

## The Digital Design Process Reflections on a Single Design Case

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*Abstract.* CAD tools are increasing their expressive and geometric power to enable a design process in which the computer model can be used throughout the whole design process for realizing the design. Such a process, in which other media such as physical scale models or drawings are no longer required by necessity to facilitate the design process, can be considered a digital design process. Rather than proposing that such a process is ideal – drawings and scale models should not be discarded – we feel that when taken as a starting point, the digital design process raises a number of new challenges to architectural design that deserve attention. These challenges concern the basic activities in design: exploration of the problem space, creating preliminary solutions, understanding consequences of design decisions, and so forth. In this paper we take the concrete design case of a graduation project that was developed from the start solely in CAD. We identify a number of key issues in that process such as continuous modeling, the model as design, continuous pliability, localized focus, and postponed decision. These issues not only have a technical, CAD-related aspect, but also are connected to architectural design. Most of these aspects are subject of contemporary debate in architectural design. On this basis, we can indicate where CAD is making a potential difference in architectural design.

*Keywords.* Digital design, CAAD

### The project

There is a small, yet increasing number of architectural projects being carried out using solely CAAD software; that is, without the use of other media such as drawings and scale models. In this paper, we would like to reflect on one of these projects to determine the current state of the art of such 'digital design' projects, and to assess where we stand with respect to computer aided design support.

The project concerned a MSc. graduation project for the design of a center for the underground scene in Manhattan, New York. The center would be located in an abandoned station of the

New York subway (Port Authority Bus Terminal Lower Level), directly under Times Square. It accommodates space for concerts, films, and other events, located in separate volumes. The skin of the total space available is a continuous surface that allows passage to all functions (Figure 1).

Obviously, the presented project does not stand alone. The number of digital design projects has recently increased world wide, exemplified by student projects from numerous universities (e.g. Rügemer 2001); competitions such as FEIDAD Award (Liu 2002); 24-hour design studios where globally dispersed teams collaborate (Hirschberg et al. 1999); increasing modeling capabilities of

software that allow new kinds of freedom in form-finding; faster and more accessible simulation software to understand consequences of design decisions (Eissa et al. 2001); and the means to customize software by added scripting languages – these all stimulate the increased use of CAD tools in architectural design. Projects utilizing such techniques can serve as a benchmark to understand where we are standing now and in which directions future development in CAAD would be desirable.

### Digital design

The main thesis underlying the project is that the computer tools and modeling techniques we have available now, enable computer models of the design to become the central medium throughout the design process. The three-dimensional model is one of the manifestations of the

computer model, on an equal level as a structural model, physical model, materialization model, and so forth. Thus, the project was developed completely with digital models from the very start, without the use of sketching, scale models, or other media. The choice to do this was expressly made, not as a limitation but rather as a challenge to demonstrate and explore digital design. In this project, the techniques of metaballs, scripting for interactive parametric design, NURBS-modeling, Virtual Reality modeling and presentation, and CNC-milling were used. Based on our experiences with the project, we would like to discuss a number of aspects which deserve closer attention.

### Continuous modeling

During the design process, a designer produces a lot of sketches and physical models. In



Figure 1. Top: Entrance portal from upper subway; portal area between upper entrance and center; transition to lower level. Middle: Longitudinal section. Bottom: Bar; concert hall structure; cinema structural, interior, and exterior skins. Images by Gijs Joosen.

many cases, a substantial part of these sketches and models are based on previous sketches and models, with differences only local at those points where the designer is thinking about the project. Sketching and scale-modeling therefore, involve lots of redrawing, tracing, and modeling. A digital model has a potentially longer life-span which does not require continuous reconstruction. The direct implication of this is that the design shows a higher degree of consistency throughout the process (errors caused through reconstruction are avoided). It also means in our view, that it pays off to consider the model as the design, rather than a representation of the design (technically speaking, it still is a representation); in other words, to take a designerly stance towards the digital model.

