

Kas Oosterhuis

Hyperbodies

Towards An E-motive Architecture

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Architects and their extended brains have the potential to be the idiot savants of today. Struck by an article in the Scientific American about idiot savants you suddenly realize that the idiot savant is exactly what the number-crunching personal computer is to the architect of today. An idiot savant is a person who is mentally retarded but at the same time displays remarkable capabilities in a specific but restricted field of knowledge. Some of these narrow-band geniuses can for example remember every single telephone number of a complete telephone book. Some of them can reproduce the complete contents of a Shakespeare novel, but without any understanding of what it is about. They seem to have direct access to the databases in their brains. But without the filters of insight which intelligent people are so proud of having. That project database is both inside your head, inside computers, and in the brains of other people carrying relevant data on the project. The exciting essay on idiot savants in SA has implications for the understanding of our brains, and for the understanding of how the architect works with computers. An architect these days creates his/her own personal interface for direct access to the project database, in order to be able to work in a process of collaborative design. [S]he must work fast, exact and above all intuitive. A well trained intuition is desperately needed to be able to decide in split seconds, like the Formula 1 driver. **The architect in society today is a well-trained hyperconscious idiot savant.** Today's architect is an information architect, able to act intuitively and to process rationally at the same time. The information architect of the 21st century combines hyperindividualistic selfexpression with a hypercollaborative approach.

The truly innovative architect designs for an open source swarm architecture in realtime. Building components are potential senders and receivers of information in realtime, exchanging data, processing incoming data, and proposing new configurations as the outcome of the process. People communicate. Buildings communicate. People communicate.

with people. People communicate with buildings. Buildings communicate with buildings. Building components communicate with other building components. All are members of the swarm, members of the hive. You must face it, buildings are subject to the digital revolution, and you must work with it. The innovative architect is not afraid of new technologies, but plays with the unheard of potential of the new media invading the built environment. The innovative architect naturally investigates and practices architecture as a realtime transaction space, as a process in realtime. **Swarm architecture is a true transarchitecture since it builds new transaction spaces.** Swarm architecture is at the same time e-motive, transactive, interactive and collaborative. Swarm architecture feeds on data generated by social transactions, swarm architecture is the hive mind of the new transformation economy. Swarm architecture is design, construct and operate in realtime. Architecture becomes the discipline of building transactions. That is what architects do, they build transaction spaces. Architects are step by step becoming conscious of the fact that they are the designers of intelligent vehicles, executing a game of life and death. Architecture no longer has the hidden agenda to resist to external and internal forces. Architecture becomes the science of fluid dynamic structures and environments running in realtime. Architecture goes wild. In the meantime the other stakeholders in the collaborative design process are experiencing the coming-out of swarm architecture. Swarm architecture manifests itself as the inevitable evolution of architecture and the building industry. The innovative architect applies swarm theory into the very fabric of society.



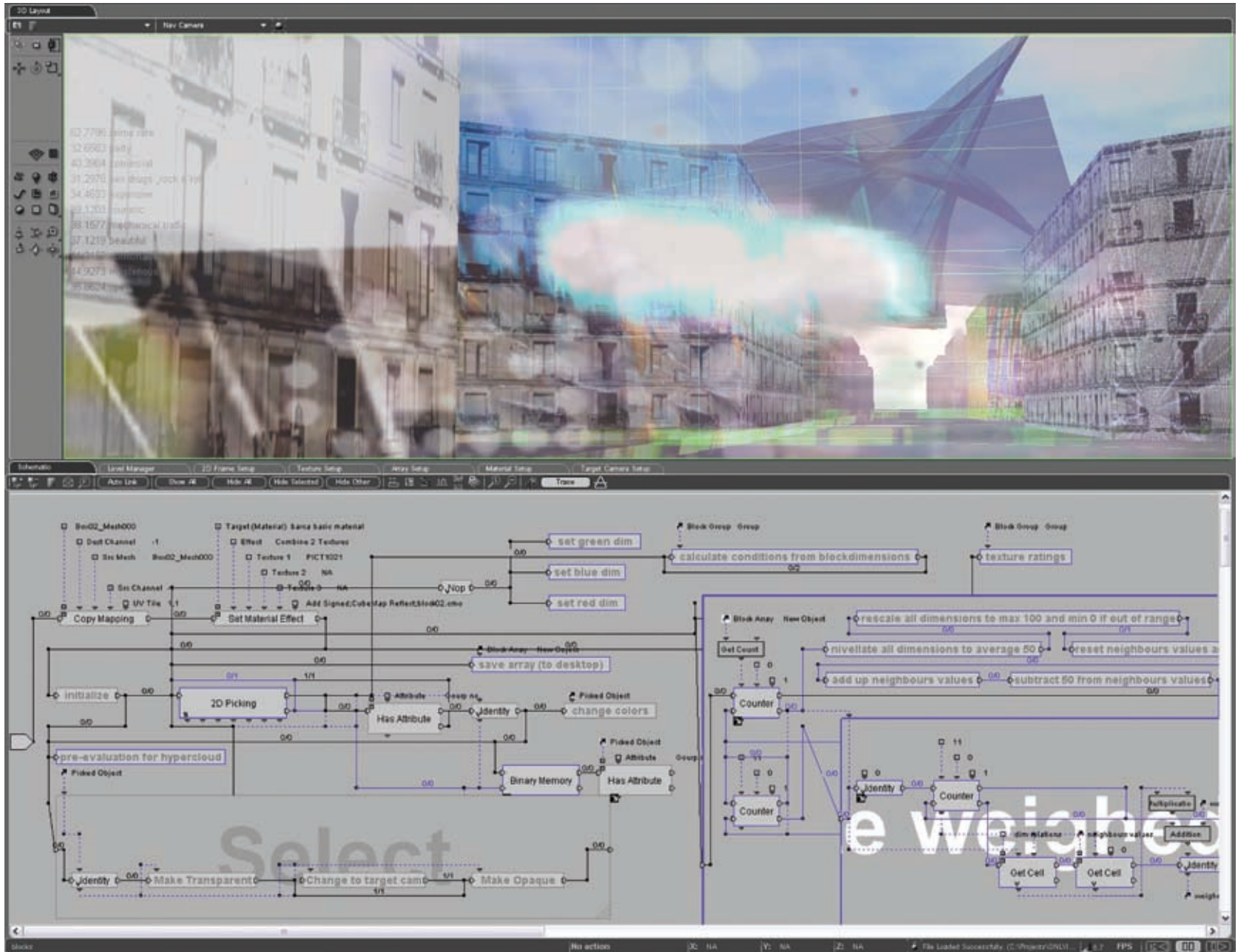
New Babylon [Constant 1974] Hyperarchitecture. New Babylon is the ultimate

hypercity of the seventies. Central in Constant's view on the possible future culture of New Babylon is that the bourgeois society is more threatened by creative acts than by a demonstrative complaint against a conservative establishment. In the hyperarchitecture of New Babylon, a city in a state of permanent transformation of atmospheres, technique and materials, the nomadic citizen – the gypsy – never returns to the same place. Simply because there is no same place at any time. If the city-gypsy returns after months of intuitive navigation through the endless structures of New Babylon the place where [s]he started from may have changed completely, both in software as in hardware. New Babylon is a huge kinetic structure operating in a true transformation economy.

