Computer Aided Design Techniques

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Original published:
Sevaldson, B. 2001. Computer Aided Design Techniques. Nordic Journal of Architectural Research, 55-68.

The implementation of graphic computing in design practice has triggered a renewed interest in the design process and a leap in the invention and development of new design methods, strategies and techniques. Central in this endeavour stands the use of the computer as a generative design engine. This has consequently led to a temporal decline of the importance of traditional design skills and breads a generation of designers with no traditional education.[1] These designers are basing their work on an intuitive trial and error way of applying the computer. Recently the traditional design skills appear to have a renaissance where these techniques are paralleled and combined with the computer driven techniques and where this results in a new synergy.[2] On the other hand we can see the contours of an endeavour to discover and develop ways to surpass the trial and error stage in design computing and to reach towards more advanced strategies. In many of those cases the computer is used as a tool to apply generative material in the design process. Some computational modelling that takes advantage of the computers generative power is used to produce a more or less abstract underlay for design. Though the arguments for doing so are many and diverse, from a perspective of design methodology such generative material is meant to produce an unanticipated output that would fertilise the design process. The use of such generative material raises questions about the design process as a creative process and the position of the designer in this process.

Creativity and the internalised elements of the creative process remains a puzzling and unexplored phenomenon. Many different explanatory models contribute to the understanding of creativity.[3] These models span from pragmatic, psychometric, cognitive, social-personality models to confluence models that try to embrace creativity as a multiple component phenomenon. Parallel to these models, which all stem from psychological research, there exists among the creative professions an intuitive and still unrecognised understanding of creativity. This perspective, based on first-hand experience rather than clinical research, might prove to be more productive for design research than the psychological ones, because one avoids entering epistemology outside the realm of design and thereby entangle in extremely complicated issues which as mentioned even within psychological research are heavily debated and still not fully understood. The designer as practitioner has a first hand experience that provides an understanding of how creative techniques work. From such a position we can investigate the creative process mostly from its results and only when strictly necessary we need to deal with it as an internalised

[1] An example of high quality, which also contains links to other operators within this sub culture of wed design, is to be found at www.ziggen.com. This is the homepage of the Norwegian Siggurd Mannsåker who has the status of a guru in this milieu of partly very young enthusiasts, several of whom have become professionals.
[2] This trend is found at the Institute of Industrial Design where advanced CAD, CAE, CAID, DTP, image processing and digital video skills are combined with traditional drawing techniques.
[3] See "Handbook of Creativity" (Sternberg 1999)

process. We rather investigate the symptoms (products) of creative processes than their internal causes. I suggest this as a productive attitude for the design researcher towards the problem of creativity.

Though there are many diverse interpretations of what creative processes are, common to all explanations is the emergence of the unanticipated. Creation implies the arrival of something new, something, which has not been imagined before.

Computer technology has helped to simulate and calculate things that have been to complex for human imagination. The number crushing capability becomes a tool of investigation and exploration simply because of its incredible speed and storage capacity. Numerous unimagined discoveries have been dependent on computer technology, e.g. the discovery of chaos mechanisms in the seventies. Equipped with a graphic system the computer becomes an engine for qualitative research where spatial formations, patterns and structures are explored. Though the core technology of the computer is digital its graphic surface and interface turns it into an analogue machine able to store, manipulate and produce qualitative and visual material. This turns the computer into an "engine of the unanticipated".

But if designers behave like scientists and leave everything to simulations and computerised emergence[4] it would have at least two negative impacts. The designer is reduced to a less creative workhorse in the design process. But more serious, the results would be unprocessed formalism with no cultural content or meaning, since culture in human interpretation has no meaning to machines.[5] To develop the potential in computer aided design we need to:

- Visualise abstract structures.
- Connect cognitive analytical processes to visual computing
- Take advantage of the computers generative power by exploiting the "engine of the unanticipated".

The instrumental techniques suggested here indicate a slightly altered but not alien role for the designer through selection, interpretation, analyses and modification. These techniques are based on the implementation of the computer as a visual tool and the designer's interpretation, speculation, codification and manipulation of the computer generated output.

Diagrams

The interpretation of the visual output from the computer implies that it operates on a more or less abstract level. Abstraction of visual representation means exaggeration of certain aspects on the costs of others. In this discussion I define the diagram as an abstraction that emphasises structural organisation, patterns and relations on the cost of typology and semantics.[6]

The work presented in this essay spins off from the discourse on the diagrams role in architecture during the last decade. This discussion was triggered by Deleuse and Guataris notion of the diagram as an "abstract machine". The diagrammatic was regarded as non-reductive and not representational but a "layer" of reality that had potential to be actualised. This essay is about operational techniques for designers and intends to look at computer aided design techniques from the perspective of the

[4] Genetic algorithm, artificial design intelligence and expert systems.

[5] Greg Lynn says that *.. the failure of artificial intelligence suggest a need to develop a systematic human intuition about the connective medium rather than attempting to build criticality into the machine.* (Lynn 1999) page 19

[6] Structural in its literal sense as the organisation and layout of formal issues like framework, outline, distribution, direction, density, border conditions and similar features of form in general.

practitioner. It is still necessary to point to the importance of this philosophical movement as a source for several of the described issues.

The diagrams we are most concerned with are dealing with structural organisation in graphical material and spatial constructs. Normally diagrams operate on a descriptive level. They describe and help to analyse existing entities and situations, mostly quantitative relations or casual relations like in bubble diagrams.

But descriptive diagrams can also describe qualitative items like how things are organised in space and how a space is composed as a whole. These are diagrams that depict formal aspects. As an example to clarify this level of form, I will use Ucellos painting "Battle of San Romano".[7]

The "Battle of San Romano" is a highly complex composition and in this example I will look at only few formal aspects. The painting is important not only because of its introduction of the perspective into open landscape scenes but also because of its virtual representation of time. The painting appears almost as a snapshot of the most dramatic moment in the story, the moment of victory and defeat. This feeling of a frozen moment stems not from the singular figurative elements (horses and soldiers) being drawn in a stiff and almost stylistic and statue-like manner. The dynamic power of the picture comes mostly from its structural and diagrammatic order.

