Inspired by a preliminary study of a number of recently completed urban plans, the TU Delft Dynamic Perspective research group developed a critical reaction and translation of the original, somewhat 'restless', deconstructivist masterplan. The design simulation focused on the segment of the general masterplan indicated in the travelling scale model. Whilst attempting to maintain the dynamic qualities of the original plan, the number of directions was reduced, an attempt was made to structure and diversify the qualities of different public spaces and the qualities of a number of visual axes was intensified.

If one wants to simulate impressions with an endoscope one needs a model. After initial experimentation, a 1:500 model proved unsatisfactory and the decision was made to build a model scale 1:200. Because of the size of the site, this eventually amounted to a physical model of approximately 2 by 4 metres! Because of the design character of the study, the model had to be relatively simple, quick to build and easily to manipulate. After preparation of the underground, simple strips of Styrofoam in different dimensions were prepared be used for the building blocks.
A number of technical rounds were carried out to test cameras, lighting, backgrounds, effects of colours and of different basic facade patterns. To apply facades onto the building blocks a method of visual '*sampling*' was used, comparable to techniques used in contemporary music production. In the initial steps, simple geometric patterns, made on the computer, were applied. Subsequently a distinction was

made between open and closed parts in the elevations by introducing a tone difference, which greatly improved the effect. In the next steps samples were taken from realised projects. This involved scanning parts of buildings into the computer from photographs and then ‘straightening’ the perspective using a photostyler program. Such basic patterns were then multiplied into greater patterns. In this way a number of types of ‘urban wallpaper’ scale 1:200 was created. These could be glued onto blocks in a very similar fashion as the application of *texture maps* in the computer. The prints could be made on different sorts of paper suggesting different kinds of materials, coloured stucco etc. when seen through the endoscope. Based on design precedents a number of facade textures was also worked out graphically. The effects of different elevations could in this way be compared relatively simply. By adding other elements suggesting scale or secondary boundaries, impressions roughly approaching a realistic image could be created. By using the model as a kind of film set, moving sequences of different routes through the design were explored and recorded on video.
The computer formed the counterpart of the physical model and endoscope. It was essential in creating the ‘textures’ for the scale model. These could naturally also be used in the 3-D digital model being ‘built’ in the computer itself. The computer model made use of the same basic floor layers of standard height (3 metres) as in the physical model.
Besides creating the samples for the elevations, other computer tests included making ‘trees’ (almost always of embarrassingly poor quality in computer renderings) from 2-D illustrations.
Besides being used for several types of animation, the computer was also used in a try-out using ‘real time’ Virtual Reality software. The same geometric model was used, but now d of the elevations were not considered as continuous surfaces to be ‘mapped’. Instead the facades were divided into regular ‘facets’ of 3 by 6 metres. Sets of fitting ‘fronts’ were stored in a project library to be accessed via a menu. By clicking on specific frames and choosing different fronts, the visual impression could be altered ‘in situ’ with relative ease.

Findings

The method used in this study obviously does not produce finished building designs, but it did prove very useful in creating an *indication* of the types of facades and other elements proposed within an urban ensemble. Created in a relatively short time, the study proved worthwhile although it was obviously limited in its scope. The exercise left a number of open ends that could each be developed further. Even though it can not truly be evaluated objectively, some notable items were brought forward by this explorative study:
- The two types of model built ‘side by side’ proved to have distinct qualities, each with specific advantages and disadvantages.
- The physical model was big and cumbersome, building it was physical work and the condition of assembling the model within the confines of the available endoscope space proved a distinct limitation.
- Lighting such a large model proved difficult and generated considerable heat, colours of materials might look different in normal lighting than in the studio.
- The texture-mapping of facade patterns worked well in both models. Because of this method, the scale model not become too complex and could easily be changed. The computer was indispensable in making the patterns. Applying textures in the scale model could be done more precisely and creatively than in the computer, but was messy.
- The overview of the ‘real’ model (not necessarily the endoscope views) proved stimulating in itself and generated ideas for variations which were incorporated in the computer model.