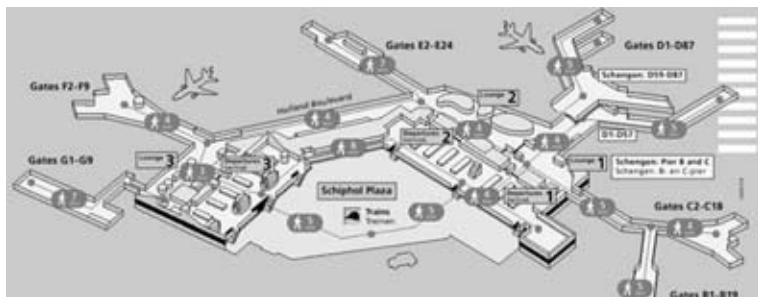
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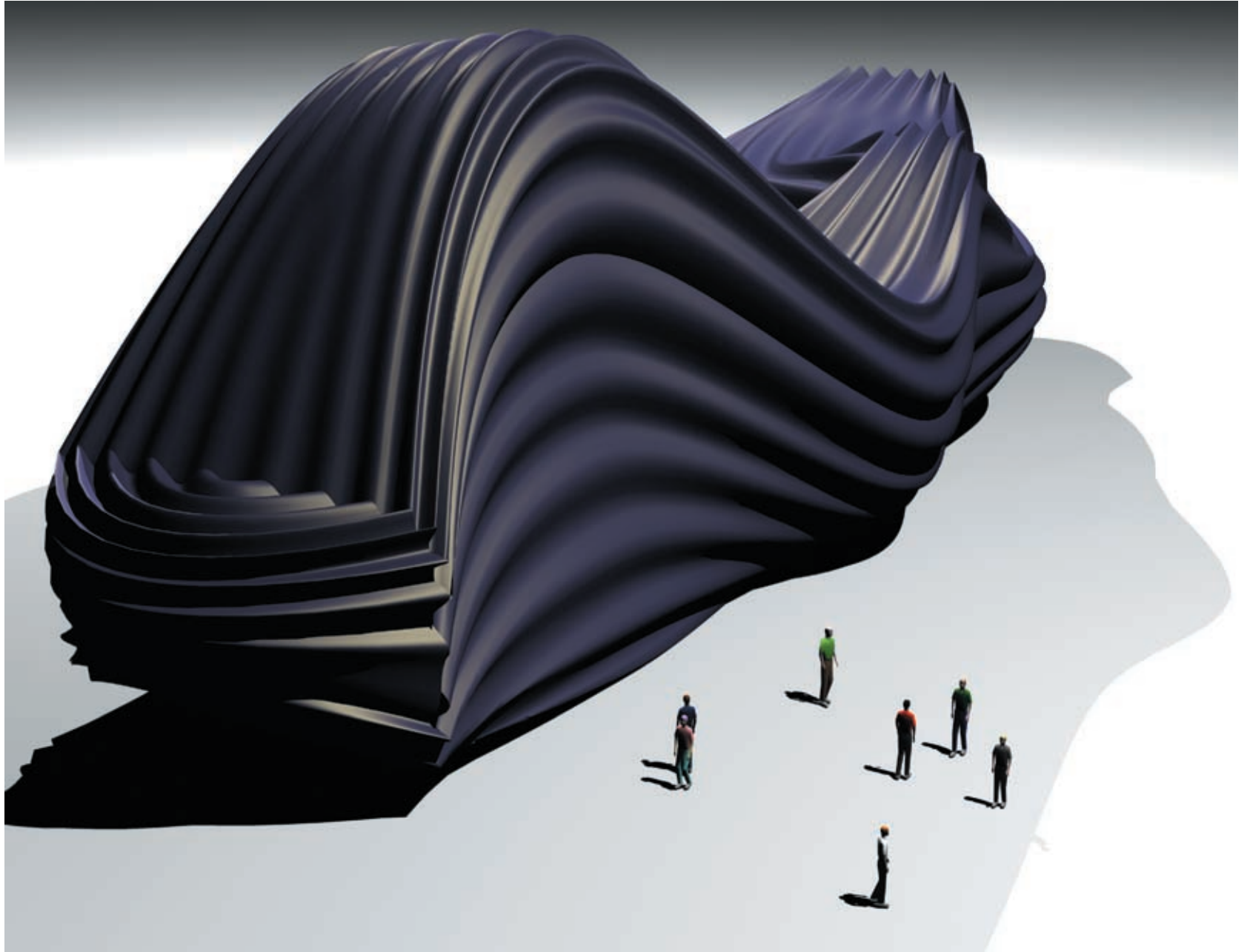
The Architect's New Data-driven Practice

In the architect's new practice students and staff give meaning to interaction in architecture and planning. They use game development programmes to build the transaction spaces for architecture and city planning. Time is spent to develop the theory and the practice of a true e-motive architecture. Research is based on the will to weave actual technologies into the daily practice. A student and a professional must spend sufficient time on the hands-on research of new building processes. They must experiment with new elastic materials. Do not think of alchemizing different materials in a traditional clash of materials, but think of experimenting with production processes, and with the file to factory process. Establish a hotline between your 3d models and the production in metal, glass and concrete, or use 3d printers for the development of three-dimensional skins. Architectonic research must be neither futuristic nor academical. Always aim at implementing the results of the research within one or two years, maximum five years. Research must not be speculative, but based on immediate practical possibilities, not yet done before, but feasible right away. Regarding the issue of authorship, a strong belief in collaborative design and engineering will show the way ahead. Think of collaboration inside a practice between artists, architects and programmers, and collaboration between the practice and people from other disciplines like composers, graphic artists, construction engineers, publishers, installation engineers. Think of collaboration with clients and random passengers. Engineers in a state of collaboration communicate as direct as possible with the actual producers of the work. And they want to communicate with them on the peaks



of intuition and logic of all participants in the collaborative process. Collaborative design in realtime promises to be the way to raise the scientific level of architecture. Collaborative engineering works if the participants feel the communication flow connected to the other members of the swarm. Communication must be established on a digital platform where the work is based on parametric and genetic design principles. Based on scripts and formulas with a multitude of variables. Collaborative design and collaborative engineering works for you when all parties involved are stimulated to submit the best of their knowledge and experience.





is an inflatable sculpture that constructs language in realtime. It absorbs sounds from the local environment and from the [global] Internet, it instantly uses the sounds as nutritious samples for hungry computer programmes producing a complex soundscape. The sound is connected to the light, ParaSITE performs during nighttime what it learned that day. ParaSITE is an early attempt to accept that architectural bodies may need to develop an e-motive intelligence of their own. That intelligence is both intuitive and rational, seen from the point of view of the newly constructed body.

The Laboratory

The laboratory is the workshop where actual digital and analogue transactions take place. The laboratory basically can be anywhere. The laboratory is a distributed being. It is built up of many nodes in something similar to a neural network. Some of these nodes are on the Internet, some in your cellphone, some in your laptop. But other nodes can be so big that they wrap around you as to immerse you in sort of augmented reality. This kind of node could be a transaction space, a space for interaction with other professionals and amateurs alike. To facilitate the process of collaborative design and engineering we need to build rooms to support group design and group decision. We could call them hives. A fine example of such a hive is the proposed second life of the pavilion of the Web of North-Holland. In 2002 a delicate, but otherwise non-interactive propaganda vehicle for the Province of North-Holland, but after the closure of the Floriade a professional fieldlab at the Delft University of Technology where students plug into the hive mind with their laptops. The Web will then become a true transaction space. The space will facilitate and stimulate collaborative group design. Within the hive a variety of multi-actor and multi-player networks are established. Collaboration and transactions in the hive can only take place when there is an operational two-way interaction between the stakeholders, when all parties involved are active, and when all parties are willing to offer the best of their knowledge and intuition. **Transactions are done by submitting and retrieving data to and from the project database**, in any conceivable disguise, through any interface. Think of experiments with sensors, keyboards, numpads on mobile phones, GPS systems, speech recognition, mouse, joysticks, bitmap tracking as negotiating

components. Think of wireless gloves and headsets as long as they are not obtrusive for the freedom to move within the interaction space.