The picture appears as open ended both geometrically and time-wise. We can imagine that there is a lot more going on outside the frames of the canvas, and we know that there has been much drama before the captured moment, and that there will be more to follow. The main movement in the image goes from the left to the right, the winning army moving in form the left and the loosing party fleeing into the background and out to the right. The lances contribute to form this movement. The movement is readable on a figurative level from the direction of the figures, the soldiers and especially the horses. But behind this figurative level we can perceive this temporality from the diagrammatic structure of the picture as well. The lances form a virtual direction and movement totally independent from the figurative connotation of the painting. If we draw a simplified diagram of the lances they form a group of lines, which depicts an accelerating movement towards the right. (Fig 1) Other elements, like the lines in the almost scenographic arrangement of the background emphasise this movement. The diagram depicts one of many possible descriptive diagrams of this complex composition.

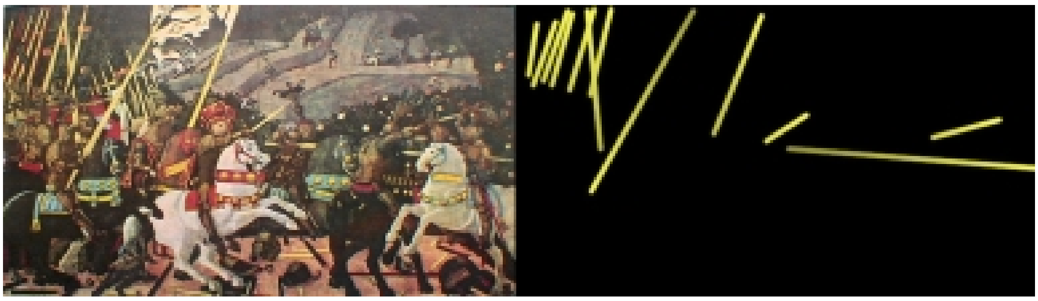

Fig 1: Simple diagram of the lances in Ucellos painting "Battle of San Romano"

[7] Paolo Ucello 1397-1475.

The diagram of the lances shows their spatial relations, direction, density, distribution, clustering and fragmentation. The appearance of the lines moving from the left to the right comes from these features. These are generic diagrammatic categories that exist independent of the representational. Even if we remove and forget the figurative and narrative, the spatial organisation of the lines implies movement, which can be developed in a speculation. (Fig. 2) This refers to the non-reductive of the diagrammatic. The painting catches a focus point in time from which there are many potentially

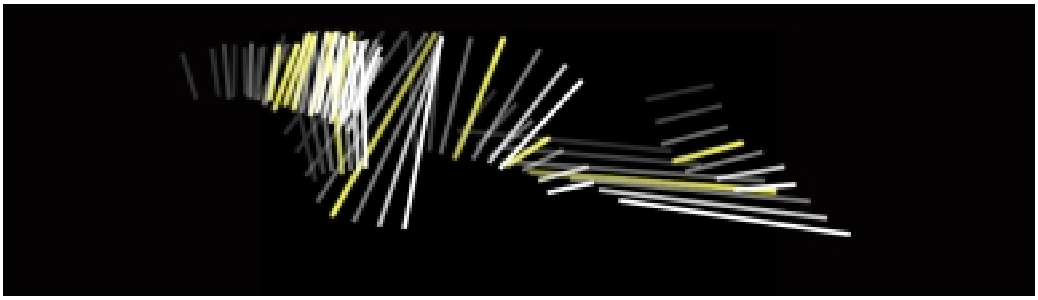

Fig 2: Speculative unfolding of the inherent movement indicated by the diagram.

While developing such spatial diagrams into increasing detail we will cross a blurred border when the diagram becomes model (model as a spatial image of the represented). In this case there is no sharp distinction between abstract spatial representation and formal model. Decois spatial construct "Ether/I" is directly derived from the movement of a dancer. It appears more as a descriptive though abstracted model of the movement than a diagrammatic representation of its spatial qualities. (Fig. 3)

Fig 3: Spatial structure directly derived from the movements of a dancer. (Decoi, Ether/I)

By comparison, OCEAN norths[8] competition entry for the finish embassy in Canberra operates on a clearly diagrammatic level. The initial diagram is a space dealing with formal aspects, indicating purely structural organisation principles. In the design process it is applied as a generative diagram. The development of the final design demonstrates a process that derives the design form the structural

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[8] OCEAN north is a group of designers from diverse disciplines, led by Tuuli Sotamaa, Kivi Sotamaa, Birger Sevaldson and Michael Hensel. The Helsinki-based group undertakes experimental design with the aim to develop an approach to design that engages [with] the dynamics of the natural and built environment.

qualities of the diagram, rather than design directly from it, which is visible from the difference between the diagrammatic space and the final implementation[9] (Fig. 4)