- The Virtual Reality experiment proved interesting. However, the set-up used was too limited. For creative manipulation an extended library and more flexibility are necessary.
- Colour in the computer needed extra attention. This experience lead to a number of try-outs and a follow-up using more subtle ‘atmospheric’ perspective.
- Animation in the computer was relatively simple but remained a time-consuming affair and tended not to be changed afterwards. With the endoscope, motion was more improvised, but a number of ‘takes’ could be made relatively easily and the best one selected.
- The experience plus the availability of the two types of model after the workshop, stimulated an educational follow-up. The endoscope model proved vulnerable and had to be restored before the educational exercise.

The Delft Educational Workshop Experiment

The results of the pilot study became the basis of the subsequent educational workshop offered by the Media group. It took place in the first four weeks of the eight week ‘Media Module’, parallel with a number of other exercises meant to acquaint the students with several types of design visualisation and communication techniques.
In the exercise, three groups and their tutors were brought together into one big group. The metaphor of the design office was used to create the proper atmosphere: the three teachers acting as the managing directors, the students as the design staff members. The ‘office’ had received a commission and an initial plan would have to be ready in four weeks time. The staff would split up into groups of three to four designers. Each group would work out a ‘scenario’ which would be presented in four weeks time, the deadline was set. The winning proposal would in theory be adopted by the office and worked out further...
The site was a tricky, triangular area, a ‘wedge’ bordered by two routes and with another cutting across it (the central triangle in the (in)visible city ‘design’, which had been removed for this purpose). Reacting to the different directions present in the adjacent parts of the masterplan (which *had* been ‘realised’ by others and were given) and the system of the visual axes would be required. An indication of elevations and material expression would have to be presented and elements such as trees would have to be incorporated into the presentation if they were important for the design concept...
A previous proposal by another office had failed to become a success. An indication of the floor space of the previous plan was given, but as this had not worked out, there was considerable freedom in creating a new proposal...

The student teams were stimulated to visualise and discuss different design strategies and to document these. They could use any traditional techniques they wished such as sketches, scale drawings, collages and models. In addition they were able to use the endoscope and computer aided visualisation techniques. During the first three weeks the students were also be acquainted with texture mapping techniques in a separate course, practising in the same digital model, which they could subsequently use as a basis for their plan presentation. The facade patterns created for the Vienna workshop were available to the students, both in the computer and as prints which could be copied and used in endoscope proposals.

Findings

The students set about their tasks with considerable enthusiasm and the workshop produced results of surprising quality and originality, considering the limited time which was available.
Nine different teams presented a proposal, each with its own motto.
The results were eventually a reason for the ‘managing directors’ to commend not only one plan but four, each of which excelled in a particular way:
- an elegant and compositionally strong ‘landscape concept’:
- a realistic and compact plan with articulated spaces and facade treatment;
- a plan incorporating theatrical effects and an impressive use of video;
- a proposal making innovative use of computer visualisation techniques.
For such a limited number of groups the results were surprisingly varied, both in content and presentation. Some tendencies worth noting:
- The different group-structures of the teams influenced their progress, some teams were good at organising and dividing tasks, for instance splitting up into sub-groups of two, other groups got collectively ‘stuck’ in the first phase, only getting out of the deadlock with difficulty.
- Although both endoscope and computer were actively utilised, a number of other techniques were used in unison, specifically in the initial development phase, collages and sketch models scale 1:500 were used rather than going straight into the 1:200 endoscope model.
In a survey held among the students about their preferences concerning media techniques via a questionnaire, there proved to be considerable differences amongst them.
- Other techniques being taught at in the Module at the same time also proved a stimulus for the presentation of proposals, notably Video production.
- The use of texture maps proved a to be a success. However not enough different types were available and the same sorts tended to be used extensively. Nobody took the time to create their own patterns!
- The textures offered standard with the texture mapping computer software did not prove stimulating. On the contrary they could lead to missteps (like the use of bricks of 1 by 2 metres or worse). In an exercise like this they should ideally be ‘removed’ from the menu.
- The lack of computer experience and particularly the lack of available computer time formed a handicap for those students who had decided using computer visualisation.
- The computer option attracted both students already proficient at CAD (which in one instance led to the kind of semi-transparent volumes floating in the air with which we have become so familiar) whilst for others this was the first real experience in the creative use of Computers. The experience stimulated a number of students to continue with CAD in the second phase of the Module, leading to further creative applications.
- The ‘real’ model, being vulnerable, was ‘finished’ after the educational workshop, while the digital model survives (as long as there is room on the hard disk), new renderings and animations can be made whenever needed.