Cybernetic Light Tower of New York [Schoeffler 1986] Programmable Sound and Light. Give and take. The cybernetic tower of the hungarian-french artist Nicholas Schoeffler takes sound, light, temperature, wind and humidity from its immediate environment. The tower gives back movement, synthesized sound and dynamic light, in changing patterns as calculated by its brains. It responds through the architecture of the spatiodynamic tower. The performing tower is a pleasure to watch, it never repeats a specific pattern, it does not replay a fixed programme, but creates the programme in realtime. The tower is a performer, an urban actor. Art has in many ways preceded architecture. In the arts in the fifties and sixties dynamic and mobile constructs and atmospheres were prototyped, which are considered actual now in architecture. It can take many years before genetic information [in this case the realtime behaviour of structures] passes on from the prototype works of art works into the genetic code of the larger bodies of architecture. Once it has settled there, its evolutionary strength can be tested on the larger scale of complete cities.

Architectural Education Revisited

In the laboratory students and tutors alike collaborate with professionals from other institutes and with visionary entrepreneurs from practice. To facilitate the concept of collaborative engineering you must build a game, which is a form of open architecture in realtime. Think of an open source

architecture. It is extremely important that designers do not only talk about the process of collaborative engineering, but that you actually make it work. **You must work in the process, act in the flow.** First then you will see and feel how beautifully complex it is, and how precise and intuitive you must act and think. You must think as a programmer writing code. The designer must deal with simultaneous development of design and communication. The software used by the Hyperbody Research Group and the ONL practice is based on a graphic interface, like visual programming. Working with the Virtools software includes the design of the architectural environment and the structure of the communication process. **The mission of the modern architect is to design the rules of the game.** The process of interaction, communication and collaborative design is a parametric game. The designers start proposing the rules of the game, and then they play the game together with other stakeholders. Modern architects design their own designtools. The players experience the parametric game of architecture as a form of serious fun. The design is the formula, the playing of the game means setting the parameters. The players realize - by connecting the 3d model of the architectural design to the database [tables, arrays] in realtime - that architecture is not an arbitrarily frozen choice of a running process. You realize that you are surrounded by a multitude of possible architectonic outcomes, which all are just as valid and beautiful as any of the other configurations. **The group design room is the ultimate vehicle for direct democracy.** Here you connect directly to the people you work for and you work with. Not only experts are among the participators in the process of direct democracy, but especially our clients, our fellow citizens, our friends, maybe also accidental users and blank-minded passengers. Everyone becomes a possible player in the transaction space, either consciously as a participator in the designprocess, or unconsciously as a passenger whose presence matters for the realtime behaviour of the swarm architecture. Architecture students must experiment with the art of collaborative design to prepare themselves for better positions in the active hive of the building society. To prepare themselves for their roles as the architectonic stage designer and game designer in a complex and fascinating practice in the transformation economy.



ParaSCAPE [ONL 1997] Sweet Spot. The ParaSCAPE project aims at constructing an until then unknown hybrid of sculpture, instrument and landscape. ParaSCAPE is a crystallized landscape, shaped in a maelstrom of poured concrete and bodily gesture of the hand of the designer, capable of processing incoming sounds, and sensitive to user input through the sweet spot on top of the sculptural vortex. The activated ParaSCAPE triggers waves of travelling lights through the lawn between ParaSCAPE and the new Mosque at the opposite side of the Strip. The processes of ParaSCAPE are running in realtime. ParaSCAPE is an alien body. People in the streets recognize a new identity, an character of unknown origin, and they experiment communicating with it. They dance on the sweet spot as to create new light patterns and new soundscapes coming from deep within. People prepare for communication with the alien, and they will name it. Then the alien body of ParaSCAPE is accepted by the community as an active member of society.

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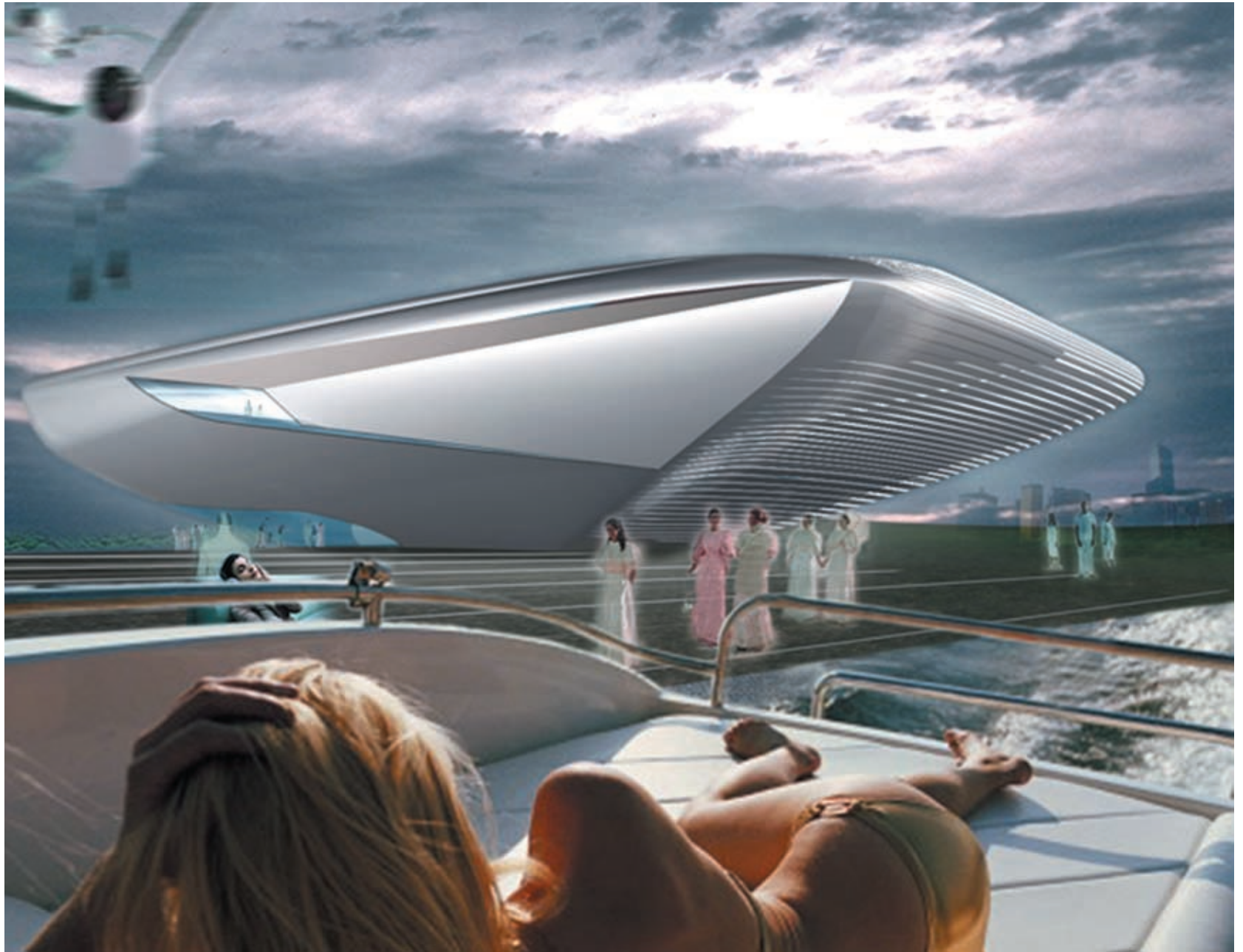
Building Bodies