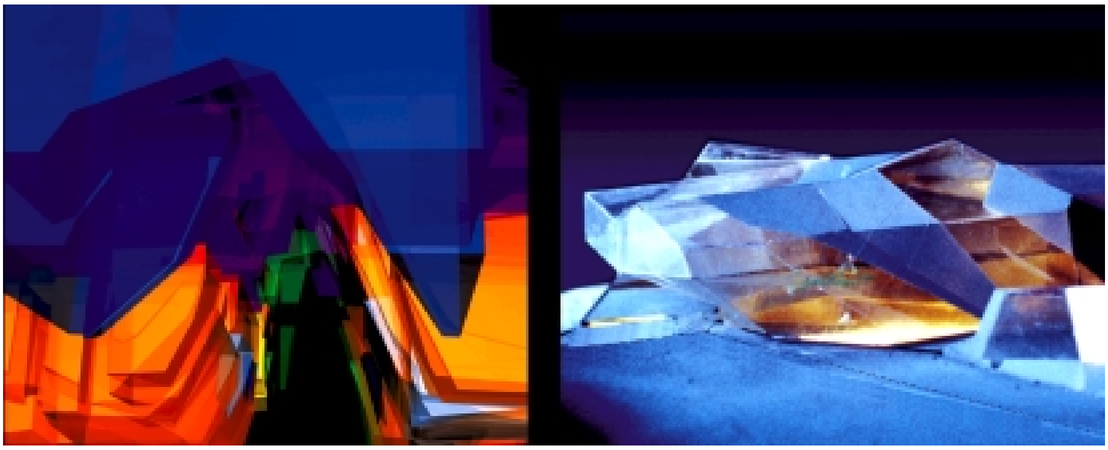

Fig 4: Generic structural diagram used to inform the design of a competition entry for the Finish embassy in Canberra. (OCEAN Oslo Helsinki, 1997)

Generative Diagrams

While descriptive diagrams describe existing entities, generative diagrams are used to generate generic structural spaces that are used to influence the design, just as very early hand made design sketches some times are dealing with spatial and systemic organisation rather than the object it self.

Generative diagrams move our initial attention away from problem solving or the imagining of formal solutions towards structural organisation. For many designers and architects this is not an entirely alien way of working. Often we start the process with mapping abstract and intuitive sketches of how things could be organised in space and how they relate to each other. Such sketches could simply represent spatial structure or activities and programs as in the traditional bubble diagram. This type of diagramming often oscillates between the descriptive and generative since they intend both to describe existing and imagined situations but also aid to explore and develop new solutions. But unlike these traditional techniques the generative diagram implies a separation of the diagrammatic and structural aspects from intention and typology.

Graphical computing is intriguing and confusing because it some times by error produces “wild” and unexpected output, that obviously should have a potential to be used. The output of trial and error based approaches is difficult to instumentalise without a good strategy. The question is how to pair the emergent out-of-control-productivity of the computer with the desired control by the human designer. The generative diagram delivers one approach that negotiates computer emergence with human interpretation and design control. It controls the wild computer and sabotages the human need for control.

Like formal descriptive diagrams (e.g. lance diagram), generative diagrams might operate on the borderline between abstract and figurative representation. Generative diagrams animate us to view

[9] Canberra credits: OCEAN Helsinki Oslo 1997, Johan Bettum, Markus Homstén, Niina Kettunen, Marianne Pulli, Bonsak Schjeldrop, Kivi Sotamaa, Lasse Wager

graphical information and computational processes in an abstract and structural way. Diagrammatic thinking in this sense opens the possibility to free computer generated material and computer software from its determined context. The material can therefore be reinterpreted, redefined, re-mapped and re-coded to instrumentalise it in a design process. All this is done in a qualitative and visual manner based on playful and intuitive manipulation of graphical represented information. The technique gives a creative boost and helps to break established design schemata.

The appliance of the generative techniques.

Computer aided generative techniques can be used in various ways:

Used to articulate the Cartesian void.

The generative diagram can be used as a spatial organiser that sabotages the rectangular dogma of the Cartesian space. The reading of space in three dimensions, organised along three axes (X,Y,Z) is central in western spatial thinking but it also provides a mental mould in which our spatial thinking is formed. It might show crucial to develop strategies to temporarily escape this type of spatial backbone structure and to develop different ones. One strategy explored in several cases during our work is to apply 2D and 3D information sets as spatial organisers. One example is the installation Chamberworks[10] at the gallery RAM in Oslo 1998, where a 3D particle animation was used to fill the gallery space which an initial structure of varied generic intensities. (Fig. 5) Areas were the particles distribution would be dense where read as areas of higher intensity. This 3D intensity map was used to inform were the metal structures of the installation where allowed to go.

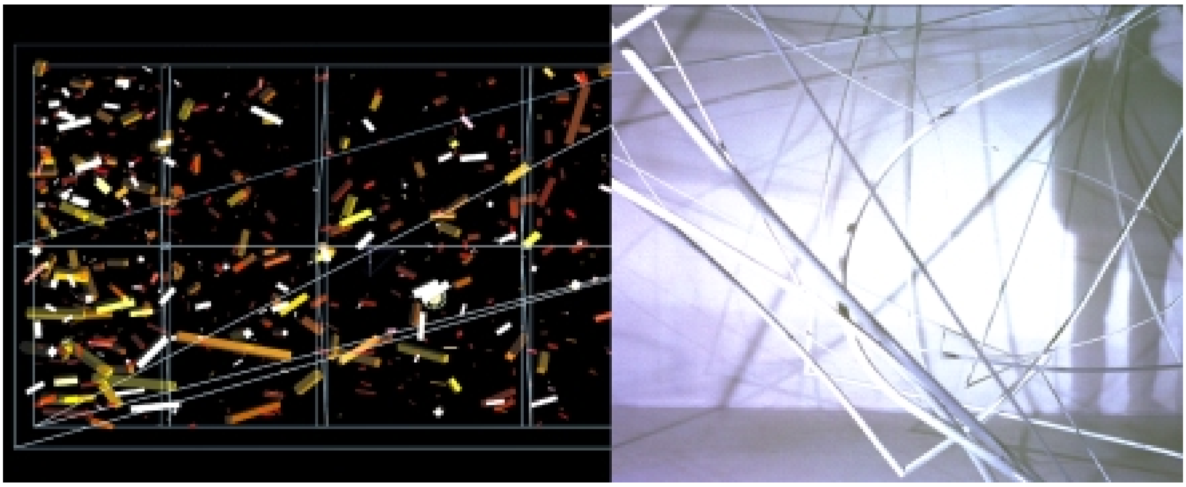

Fig 5: Chamberworks. To the left initial particle animation. To the right final installation. (OCEAN Cologne, Helsinki, Oslo 1998)

Used to introduce uncontrolled structures to a design.