Conclusions and CAAD Perspectives

What conclusions can be drawn from the Media group (in)visible city experience?
As the project took the form of a pilot study and a limited educational experiment, the results should not be generalised. However the findings may be indicative of the ways in which design media are applied and may be developed further...

One aspect which was underscored by the project is the fact that designers have varying, personal preferences towards design media, and that the combinations of media used may fluctuate, depending on the type of project they are working on and the phase of the design process. During their studies, students should get the chance to become familiar with *different* media and learn to develop their personalised 'handwriting'. This holds for 'traditional' design media, but also for CAAD techniques.

Non-digital techniques still figure prominently in the design landscape, partly due to their 'closeness' to our own physical and mental makeup (techniques like sketching and drawing are comparable to handwriting and making models appeals to building abilities which we start developing when we are very young, the co-ordination between the brain and hands in all of these is very direct).
At the same time the introduction and continuing evolvement of computers offers opportunities for design which go further than applications as an efficient digital drawing device...

The teaching of Cad needs to be an integral part of the educational curriculum at faculties of Architecture. It should not just be a kind of 'driving school' for computer aided drafting but neither should it become a separate *design school.* It is extremely important that students become confident with the familiar types of software and develop insights into the underlying computational organisation, so that they may learn to use the computer as an instrument. They should develop an inquisitive attitude rather than being intimidated by the computer and learn to explore its possibilities. An effective way to familiarise students with such potentials is by setting creative tasks which stimulate inquiry in a designerly way.
The University setting offers excellent perspectives for creative evolvement of computer-assisted media because of the knowledge and experience which is present, but also because of the freshness of the educational environment. Developers of new applications should not be dogmatic but should attempt to learn, wherever possible, from the qualities of existing techniques.

Another aspect which came out of this study was the usefulness of facade 'structures' in environmental simulation, both using the endoscope and the computer. In this project the choice was limited and a more varied assortment would be required. A CAAD application using a large, and ideally interactive, database will require both structural and desktop clarity.
For the future of CAAD, interesting opportunities may lie in *precedent based* design methods. Creative use of precedents could prove particularly useful in simulating the visual effects of intermediate design options during different phases of the iterative design process. Such an application could primarily be of benefit for design evaluation, testing of options and decision-making. Research aimed at ways of structuring and manipulating precedent based architectural data could prove to be a worthwhile contribution to new computational applications. This involves research into the study of the 'science' of architecture (rather than considering architecture as a science) and has already led to interesting studies (Coyne and Yokozawa, 1992).[16]

Ultimately the ambition of research concentrating on design media, such as Computer Assisted Architectural Design methods, should be to *extend* the existing creative *palette* of designers, both in education and in practice.
The study of precedents for the benefit of design visualisation media (currently being explored by the Delft Dynamic Perspective group) might bring together the interests of designers *and* researchers and result in a kind of *creative symbiosis* between the two groups within the profession: the restless, impulsive and creative 'hunter/gatherers' (the designers) on the one hand and the more methodologically inclined 'farmers' (the researchers) on the other. A kind of computer based, on-line *artist farming* project might develop, aimed at creating insights into architectural *content* and *operations*

through the evolvement of interactive structures which could benefit both the understanding of architecture *and* creative design processes...