Back in the seventies and eighties of the 20th century the art of prefabrication reached it's summit. Advanced office buildings were conceived like unibodies. Prefabrication is precise, fast and accurate. One must develop the important details from the very beginning of the designprocess. A good example of a building body designed in the late eighties based on customized prefabrication is the BRN Catering headquarters [Kas Oosterhuis and Peter J Gerssen 1987]. At first glance a simple black box. But at closer inspection it reveals it's intelligence: effective in detail, smart climate control, extremely energy conscious. The design of the machinery inside refers to the motorblock. That piece of machinery is not put on top of the roof as usual but placed in the pulsating heart of the building. Usual practice for cars, but exceptional for buildings. This attitude provokes the idea of a building as a complex



integrity. The concept of a building as an unibody, as an input-output device. As a structure that is synthetically conceived as a complex whole. These synthetic buildings represent the exact opposite of the then upcoming deconstructivist's attitude. It is here at the end of the eighties that a firm basis was laid for the notion of building bodies. The building body is a vectorial body, shaped by interior and exterior vectors. The vectors act as multiple forces working upon that body. From the inside out and from the outside inward. **The building body is a wellbalanced structural integrity.** And that building body needs a skin. An exterior skin and an interior skin. Basically exterior skin and interior skin must be seen as a continuum. There is a change of climate rather than an opposition between inside and outside. **Windows are warpholes where the exterior skin folds back into the interior.** Doors are cuttings out of the skin. Like the mouth in the animal's head. Nothing obstructs the continuity. To view buildings as building bodies changes the way one looks at built products. Architects no longer deal with the repetitive catalogue style of the fifties, assembling buildings from the bit's and pieces following the rules of linear industrial production methods. These days mass-production is no longer the rule. Nowadays mass-customization is the a most viable production method. In the process of mass-customization series of unique elements are produced. Series of unique building parts, put together to form the unique unibody, the synthetic building body. A building body can only go hyper if it has a consistent body in the first place, carrying and processing the information flow.

Building Bodies [ONL 1995 - 2003] Mass Customization. A building body is a complex integrated system of customized building elements. Body building is the act of building consistent metabolist unibodies. The building body is a vectorial input > output device, shaped by interior and exterior vectors. The vectors act as multiple forces working upon that body, from the inside out and from the outside inward. The building body is a complex system of customized building elements. The concept of the building body is opposed to the idea of the bits and pieces form the fifties and sixties. The building body does not use prefabricated elements from the building catalogue. The structural components of the building body are made especially for that specific body. They may have been mass-customized, but never mass-produced. While the old process of mass-production aims at producing many of the same elements [and hope for future absorption by



the market], while the process of mass-customization aims at producing unique elements applying data driven production methods. Building bodies designed and produced according to the rules of customization are more intelligent than the building collages of mass-produced building materials. Building bodies are synthetic, integrated and unique.

8

Data Carriers

You hear, see, smell, feel, taste, you process the information in your brains and other organs. The processing of the information lead to the productio of images and sounds, and you put other processed matter into the world. People are metabolists by nature. Information is always subject to a continuous process of transformation. In that process there are many moments that the information travels from one processing unit towards the other. Information may be sent through wires, or may carried by a vehicle. People are such datacarriers. Imagine a somewhat more complex situation where you find yourself in in daily life. When youy drive a car, the car carries information in the form of the luggage and in the form of yourself as the driver. At the same time the driver of the car carries both the information that [s]he embodies as the information that [s]he processes in real time. The information produced during the process of driving a car consists of signals sent out by the car to other vehicles: speed, direction, indicator, backlights, headlamps, sound of the claxon. The information carried may be uploaded or downloaded upon arrival. Information just keeps flowing and traveling. Information never stops to be processed. **It is productive to imagine buildings and other products as running processes in realtime.** And humans are part of that process. They trigger things, they catalyse, they vectorize, they open doors, they close windows. They are the switches themselves. Now if one applies this notion of information processing to buildings and architecture, then think of buildings, which are continually absorbing information, processing information and producing new information. None of these building bodies are isolated processing machines under any circumstance. They are all connected through the information flow. Connected to each other in the city, connected to the world through the Internet, connected to the users through the user's interfaces. The light switches, the doors, the windows, the computers, the television

set, the seats, the stairs, basically everything, which the user touches, is continuously displaced, changed and transformed. All processes run by buildings, products and users together play a key evolutionary role in the worldwide process of the formation and transformation of information.