The aim of the mentioned strategy of Chamberworks was twofold. Not only was it meant to articulate what was an empty rectangular gallery space (Cartesian void) but also to resist and disturb our mental

[10] Chamberworks credits: Johan Bettum Michael Hensel, Markus Holmstén, Helsinki, Kim Baumann Larsen, Birger Sevaldson, Dan Sevaldson, Kivi Sotamaa, Helsinki
Other credits: Soundscape: Audun Strype from Strype Audio., Video: Øyvind Andreassen FFI

images of what the gallery space could be. By establishing uncontrolled and "un-designed" initial spatial structures which where used as scaffolds for the design, the design of the gallery was allowed to be both designed and emerge from the uncontrolled, computer generated material. Scaffolds, unlike templates are of different geometry than the final design and are not recognisable in the final design.[11] They operate on a purely diagrammatic level. The particle animation scaffold was applied to the design through a phase of physical modelling, where the particle animation was mapped with prints of even distributed sections on transparent overhead sheets. These sections where used to negotiate an initial wire model with the intensity space of the particle animation. (Fig. 6) In the end the influence of the particle animation on the final installation in Chamberworks was minor, since many other strategies where applied through out the design process. But the principle demonstrated here is important. The paradigm of a fully controlled design process, based on the assumption that each problem has one correct solution, contradicts both our contemporary conception of deconstructed meaning and the adaptation of environments over time. A paradigm where design control is negotiated towards uncontrolled information (abstract, simulated or real) seems to have the ability to inject an inherent capability to cope with uncontrolled futures. It resists the idea of the perfect (static) and emphasises the unfinished, the developable and the imperfect.

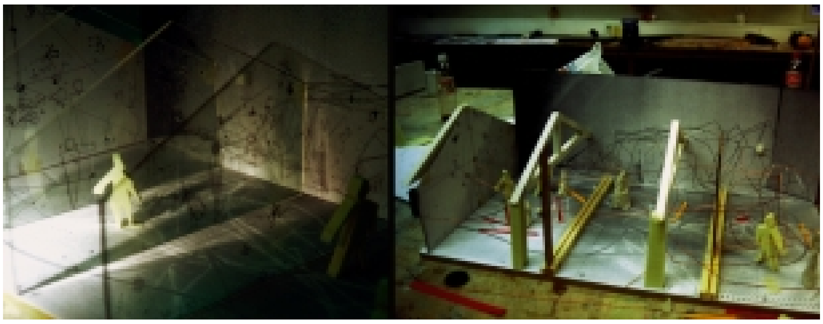

Fig 6: Chamberworks. The mapping of the particle animation was implemented in the design through a stage of physical modelling. (OCEAN Cologne, Helsinki, Oslo 1998)

Used to break design schemata.

Along these paths we also meet the problem of typologies and schemata. While typologies are essential in our perception of the world they can appear to be obstacles when we want to reach new solutions and/or design for changing environments. In such situations we need in periods to escape from our spatial vocabulary to invent new ways of organising space and finally to reach for new types. But our design schemata reach beyond the conception of types. They also influence our immediate ways of organising space. We design according to a learned scheme of territories and distribution, where the aim is to avoid overlapping and conflicts and to strive for clarity. This as well can appear as a straight-jacket and hinder the arrival of new potentially powerful solutions.

Ambient Amplifiers is a design and research study aiming to explore how digital speculative modelling can contribute to the formation of generic concepts, (like programmability of built form) applied to a real life scenario. The project, located to a park area in the east of Oslo, treats a series of elements and sites within the area and indicates several interventions mostly developed to a sketch level.[12] In the

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[11] Stan Allan refers to certain structures serve as scaffolds for events unanticipated by the architect. (Allen 1999) page 54

[12] A more extensive analysis is to be found in the proceedings of the Conference on Architectural Research and Information Technology, Aarhus 2001.

project Ambient Amplifier the central area of the Tøyen Park in Oslo was redesigned with the aim to reinforce the existing complex pattern of activities. The main elements in this strategy were a set of various generic islands, (constructs that could appear in various stages of un-finishedness, from ground articulation to pavilion) a system of surfaces operating between path and leisure-ground and the redesign of the street system in the area. (Fig. 7) The islands where distributed on the ground of an uncontrolled input to the layout. A particle animation that was generated from site information and abstracted site forces was stopped at a point where it showed a distribution in the field that potentially would provide the needed density and distribution to serve as an underlay for the layout of the islands. This layout produced a series of conflicts, both with the existing street system and the fencing of the nearby botanical garden. The careful negotiation of these conflicts initiated the new solutions of the programmable street and programmable fence, both entities that where adaptable towards the changing events taking place on the site. The programmable street and programmable fence became new typologies in the project.

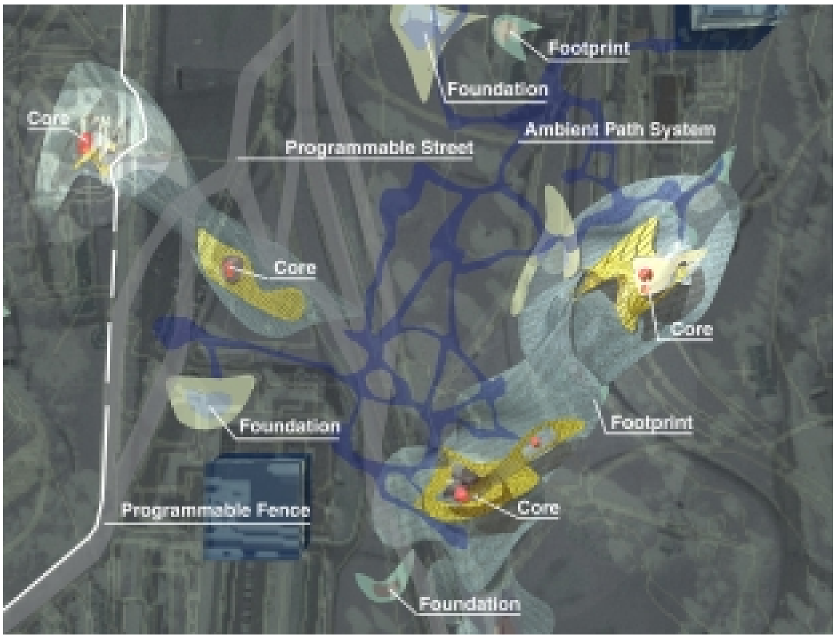

Fig 7: Ambient Amplifiers: Overview of the system, Path system, Programmable street and fence, Islands in four states of unfinishedness: footprint, foundation, frame and core. (Ocean north 2000)

Used to instrumentalise adaptability.

