Constructing the Amorphous
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Abstract
“Constructing the Amorphous“ entails the ongoing research into a concept which aims to develop a new understanding for Art, Design and Architecture. Rigid, reductivist and confrontational methods based on static geometry, prejudice and competition are to be replaced by dynamic, interdisciplinary and integrative models. In my current art practice I computer simulate existing architectural spaces whose interior I redesign into sculpted environments, based on creative irregularity, rather than idealised geometry. These computer simulated “soft“ environments are realised on an architectural scale as temporary installations. The rationale for sculpted environments, as well as the explanation of how to build such full-scale models, is exemplified using the Darren Knight Gallery project. The benefits of virtual representations versus an approximated full-scale model are discussed, assessing both cost and equipment implications. Comparisons are drawn with current rectilinear full-scale modeling techniques, utilizing bricks, blocks and panels. The research project “Constructing the Amorphous“ is conceived as an interdisciplinary journey through different academic domains and aims to branch out and broaden horizons rather than reducing its investigations into a more and more specialized area. Therefore this paper refuses to end with a singular conclusion.

Fig. 1 Plan (bottom) and elevation (top) of re-designed gallery.
The Darren Knight Gallery Project

The entire project entails a number of interrelated works:

1. Measurement and computer simulation of the actual gallery;
2. The re-designing of the gallery into an environment evoking the geometry of nature rather than the man-made;
3. Production of high quality, computer generated visual material such as dye-sublimation prints, slides and broadcast quality videos of walk-throughs;
4. The building of the actual “soft” environment from corrugated cardboard as a temporary full-scale model;
5. Documentation of the project on the World Wide Web through HTML and VRML and
6. Documentation of the installed environment and viewer's perception of it through text, slides and video.

For the purpose of this conference I would like to briefly elaborate on points 2 and 4 - firstly why sculpted environments? - and secondly the actual building of the full-scale model.

Fig. 2 Why sculpted environments?
The reasons for wanting to create “soft“ or highly curved environments are manifold. First of all I believe in the theory that the environment we grow up in plays an important role in the development of our overall awareness. It is not hard to imagine that someone who grew up in the tent of a nomad family would have a fundamentally different conception of the natural environment, leading to a different world view. I am also convinced that there is a correlation between our built environment with its flat, rigid and reductivist geometry and the tendency in people to hold on to outdated thinking patterns with respect to society for example. Our home - unsere eigenen vier Wände - that is where everything is organised the way we like it without the need to compromise. Straight designs create functionality, privacy creates a comfort zone without surprises from intruders and the solidity of the walls will guarantee that it will stay like this for ever. Wouldn‘t it be great if we could organize our country according to this model? Clear and straightforward guidelines allow for easy evaluation of political decisions - secure national borders guarantee that no intruders enter our comfort zone and all this built solid enough to be passed on to our children.

The complexity of multicultural societies demands more flexible and more complex thinking patterns. This change in society is being reflected by an increasing number of quite complex architectural projects. The curve, however, is still absent with the exception of Frank Gehry’s latest designs. Looking at nature or at sensuously curved sportscars or at celebrated architectural solitaires such as Utzon's Opera House in Sydney, I think there is sufficient proof that highly curved buildings would be welcome. Creating these complex shapes in the computer is still not
easy, finite element analysis allows for their structural evaluation - but how
do we build them? - which leads me back to point 4 of the Darren Knight
Gallery project.

The sculptural design for the gallery was created triangle by triangle in the
computer. This ineffective way of designing with a 3D modeller leads to the
desired irregularity which would be very hard to achieve with any other
method. With the design of the triangulated surface, or skin, completed, a sup-
port structure was designed which reinforced the skin but also allowed me to
prefabricate segments of the skin as transportable units. Thus the entire de-
sign was broken down into 82 totally different segments that fitted through
the front door of the gallery. Arranging them in sequence of assembly made
it possible to check for “lost” triangles or access to “seams“ where the
triangles of different segments needed to be joined. Organised in this way
pre-production of the segments was estimated to take 2 weeks and a further 6
days were planned for the installation process. Due to storage problems at the
factory I had to build everything in the gallery which took 12 long working
days with occasional help from some friends.