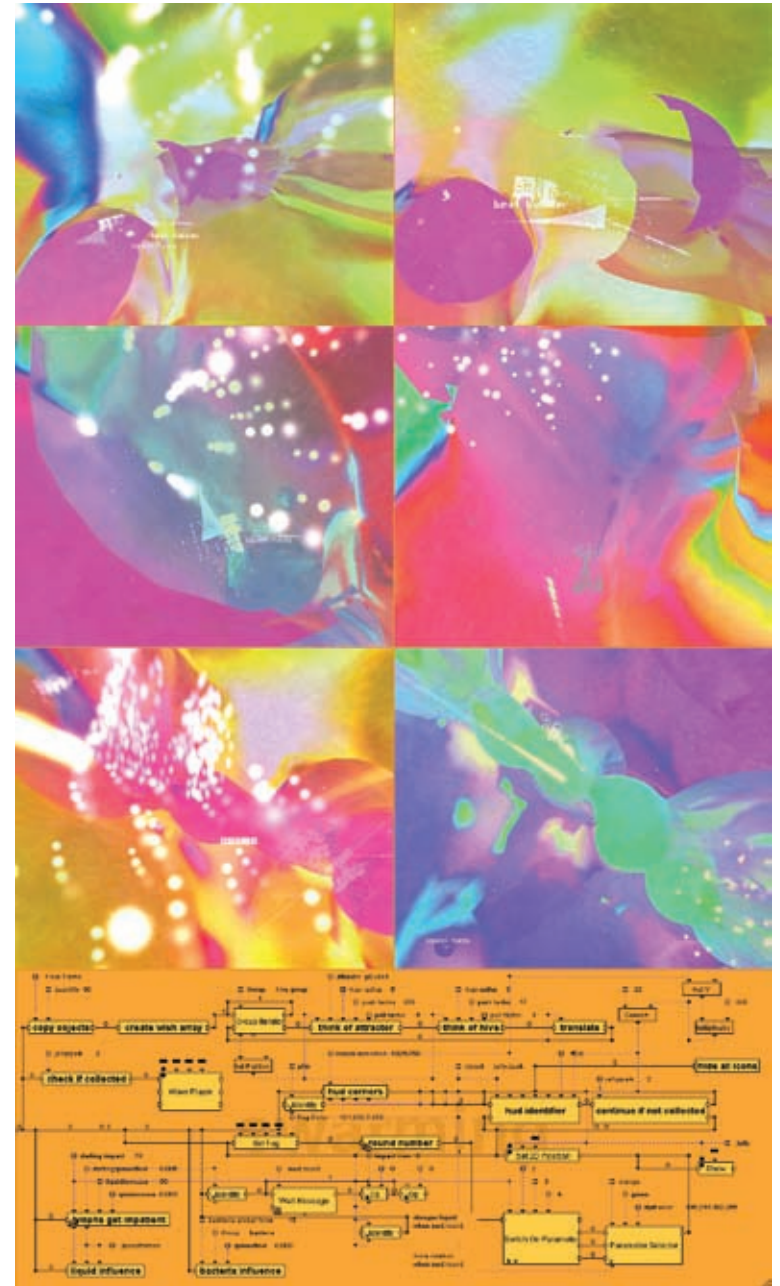
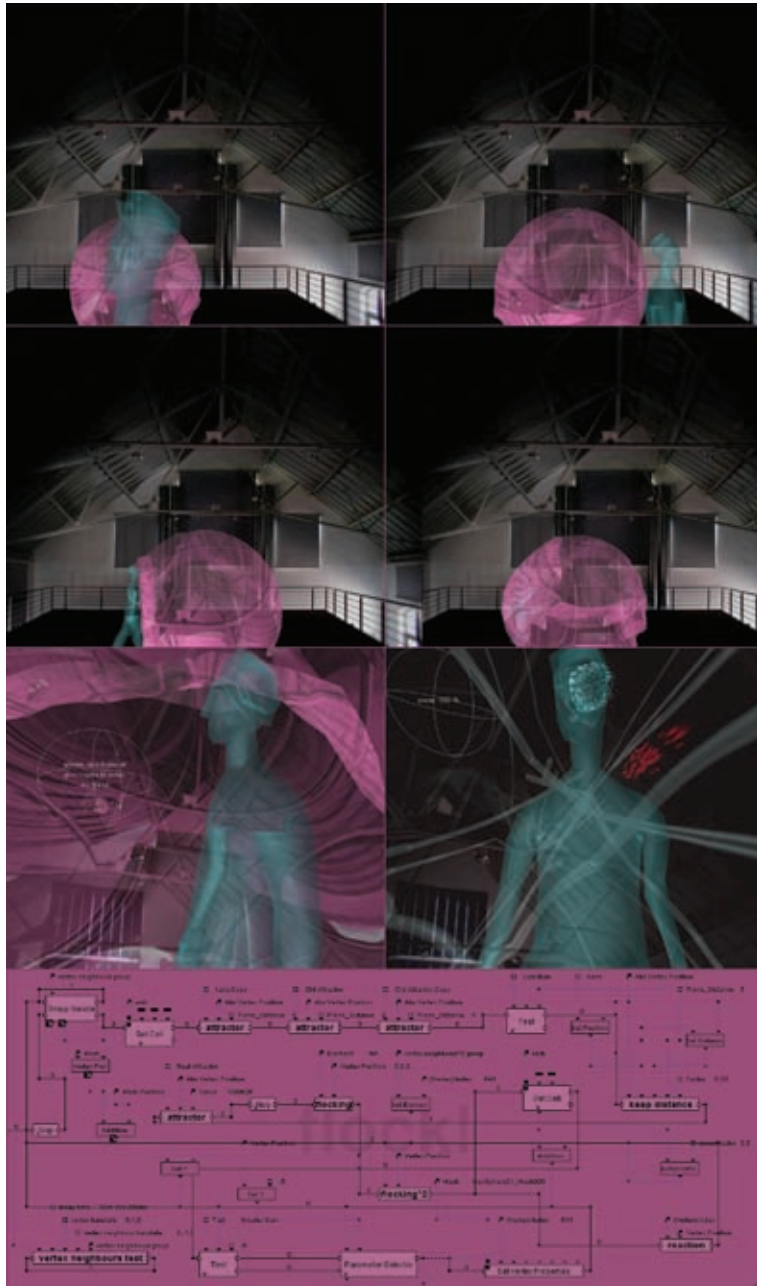


TT Monument [ONL 2002] File to Factory. One work of art, one detail. The complexity of the TT Monument is in the surface, not in the number of different elements put together. The TT Monument is one continuous surface, one material, and hence one parametric detail. To practice parametric design is absolute compulsory for a successful file to factory process of executing the built projects. One must directly connect the 3d model of the design to the production techniques in the factory. Machine to machine communication, from the PC design machine to the production machine. For the production process of the TT Monument a Nurbs surface 3d model was made and sent in the disguise of an IGES file to the milling machine of the modelmaker. The connection relies on a common language, which is spoken by the machines at both ends, the PC of the designer and the cutting machine of the producer. Direct and unfiltered shortcuts are needed. The machine reads and the file and executes the script like an idiot savant.

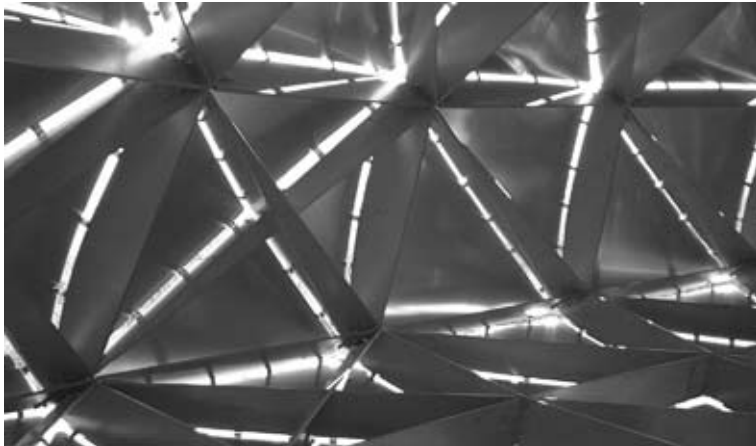
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InformationTheory

Information has the intriguing tendency to enhance it's complexity. **Scientists observe an universal evolution from pure energy [the intial stage of our universe] towards pure information [the final stage of our universe].** And the good news is that the humans, simply by performing all the operations which they perform daily, contribute to that evolution. They assist in the inventions of ever greater complexities, they assist in the conversion of material from their raw information states into products representing a much higher state of information. People are so lucky to catalyse the increase of the information coëfficient of the world around us. Life is rewarding. There



is an increasing awareness of the importance to build new theories on the nature of information. Some scientists [Stephen Hawking] speculate **that all matter and energy may be described as a specific state of information.** Other scientists [Tom Stonier] go one step further and propose the existence of infons. Infons are information particles, which are essentially different from electrons and protons. The introduction of infons opens up a new non-materialistic view on the microcosmos and the macrososmos alike. Tom Stonier illustrates his view by looking at the electronic billboards on Times Square. One experiences waves of information, but when it comes down to describing the process in the behaviour of electrons and protons the billboards do not change when the information content changes. **Hence it is obvious that there are waves of information propagated through the system.** Stonier proposes convincingly that similar waves of information flood through the universe. And he states that in the evolution of the universe people are experiencing and developing [that is as seen from our arbitrary human point of view, that's why I prefer to say that we humans are assisting in the development] ever higher complexities of information content. Life is a thriller.