The idea of the uncontrolled and unfinished as a strategy for temporal adaptation could be developed further. If we assume that adaptability is a structural or even geometric feature we could try to design adaptability into constructs on a structural and geometrical level rather than making constructs that are either mechanical flexible or easy to alter by rebuilding. Generic articulated geometries have in some cases a better ability to host and even trigger unexpected events than an open plan solution with no geometric articulation. This ability to adapt through articulation was used in the design of the “islands” in the project Ambient Amplifiers.[13] (Fig. 8)

[13] OCEAN north. Birger Sevaldson, Phu Duong 2000.

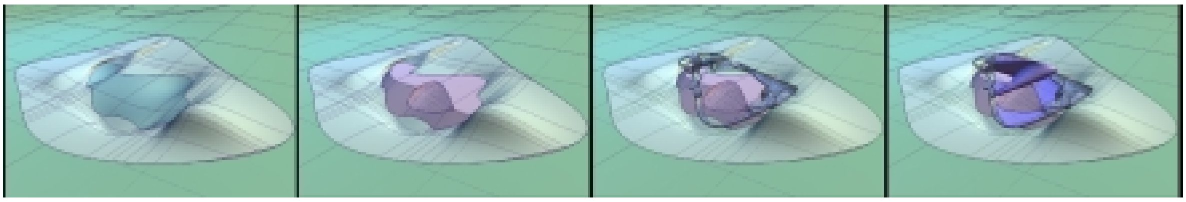

Fig 8: Ambient Amplifiers: The "Island" constructs in four differents stages of "unfinishedness": footprint, foundation, frame and core. (Ocean north 2000)

The implementation of generative diagrams

The generative diagram appears in many forms, from particle animation to colour underlay. The ways it is implemented into design are as various:

Direct form generation

The generative diagram can operate as a structural diagram of form in the same way as the descriptive diagram we have drawn from Ucellos painting. A_drift is an entry to an invited competition for a time capsule for the next millennium.[14] A series of nine capsules where suggested to be dropped in the Antarctic ice in positions that would reliece the capsules into the ocean after calculated time of one thousand years. The capsules had two voids to contain objects. The voids were produced with a skeleton animation in Alias|Wavefront Studio. (Fig. 9)

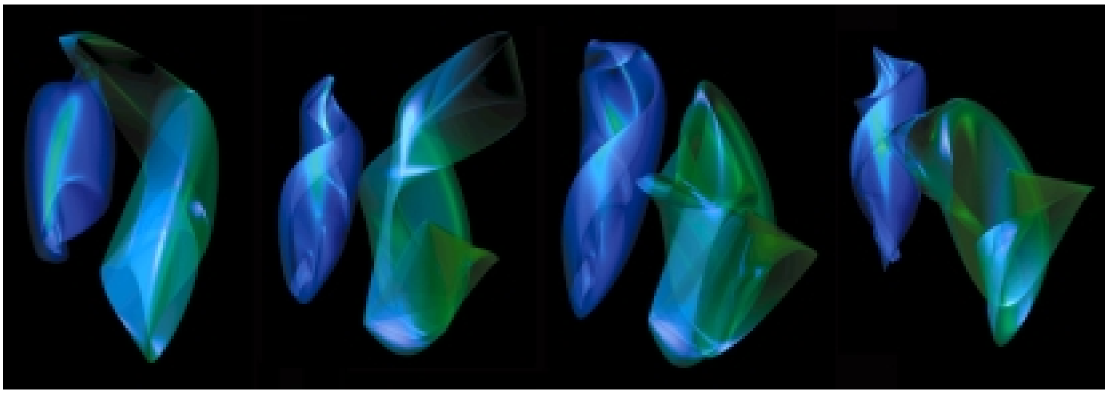

Fig 9: a_drift: Four frames of the compute-ranimation used for the design of the inner voids. Skeleton animation with multy clustering of control points. Software: Alias|Wavefront Studio. (OCEAN Helsinki, Cologne, Oslo 1999)

This multy-clustered animation had a feedback effect so that every run would produce a new deformation of two spherical forms. Certain frames were selected to operate as form diagrams. The selection was done from formal design criteria, the two voids should not intersect, and the forms should be complex but still distinguishable. The shapes where refined in the CAD software, where all self-intersections of the surfaces where eliminated so that they actually where possible to produce, but with the intention to bring

[14] OCEAN north was invited by the New York Times by Herbert Muchamp together with 50 architecture and design practices world wide. The entry by OCEAN north made it to the final 10 and was exhibited at the American Museum. Winner of the competition was Calatrava. A_drift credits: Johan Bettum, Michael Hensel, Birger Sevaldson, Kivi Sotamaa, Tuuli Sotamaa, Helsinki. CONSULTANT:Tero Kolhinen

as much as possible of the wild and un-designed qualities of the animations further into the design. The outer hull started as a cylinder that was negotiated towards the inner voids via several additional layers of material surfaces. (Fig. 10)

Fig 10: a_drift: From the left: Computer rendering of capsule model with partly transparent outer shell (Birger Sevaldson). Clay model of inner core (Tuuli Sotamaa). Rapid Prototyping model of capsule. (Birger Sevaldson) (OCEAN Cologne, Helsinki, Oslo 1999)

Spatial organisation, colour space.
Generative diagrams can be used as spatial organisers as mentioned earlier, to operate as alternatives to a Cartesian organisation of space. We cannot entirely escape the Cartesian space, especially in the context of computer-aided design, where both 2D and 3D software is based on Cartesian coordinate systems. But we can within the global Cartesian space establish customised local coordinate systems that diverge from the straight global system. Also we could integrate other descriptions of depth than the mathematical ones, like the visual perception of space in colour compositions. In the following example the visual depth of graphical images are mapped to various local coordinate systems.