The successful realization of the design into the full-scale model depends lar-
gely on an “unfold“ or “flattening“ tool that takes the 3D design and produces
a pattern for computer controlled cardboard cutting and creasing on a flatbed
plotter. Based on a self-written piece of software, a program was written that
unfolded all the triangles in a way which minimised the total cutting length
and maximized the creasing length. Overlapping areas in the pattern were re-
moved manually at this stage. Thanks to the sponsorship from Visy Board, a
major cardboard packaging manufacturer, I was allowed to use their speed-
plotter and during 4 night-shifts I cut the approximately 2,500 differently
shaped polygons from 251 dxf-files. A recently installed 3x5 m. plotter
would reduce the numbers of dxf-files by factor 4!
Fig. 5a-b Wireframe versus "reality" and video with path through installation.
Fig. 6a-b  “Flat” VRML image versus „reality“ and a full-scale model.
Virtual Representations Versus an Approximated Full-scale Model

With the Darren Knight Gallery project being a test-case with a full-scale realization as its final stage, I tried to examine the design “virtually“ in as many ways as possible through traditional CAD representations to rendered images, rendered fly-throughs, stereo viewing with Chrystal Eye Technology and VRML files.

*Representation within the CAD program:* wireframe representation is incapable of showing the 3-dimensional depth of highly curved surfaces. Rendered views, including hidden line removal take too long in the case of a slightly more complicated design.

*Video:* Walk-through videos are very helpful - however the linear quality of video restricts the camera angle to a pre-defined path. No real interaction is possible. Production is very CPU expensive.

*VRML:* The files are easy to produce and it is a powerful way to view a design from many angles. However there are very limited lighting or surface texture options. The system allows you to view only - i.e. it is not possible to correct the geometry directly in the VRML file.

*Full-scale model:* The impact of a full-scale model is instant. The design is instantly comprehended in its entirety and questionable areas can be evaluated over a greater time span than what would normally be possible in a VR system. Another major advantage is the fact that it is more easy to simulate social activity within a full-scale model. It is possible to invite a number of friends, have a party and discuss right there and then what is good and what is bad.

Cost and Necessary Equipment

Apart from the “unfold“ or “flattening“ tool the necessary software at the design stage are off-the-shelf products. Cardboard cutting requires slightly modified file formats with different line attributes for cutting and folding. As most cardboard companies use the cutters only for internal prototyping rather than as a service, they do not have fixed pricing structures, however, it is generally much cheaper than laser- or water-jet cutting in harder materials. The cost of cardboard itself is very low compared with other sheet materials. Set-up time depends on how efficiently the data has been prepared before cutting. Some consideration should be given to a support or reinforcement system. With the low weight and high rigidity of corrugated cardboard, however, the requirements for support are quite minimal in most cases.
Comparison with Bricks, Blocks and Panels

One of the most ironic errors the software industry has made in developing CAD programs has been the copying of the simplified drawing board and projective geometry techniques for the design of CAD software interfaces which meant that the simplified geometric language which dominated the pre-computer construction paradigm was literally copied into the computer age. It is interesting to observe how 3D animation packages and visualization software include more and more physics based modeling tools for more natural looking effects (clouds, fire, etc through particle systems - bulging muscles or bouncing hair through finite element etc.). This shift from rigid geometric to dynamic physical modeling will change the modeling part of architectural CAD programs. And a new generation of architects will want to make use of these tools resulting in highly curved, organic geometry options. Bricks, blocks and panels belong to the old generation of rectilinearity, struggling to model anything curved in one direction - incapable of modeling curved surfaces in two directions. The approach shown here might be a first step on the road that will develop architecture from the age of Lego™ to the age of automated fabrication without getting lost in the hype of cyberspace.

The Future

It is certain that immersive VR will play an important role in architectural modeling. It is also certain that it will take at least another 10 to 15 years before the technology is developed to a level where it can suggest reality in a convincing way at a price affordable by the average architecture firm. During the development of immersive VR a calibration process needs to take place that allows to check the suggested virtual model against the reality. The ideal location for the task would obviously be a full-scale modeling lab fitted with an immersive VR system. One thing, though, that I can't figure out - how will they ever manage to simulate the perceptions of going up or down a flight of stairs?