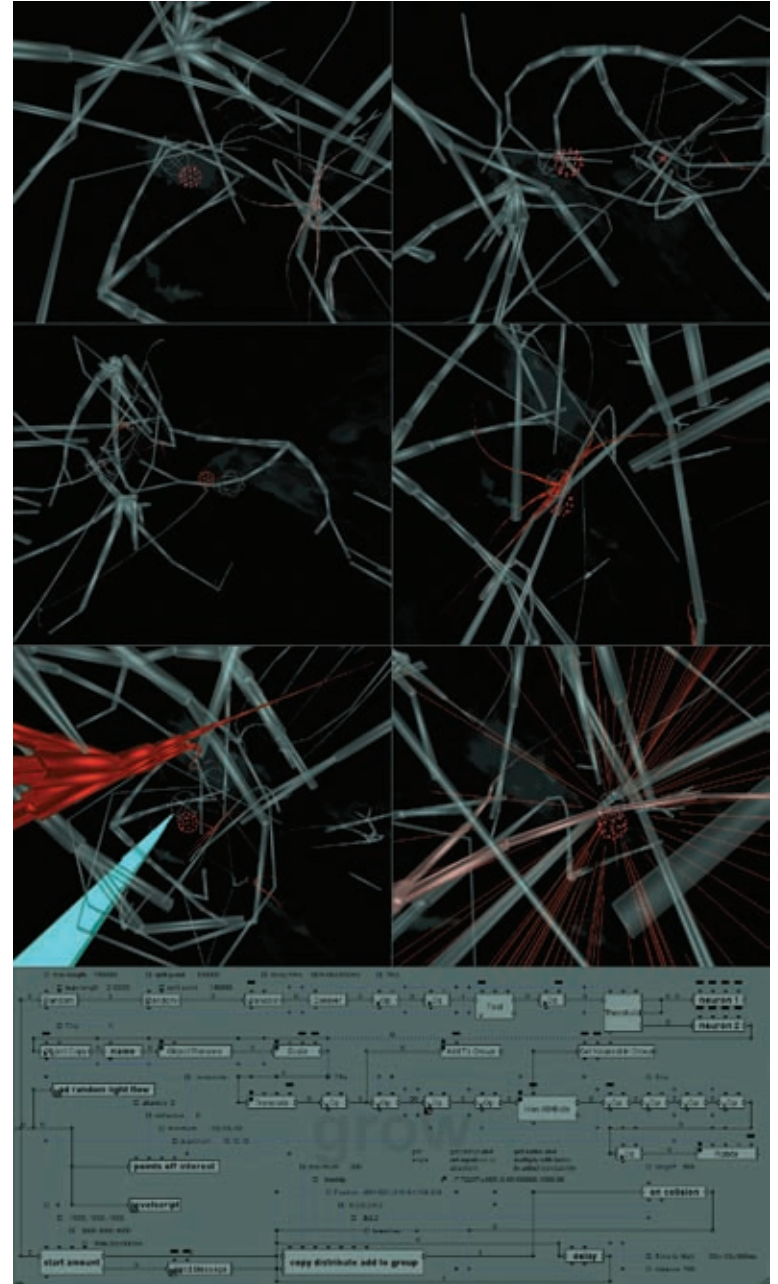
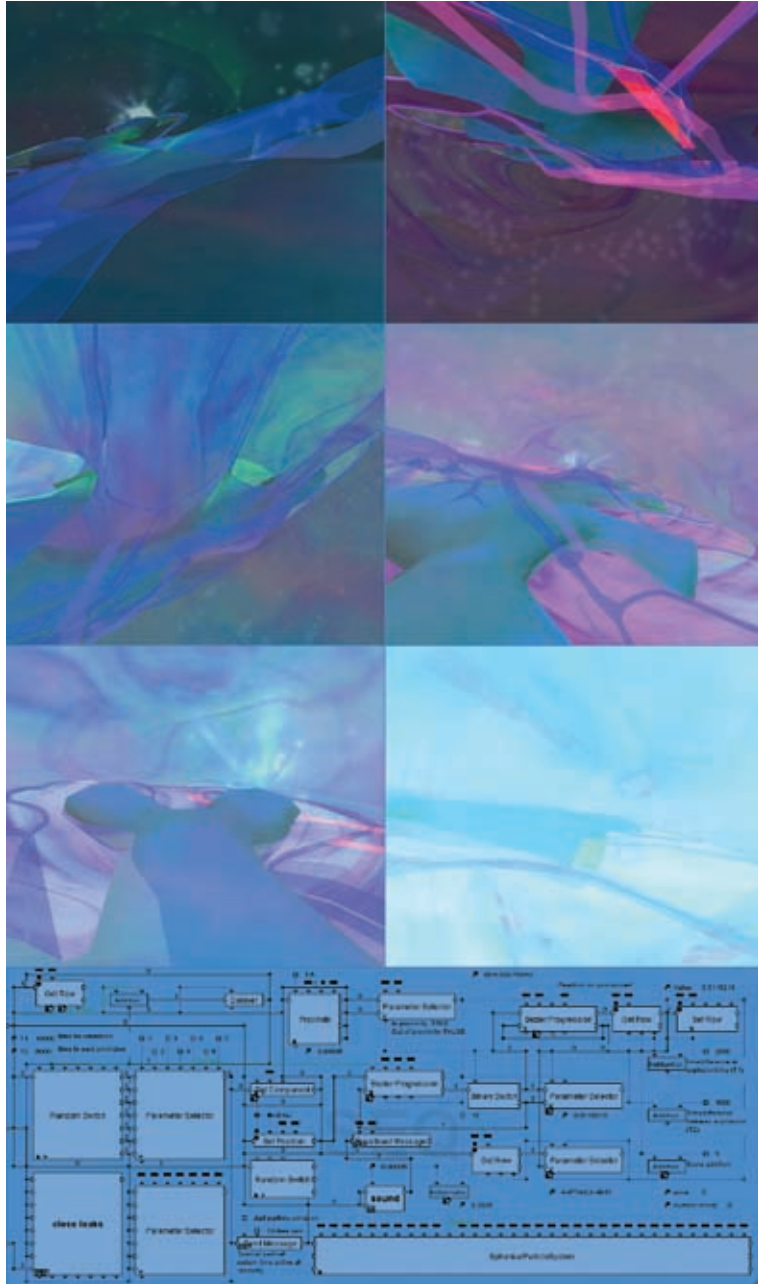
WEB of North-Holland [ONL 2002] One Building One Detail Mies is Too Much. Traditional buildings tend to have many different details. Minimalist architecture aims at reducing the number of details. Reduction of the number of details gives space for concentration on the quality of the relatively small number

of details. Less is more. Less details gives more quality was the obvious aim of Mies van der Rohe. But let's face it: Mies is too much. Too many details. Suppose the building body knows only one detail. In order to intelligently deal with a variety of situations, that single detail must be parametric. For the production of the Web of North-Holland an exact procedure was written how to pick up the separate elements from the 3d model and prepare them for the production with the steel cutting machines. An Autolisp routine describes the exact procedure in a few lines of code. One parametric detail fits all. One building, one detail. In the data-driven file to factory process of mass-customization each element is unique, but each element is subject to the same procedure but using different values for the coordinates of the vertexes, for the rotation angles, and for the width of the steel plates. In the customized production all unique elements are numbered. The elements are assembled onsite according to a similar straightforward procedure of how and in which order to put them together.

10

Input > output Devices

Buildings are input-output machines. Living organisms, industrial products, and digital machines alike are input-output machines. You are like that, every single household appliance is like that, a computer is like that, all buildings are like that. There is always some mass of material or information that is eaten, absorbed, infused or downloaded by any of these information-processing machines. And all of these machines change the nature of the stuff that went into their bodies. A gas that enters a car is expelled as heat and carbon dioxide. Water that enters a building may be used by the installation for flushing the toilets, or it may be consumed by the inhabitants. People entering buildings are changed too. **No one leaves a building as the same person that entered the building.** Think of what has really happened between that moment of entering a building and leaving it. How do people exchange information with our environments? What does one actually process? The heat from radiators enters our human bodies, the artificial light comes into the brains through the eyes, people leave traces of their skin when touching a light switch. People hear [input], people think [process] and people speak [output]. That is transformation of information from person to person, taking place inside a building body. This makes it obvious that the nature of the information, which enters the building body, is subject to a continuous change. It is converted in realtime into other states of information, mostly



into lower forms of information when it is simply consumed. But intentionally by constructive effort [although improbable according to the second law of thermodynamics] it is converted into higher forms of information as well. New things are put together, surprising new combinations are made, inventive new brainwaves come out of the transaction process. **The designer of the 21st century is hyperconscious of the fact all architectural places are basically transaction spaces.** [S]he knows the information flow, and [s]he gives shape to it. **The designer is a stylist of all the flux through the building body.** However the modern designer is more than that. [S]he also gives shape to all the flux of the physical building body itself. The designer shapes that building body that eventually will change shape and content in realtime.