VORB is a series of workshops that where conducted at the Oslo School of Architecture from 1997 to 2000. VORB stands for *Virtulle Objekter Rom og Bevegelser* and translates to "Virtual Objects Spaces and Movements". In the workshops initially the potential of the virtual computer generated spaces was explored but they developed to investigate the virtual on a more general bases.

In the workshop of 1999 the students where asked to find a graphical image of certain qualities. The image should be non-figurative, it should have a certain complexity and it should render areas with varied intensity and with variation in the sharpness and quality of the borders between its graphical shapes. These images were used as seeds for informing 3D space.[15]

[15] This technique was initiated by Jeffrey Kipnis who named the implementation of imagery in such a way for colour graft.

A colour image can be read as a data array where the numbers of each pixel could be recoded from colour intensity to e.g. z depth. This approach was applied in the first example.[16] (Fig. 11) The initial image was filtrated in Photoshop to produce a series of images, each of them operating as descriptive diagrams of the initial image, emphasising some aspects on the cost of others. For each diagrammatic image a separate rule for spatial mapping was applied. This resulted in a rich space where several surfaces intersect, all derived from one image. Each surface indicates a local coordinate system since the z-depth is modulated into a new topologically formed position.[17] The surfaces in NURBS software have their own inherent coordinate system, positioning the surface locations according to the anatomy of the isoparms. These coordinates are normally called U and V where the surface normal corresponds to Z. Similar techniques are easy to conduct with the bump-mapping or displacement tools in many 3D visualisation programs.

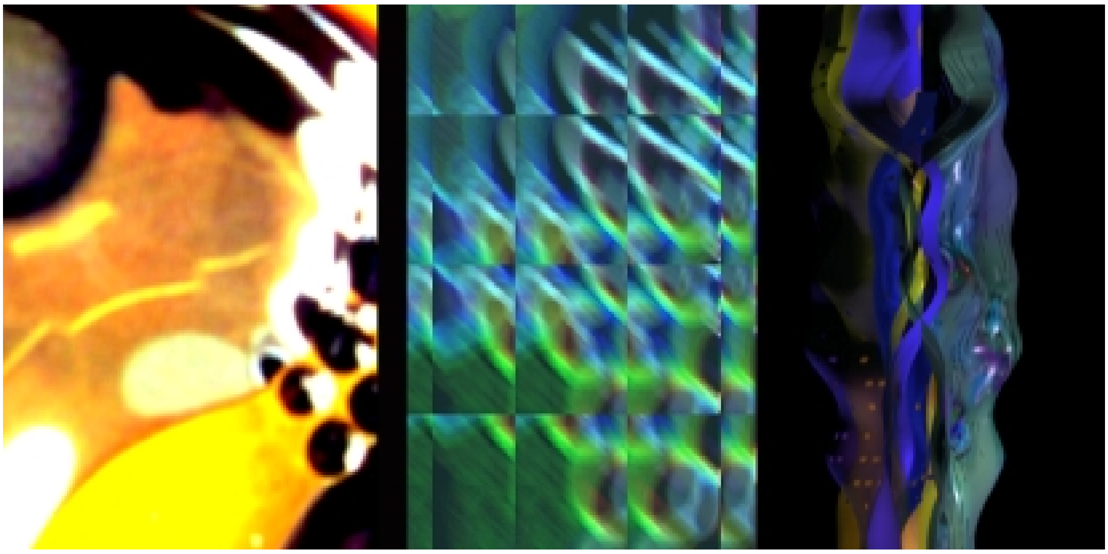

Fig 11: VORB3: From the left: Initial image, Filtered and manipulated image sample. Spatial construct derived through displacement (bump-) mapping and additional techniques. (Oslo School of Architecture IFID 1998.)

In the next example a similar approach is applied to displace the surface in three dimensions. But here the depth information was simplified to appear as a limited number of columns (data reduction). A cylindrical polar co-ordinate system was used to map the space instead of a normal X,Y,Z system, which resulted in a space organised around a cylindrical backbone rather than a rectangular.[18] (Fig 12) The polar system is described by sweep angel, radius and height. Combining the two approaches would produce nested local coordinate systems for a more advanced treatment of spatial issues. Though these approaches still operate with in the Cartesian global system they help to resist the Cartesian paradigm and point to the fact that the way we basically describe space has a deep impact on our designs.