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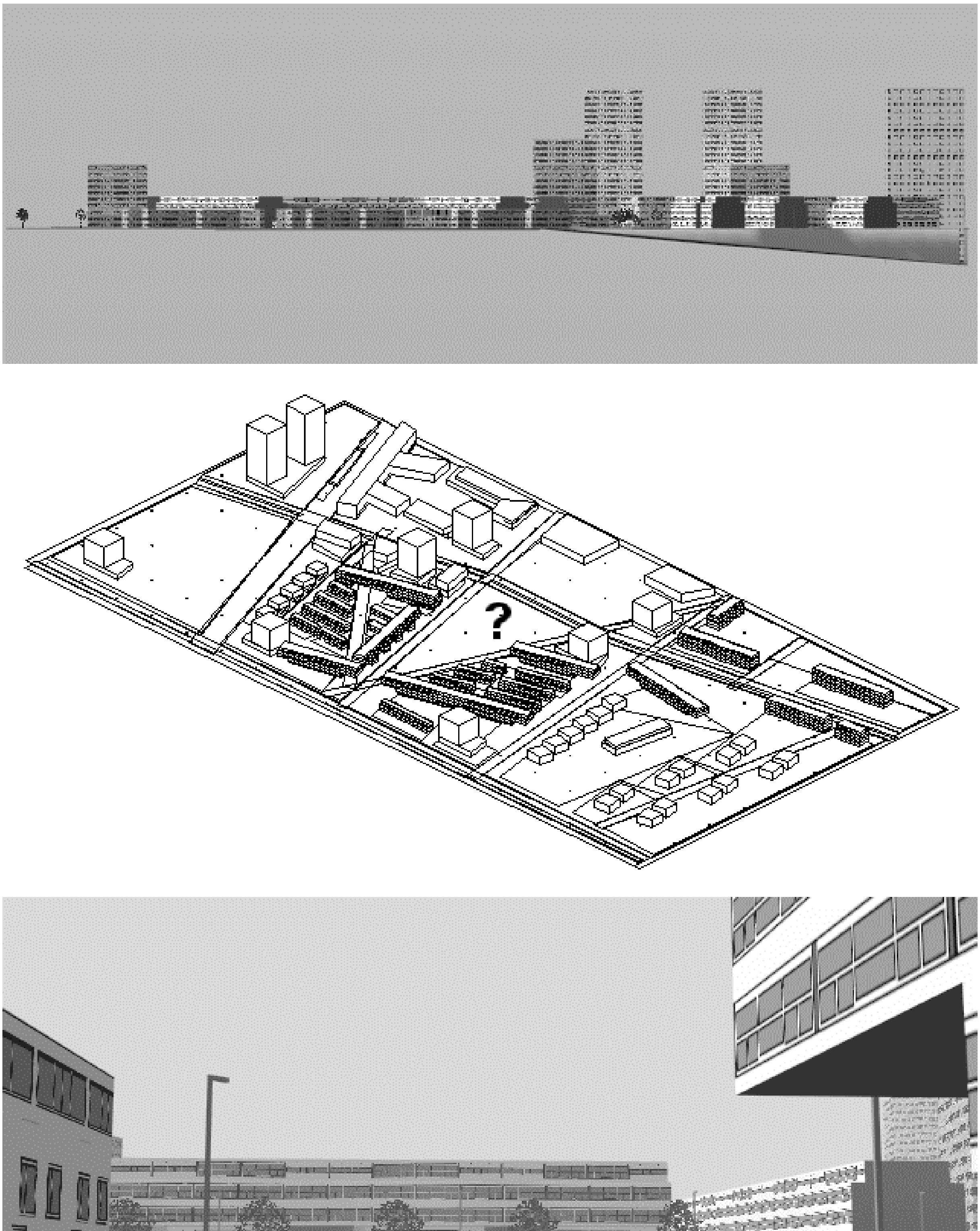

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