Folds in Car Bodies E-motive Styling. Consider the fold in the car body and the fold in the building body of the WEB of North-Holland. These folds are formed by parametric transformations from a single set of algorithms [created through surface modeling in the computer]. Describing the fold the formula for the surface remains the same, only the parameters change along the fold. The input values for the handles on the vertex change. The input values for the angle folding the two sides of the surface vary. Great folds slowly appear and gradually die out.

If the fold would have a continuous angle and would show no transformation along its course from one side to the other it is not a fold, but a buckle. It is not allowed to change the nature of the material at the other side of the fold. Both the 3d surface model and the applied material where the folds acts upon must be a single parametric continuity. Folding techniques are successfully tested in natural bodies and have found their way through automotive styling of consumer products to the e-motive styling of large programmable time-based building bodies. Parametric building bodies are designed to produce the fold from their genetic codes. These parametric folds of the building body have no relation to the mathematical construct of folds Deleuze is referring to.

11

Information Flow

Picture the flow of data flooding towards the idiot savant. Paraphrasing the native hungarian american psychologist Mihály Csikszentmihályi the idiot savants must be in flow when establishing the hotline between their brains and their output devices [mouth to speech, hands to paintbrush]. **People in flow are happy people.** Because there is no barrier between their brains and their body. They experience their own body and brains as one unity, as one undivided unibody, without having doubt about the rightness of things. How does this concept of flow apply to architects? These days the modern designer uses animation and game programmes [Maya, Virtools] to bring the projects into a state of flow. They set up processes in the design phase as to generate geometries and behaviours. Psychologically the state of flow is something that has no boundaries in time. One would want it to go on forever. And idiot savants can do that. They keep memorizing the data, without hesitation, endlessly. Once the drain is established, once the shortcut is made, they just have to let go. And how difficult it is to stop. And how subversive of the architect to freeze the flow and stop the process. The often heard excuse is that the architecture that needs to stand, that it needs to be built solid. Architecture is seen by traditional architects, who are not familiar with the new paradigm of time-based architecture, as the art of making static objects. Suppose that this is no longer the case. Suppose society is heading for an architecture that is basically dynamic. Suppose architects are designing for the era of time-based architecture. Then you would not stop the flow. You would let go. **You would want to be a hyperconscious**

idiot savant, connecting directly to your project databases in realtime. And you would find ways to continue the process into the life of the constructs themselves. You would run the process of a programmable architecture.



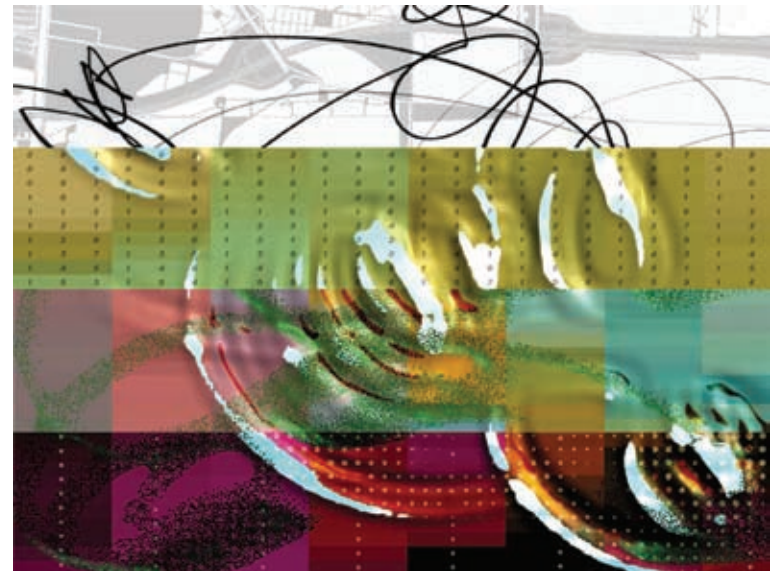
ADA Space [ETH Zürich 2002] Sensory Space with Brains. The visitors stepping into the interactive ADA Space are identified using the visual tracking system and the sensorial floor tiles. Each visitor that enters the interaction space is given a unique ID number. The bitmaptracking devices monitor patterns of groups of people. Lights within the active floor tiles, light fingers projected in the room, and sounds created by the Roboser programme respond to the movements of the visitors. ADA will give cues to the visitors as to lure them into certain positions in the space. Space and people are playing a game together. ADA uses her advanced neural network to process her responses in realtime. ADA is the most intelligent physical space operational so far. ADA is a space that is a brain. Visitors walk in the brain. Techniques and experiences as developed by ADA are the evolutionary predecessors for developing complex adaptive systems for the e-motive architecture of the hyperbody.

12

Direct Access to the Project Data

Direct access seems to be equivalent to the list function in programmes like Autocad. It is an open tunnel to a table containing all registered data. In human brains these data come in through the eye, the ear, the nose. Everything is recorded somehow and somewhere, but normally we can remember only a fraction of it. This is because we filter these data in order

to be able to behave socially. It would be very inconvenient if we could literally reproduce everything, which was stored in our brains. Reproducing the data would take a lot of time [you only live twice] and we would not have time left to interact socially, we would not be able to form a society. Have you ever seen those piles of paper, which the computer produces when listing a complex calculation? You do not want to read this, you may have a look at it to scan inconsistencies, but not for actual reading or understanding. **Having direct access to the project database is blocked for social reasons.** The shells around the database form the interface between database and environment. So is the case with computers. The operating systems, the computer programmes form shells around the project data, to make it possible for us humans to communicate with these data. To make it possible for us to give meaning to the data, to make interpretations, to propose changes, to produce new data and to have them sent back to the database. **These shells represent our social transaction space.**



Polynuclear Landscape [ONL 1998] Programmable Surface. In the process of e-motive architecture the designer aims at designing a building body displaying realtime behaviour. While the swarm of co-designers and co-users work in



realtime both during the design process and in the life-cycle of the building body, the process never stops and leads to a mature time-based architecture. The identity of the 3d model in the collaborative design game jumps from the design process right into the life-cycle. The Polynuclear Landscape is a design for a process of the next 25 years for Almere-West. Step 1: The landscape is formed by a computercontrolled digging machines following the path of the polynuclear sketch. The path may be adjusted during execution. Step 2: The site is regarded as a vast database of 320 lots. Each lot is flagged with a number of parametric values, which change in realtime, responsive to micro- and macro-economic developments. One of the rules is that neighbouring lots may not be owned by the same entrepreneur. Step 3: The landscape crystallizes from the top of the newly created hilltops down to the valleys. The overall scheme is based on a ground-balance. The built form is the hard aggregation of the soft landscape, like ice is the freezeed aggregation form of water. Step 4: The database is permanently activated over 25 years and generates exponentially multiplied differences in the developments of the 320 lots. After 25 years Almere-West is a complex new landscape with over 100.000 people in a rich environment with no apparent repetition at all. Thanks to the realtime parametric design concept, based on a simple set of rules inscripted in the genetic code of the city/land-scape.