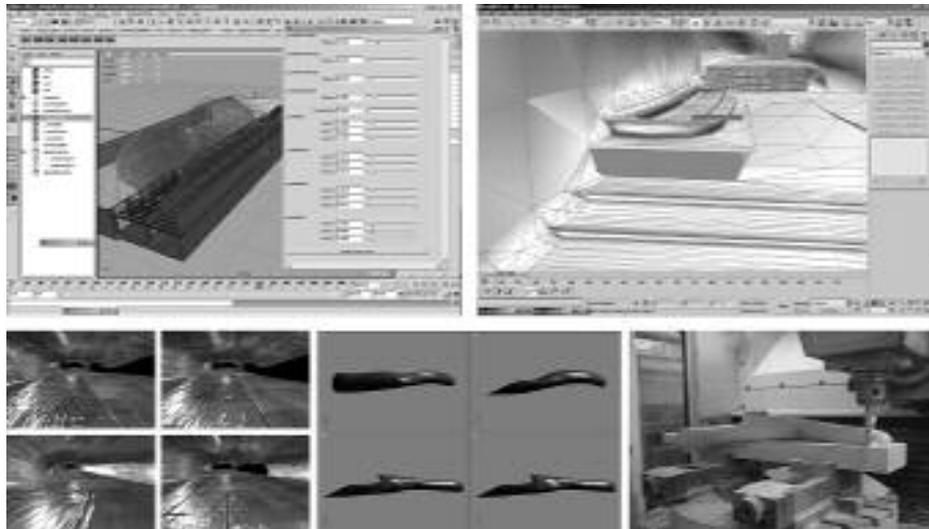
The benefit of higher consistency also leads to a loss, namely, the chance to gain new insights that occur in sketching and scale-modeling. Since there is no need to reconstruct those parts of the

design that are not under consideration, there is also no occasion to create and find changes in those parts that may happen by accident while reconstructing the design. Furthermore, it may well be that the physical act of sketching (making marks, tracings, drawing lines, etc.) and scale-modeling (creating parts, assembling the model, etc.) have a different impact as such because they address different sensibilities of the designer.

### Continuous pliability and localized focus

The technique of NURBS-modeling allows for a gradual development and refinement of a shape without the need to delete an old shape and create a new, improved shape. This extends the potential life-span of a model during the design process. Because a NURBS-surface is the result of a computation, it becomes easier to consider the shape as a preliminary one which is under

Figure 2. Top: interactive examination of the concept in the context; continuous pliability of surfaces. Bottom: development of the central hall by parametric change; development of cinema as NURBS surface; CNC milling of cinema. Images by Gijs Joosen.



constant revision, rather than as a fixed shape – a property which it has in common with parametric design objects.

NURBS-modeling keeps continuous surfaces, while at the same time the level of detail can be adjusted in the places under consideration by means of refinement of the underlying NURBS-equation. This implies that design changes occur locally while the rest of the model updates the changes that are made. Modeling therefore, becomes an activity of localized focus, which shifts to other areas once a particular part has been worked out. This shift of focus is not as such different from other design processes, but what is different is that the model accommodates these changes for a longer duration without the need to replace it.

### Postponed decision

Combined with localized focus, designing becomes a constant process of gradually refining parts of the design. At some point, the NURBS surface has to be translated to a build-able solution. Such transformation usually leads to a loss of versatility. Therefore, it pays to keep NURBS-surfaces as long as possible in the design process: the decision to ‘collapse’ a surface has to be postponed. This position is often at odds with other pressures in the design process, such as the limited amount of time. It also means that a NURBS-model has to be seen as temporary, despite its smooth appearance as an end-result.

#### Discussion

The project presented above demonstrates the possibility of digital design. Although every single aspect of CAD-modeling is dealt with in many other projects (as showcased for example in previous eCAADe conferences), the combination of all of these with the exclusion of other kinds of media, still occurs rarely. This is due to:

1. Each software has a high learning curve

before it is mastered to a high degree of skill.

2. Exchange between software usually leads to data-loss because formats are not completely exchangeable.

3. Extension of functionality to add custom-made functions is difficult.

4. The flexibility and versatility allowed by NURBS-surfaces does not have a match in traditional shapes.

The main cause seems to lie in the fact that most CAD tools are still considered for final production stages and presentation rather than early design. Also, there is a lack of suitable computational representation for architectural design (texture mapping for example, is a computer graphics technique that has no bearing on the actual materialization represented by the texture). These problems need to be addressed before CAD-tools become more accessible to their users.

Although digital design has become an option, we do not advocate that digital design should develop into a process which excludes all other media. As indicated above, scale-models and sketches address different sensibilities that better capture other aspects of design. Nevertheless, we hope to have identified a number of new issues (continuous modeling, the model as design, continuous pliability, localized focus, and postponed decision) that play a role when digital design is involved. These aspects are not dramatically new, but nevertheless require a different attitude towards CAD-models in the design process.

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