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[16] VORB3 Oslo Scool of Architecture IFID 1998. Ina Nicolic, Anette Martinsen, Rene Safin, Gergely Agoston.
[17] Local coordinate systems are often used in CAD systems, especially for architecture. E.g. a part of the building that stands in an angel to the rest ofthe building could easily be constructed along its own local co-ordinate system, standing in the correct angel to the global co-ordinate system.
[18] Kristina Ruf

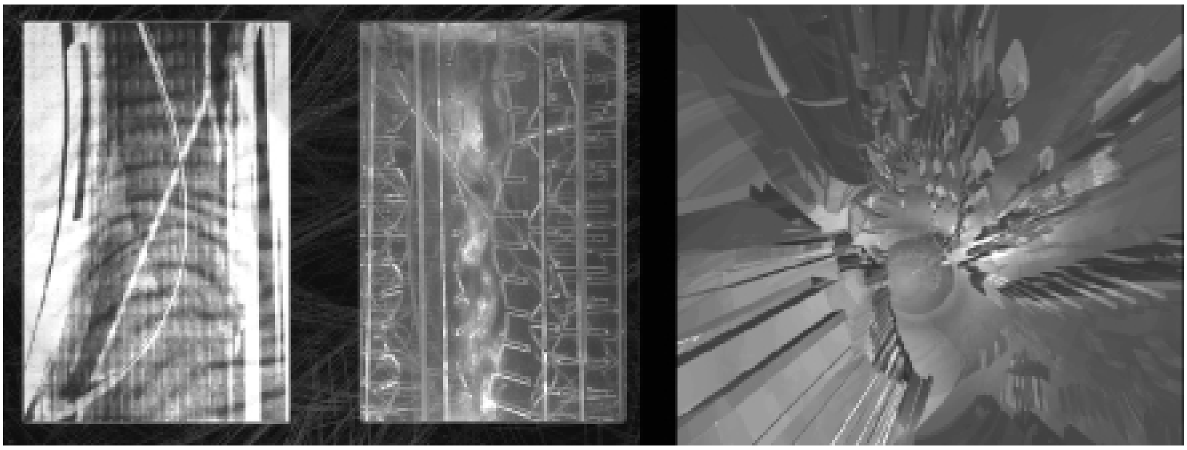

Fig 12: VORB3: Initial image sample. Physical model of polar (cylindrical) space. Digital model of polar space, looking down the centre axes. (Oslo School of Architecture IFID 1998.)

Anatomy of movement

Later VORB workshops investigated the possibilities to produce geometries that where derived from captured motion forms with the assumption that such geometries would be suitable for inhabitation by similar related motions, a form of advanced *body-reflection*. This was done in the scale of the body and in the scale of the interior. The first example was based on graphical manipulation and processing of both video and still images of staged movement.[19] (Fig. 13) Line geometries where derived through graphical filtering and manual tracing of construction lines. This approach stems from the studies of movement first initiated by Etienne-Jules Marrey.

[19] Conseptual Design , Oslo School of Architecture IFID 2000. Bergem Anne Lise, Heidi Devik Ekstrøm, Hanne Marte Holmøy, Heidi Susanne Leren

Fig 13: Conceptual Design 2000: Staged video used as To left, frames from video, actor with textile "body cursor". Below left, Physical model directly from the video frames. Top right, physical models derived from several series of graphically manipulated video frames. Below right: sketch of spatial divider / resting wall designed with the preceding models as input and templates. (Oslo School of Architecture IFID 2000.)

In the second example, a waiting lounge for a ferry company in Oslo, a particle animation simulating the main trajectory of the traffic through the space, was used to articulate the lounge into various zones of intensity from long term waiting to last minute arrival.[20] (Fig. 14) Areas of highest particle intensity where read as shortest-term use, like the route directly towards the ferry entrance. Lowest intensity areas where coded for longest term waiting like for people who want to take a nap while waiting for hours, similar as what often happens on airports. The space was organised in levels where the highest level was for longest term waiting, creating a "valley" for the fastest track leading directly to the ferry departure. The particle animation helped forming the level edges in a generic but articulated way assumable providing conditions for formation of temporal territories through inhabitation.

[20] VORB3 Oslo Scool of Architecture IFID 1998. Kristina Ruf.

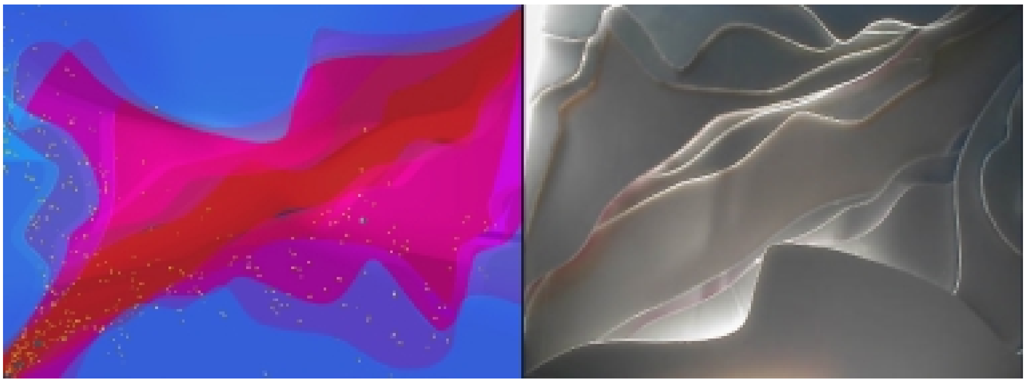

Fig 14: Conceptual Design 2000: Left, Plan view of digital model with particle animation and derived initial sketch of the waiting lounge. Since only one frame of particle animation is shown, the relation between the animation and the resulting form is not obvious on a still image. Right: Plan view of physical model with lighting beneath steps. (Oslo School of Architecture IFID 2000.)

Emergent Spaces

Resent work by OCEAN north[21] contributes to how the generative computer generated diagram can embody time through the appliance of animation techniques. The generative diagram unfolds over time through animation processes. This we call the *Dynamic Generative Diagram*.[22]

The unfolding of time-based sequences is inherent in program and hence in architecture. Such sequences operate in fields of parallelism (time), mutual influences complex relations. It is one of the most challenging tasks of the designers and architects to include these real life events into planning. One approach is based on prediction: simulations or qualified speculations and scenarios of real life events. But the weakness of this approach is that predictions frequently fail: the simulations and or speculations become too specific and the real life future can turn out to develop in a different and unexpected direction. The predictive approach, dealing with a complex system and the tuning of its parameters, is only relevant if the system and its parameters really succeed with its prediction. To cope with an open ended future where the parameters in the system could be exchanged or even the whole system could be replaced with another, leaving the parametric simulation or speculation as irrelevant, one has to develop equally open-ended strategies. One possibility is to move to a level above specific programming, where one only operates on generic content and where form is the framework for a long series of possible futures. Then one could test the systems ability to survive through series of parameter driven scenarios. These scenarios are not meant to predict any possible future, but only to test the systems ability to absorb unexpected futures. Therefore extreme and unlikely scenarios are as useful as the more realistic ones. (e.g. worst case and best case scenarios)

Generative techniques are inductive and explorative techniques. But frequently we see that they are mixed up with attempts to apply deductive logics. This is bound to end up with confusion. Instead of forcing generative processes into logics of parametric programs one could design on a structural level and only indicate a framework (repertoire) for program. This approach was suggested in the project Ambient Amplifier. Similar approaches have earlier been tested in smaller scale with *Extra Terrain* and

[21] http://www.ocean-north.net

[22] The use of animation in such a way has been suggested earlier.(Lynn 1998; Rakatansky 1998; Lynn 1999)

Intencities.[23] (Fig. 15) These are designs with a clear imagined "theme" of use but no defined program as such. Program is replaced with a repertoire of possible events, which will have their own programs but which will be defined first when these events take place or are in their planning phase. Detailed programming is a real time activity left to the user. These themes or repertoires are framing a limited number of normally related activities. When these themes and repertoires are defined one can use them as a framework for generative computer modelling. This approach avoids the specific and parametric details and leaves more to synthesising design intuition. The results are tested and negotiated towards detailed scenarios. The approach also allows for generative diagramming since there is no other logic forced into the diagrams than the formal compositional and geometric/structural and the relation to the initial loosely defined repertoire of possible events.

Fig 15: To the left: Intencities, urban installation that provided a long range of possible inhabitations where surfaces ambulate between on different vaguely indicated programmatic possibilities, e.g. transportation routes transformed into spectator stands. (OCEAN north 2000) To the right: Extra Terrain. A "furniture piece" consisting of a programmatically and typologically decoded surface. A device for resting the body, but which has no indication of typical use. (OCEAN Helsinki 1996)

The generative material can be applied to the diagrammatic field of forces to articulate it qualitatively in a similar way as landscape articulates travelling. But since form also is able to trigger program (to host, embed, "dock" and spin off events) the qualitative articulated treatment of form generates a seamless interrelation between form and program. The generic material introduces qualitative articulation to the program. It gives form to the forces and introduces therefore implications to the very core of design (giving form) and hence design creativity. From that position the generative material can be used for suggestive purposes, to modulate spatial "gestures" or potential events (actualities), to rehears triggering conditions, adaptability to unexpected events or uncontrolled scenarios.

Computer animation is the ultimate tool to produce large arrays of possible solutions in an "out of focus", disinterested and uncontrolled way. Since such arrays are sequential they can be remapped and recoded in systems where the linearity of time is manipulated through superimposing, reversal, scratching, merging, collapse, and the separation of sequence from time and duration.

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[23] Extra Terrain credits: OCEAN Helsinki 1996 Markus Homstén, Kivi Sotamaa.
Intencities @ Artgenda 2000 credits: OCEAN north Architecture. Juha Fiilin Multimedia Design. Katastro.fi Multimedia Design. Janne Räisänen Fine Arts. Klaus Haapaniemi Graphic Design. Gruppen Fyra Choreography & Dance. Placebo Effects Oslo Rendering and Animations. Helsinki International Production Office.

Summary
Generative Diagramming contributes to produce complex geometries derived form site information and deformed by site-specific forces or introduced information. These geometries when negotiated towards real life situations produce spaces, which are adaptable, flexible and programmable, yet articulated and rich.
This type of flexibility comes from the richness of these spaces.

Since the computer (in such a process) is an engine for the production of the unanticipated the designer's attention is moved from production to preparation and postproduction, which means decoding and coding (projection). To use the computer this way implies an intimate human-machine relation since the result is only unanticipated in context. The human's role is to be the "un-anticipator".

The generative diagram, which initially only deals with generic structural information, is implemented through interpretation regarding the specific context. Human sense (meaning, culture, program) is thereby projected to the material, which injects content to generative form.[24] Though projection is increasingly important compared to a "traditional" (internal self-centric) design process, the designer is by no means removed from production. But the production process is altered and in stages separated from projection. The designer is in phases obliged into a state of disinterest and detachment, operating the parameters of the processes rather than being the process engine him or her self. [25]

The diagrams role in the creative process is to give resistance to the obvious. Eisenmann described this as overcoming the motivated where the diagram is to act as a resistant agent to *"...separate form from function, form from meaning and architect from the process of design."* (Eisenman) p. 214

Allen, S. (1999). Points + Lines. New York, Princeton Architectural Press.
Arnheim, R. (1969). Visual Thinking. Berkley, University of California Press.
Eisenman, P. (1999). Diagram Diaries. New York, UNIVERSE.
Lynn, G. (1998). Fold, bodies & blobs. Collected essays.
Lynn, G. (1999). Animate Form. New York, Princeton Architectural Press.
Massumi, B. (1998). Line Parable for the Virtual (On the Superiority of the Analog).
Beckmann J. The Virtual Dimension Princeton Architectural Press.
Rakatansky, M. (1998). "Motivations of Animation." Any **23**: 50-57.
Sternberg, R. J., Ed. (1999). Handbook of Creativity. Cambridge, Cambridge University Press.

[24] Though meaning is already present since the designer introduces a priory and intention-driven selection through the choice of technology, design of process and selection of parameters.
[25] Disinterest and personal detachment to the process of creativity connects on one side to ethics of science (CUDOS) on the other to certain movements in art. See also Eisenmann: *My use of the diagram proposed a different rationale, one that could be both more logical and more involved with a process of architecture somewhat distant from the design process of the traditional author-architect.* (Eisenman 1999) page 49