13

Distributed Being

What is the nature of a project database? Brian Eno wrote a song titled Distributed Being [from the album Nerve Net, with Robert Fripp 1992]. That is exactly what a project database is, or should be: a distributed being. It is definitely not a large recycle bin like it is often depicted in diagrams and flowcharts. It is not a big passive box where you dump layer after layer of new data. **A project database is a being in evolution.** It is not a static thing, it transforms after each input. Many of these inputs are organized in realtime. Maybe not in the computer yet, but sure in the brains of the designer. These transformations are triggered by different actors, by different stakeholders in the design process. Parameters may be set by the clients, by external circumstances like the AEX index, by the experts, by the whimsical preferences of the architect, by a new piece of software, by passengers, by the changing circumstances of the weather. Or the parameters may be set by the absence of accurate knowledge, by a lack of adequate software tools or by the failure of a collaborative social structure. The project database as a distributed being is an entity, which develops according to vectorial forces from

within and from without. In which phase of development does a project starts to be a project? When is it recognized as a being? **What rights does the project have? Who owns the project data?** There is a possible solution to these questions. Suppose the juvenile project is not owned by anyone, but has a right to be of it's own. Suppose the project is not located at a fixed place in someone's head or computer, but consists of many scattered data linked to each other in realtime. Suppose these sets of data operate like the birds in a swarm. Like a network, like the brains. Always evolving sets of data, not controlled by anyone in particular, but by the will to stay in the swarm. Suppose all these sets of data evolve at an individual rate. None of these nodes of the network would evolve exactly in the same speed or direction. When that picture becomes clear, then you may start thinking of a project as a distributed being. **The designers do not own their projects, they assist in bringing them up.** Like the driver operates the car. Like the father and the mother raise their child. The designers and the other stakeholders feel responsible to do exactly that and collaborate with a multitude of resonating minds to make the best of it.



Variomatic [ONL 1999] Webbased Parametric Design. Where does the parametric 3d model live? In the PC of the designer, or on the Web? The Variomatic catalogue housing project offers a webbased design tool for the future client. Built in the game development software program Virtools the Variomatic house is presented as a 3d model on the Web. Interested clients use a 3d viewer on the webpage to check the house from all possible viewpoints. But there is more: the clients can make changes in the geometry in realtime. The clients become the co-designers of their house. After having played with the shapes and the materials mapped onto the geometry of their choice, the webbased clients can submit their choice. They do not submit the full geometry, but only the data needed to describe their particular configuration of the parametric 3d model. This is most effective for communication via the Web. Small packages of data can be sent efficiently, while the larger files of complete 3d models would take too much

time to be able to work in realtime. Each time the webbased Variomatic house is viewed and changed the client creates fresh new updates locally. While the formula of the Variomatic lives at the ONL domain, all possible configurations are built in the computers of the clients. The Variomatic is a multitude of homes. Variomatic is a distributed being.

14

Artificial Intuition

In your dreams you are allowed to have direct access to your personal image-bank. Just like seeing is an action in realtime, dreaming is an activity constructing storylines based on a vast database of images, relations, proportions, contours, colours, smells, texts, and other possible disguises of information. **Data are distributed in the brain, connected to events, stories and data exterior to the brain.** Deep down there is a generic process running, processing all information – images, texts and relations alike – into and from raw data in a dynamic experience database. In the early nineties, briefing the participants in the workshops Artificial Intuition in the Aedes Gallery in Berlin and at the Delft University of Technology [Ilona Lénárd and Kas Oosterhuis 1990] **the participants were encouraged to train their intuition in order to steer their logic.** Now it is understood that the brief of the workshop actually implied to construct direct access to distributed project databases, unfiltered, spontaneous, direct, actual. Spontaneous action establishes a hotline between intuition and logic, like idiot savants can do. Personal computers play a crucial role in this procedure. By spontaneous design actions you find routes to connect your intuition to the calculation speed of the computer.



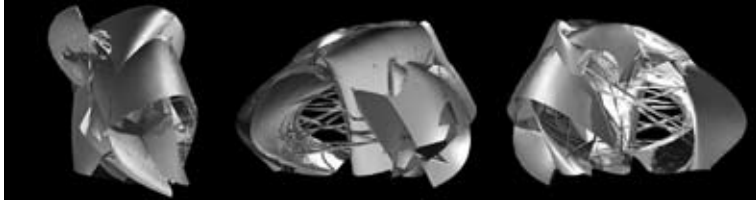
Saltwaterpavilion [ONL 1997] Realtime Behaviour. The essence of architecture is not the visual appearance as humans see it. The essence is in the genetic code. The genetic code of a building body is a set of rules and algorithms, animated

by the circumstantial parametric values placed into the formula's making up the genetic code. The visual appearance is the outcome of the process running the genetic script in a site-specific and time-specific environment. The genetic code of a building body with realtime behaviour is described in a script, a procedure, the process may be viewed in the form of a flowchart. The building body is seen as an input > processor > output device. The flowchart shows the dataflow coming in, it shows how it is processed, and what type of output is generated. The flowchart of the Saltwaterpavilion shows that the incoming raw data from the weather station on a buoy in the North Sea are interpreted by the MAX software into midi-signals steering the slidertables for the programmable fiberoptic lights and the soundsamples in realtime. The sensorial result is an unique streaming experience, together with an always unique soundscape generated in realtime, unpredictable like the weather. The interior of the Saltwaterpavilion is never the same, that's why it can not be experienced and analyzed through a static picture. It feels like living inside changing weather conditions. Body buildings with realtime behaviour are streaming bodies, to be experienced in realtime only, to be analyzed through process schemes.

15 Split Second

Training the intuition is topsport. A Formula 1 driver, a top tennis player, a soccer topscorer, they make decisions in split seconds. These decisions are way faster than thinking. What happens here in the brain? They must have these kind of hotlines also, these shortcuts between their motoric system and their Formula 1 database, tennis database, soccer database. Deep down in their brain all possible situations and actions are etched, and in a split second they choose for the right action. Faster than lightning, more precise than extensive calculations, astonishing concrete and absolute accurate. Being heavily involved in the actual design process, the top designer makes these split second decisions as well. **Good design is topsport.** And this sensitivity can be and must be trained. Like the way you can learn logic thinking, your intuition can be trained too. To allow yourself to act intuitively behind a computer device is a liberating process. You should allow yourself to have direct access to your distributed project databases. How can you as a designer do that? **Invent a process, run the process, jump right into the process and make your split second decisions.** Sculpt your information in realtime.





Data-driven Architecture [Marcos Novak 1998] Constructing the Alien. Marcos Novak describes his work as constructing the alien. The alien stands for something, which has not yet been there before. The alien represents the unknown. Think of the Black Monolith [A Space Odyssey 2001, Stanley Kubrick 1968] causing the evolutionary leap of apes into mankind. The apes are experiencing a strange phenomenon, built with edgy corners with an for them unknown technique, built from an yet unspecified material, radiating until then unknown syncopated wavelengths. The apes simply jump into another mode, they could not just ignore it, and they decide to develop language as an appropriate technique to deal with it. Compare the alien monolith with the data-driven constructs invented by Marcos Novak. This data-driven architecture communicates an intrinsic form of genetic integrity, they look unfamiliar and challenging at the same time. They trigger our imagination, they urge us to take an evolutionary leap in our understanding and appreciation of architecture.

16

PC Computation Power

Ray Kurzweil speculates that by the year 2050 one single personal computer may have the computing power of the total human population of the earth [Ray Kurzweil, The Age of Spiritual Machines 1999]. Just imagine! How will humans relate to these small but extremely powerful machines? How will you work with these super idiot savants? Finding ways of dealing with this extreme computing power is one the challenging issues, which our society is facing in the coming decades. You can bet on it that a well-trained intuition is an absolute requisite for a successful communicative relation between [wo]men and machine. Maybe **the only way is to develop ways to connect directly to the processes running in your powerful pc, and act like an idiot savant would.** It seems obvious that it is useless trying to compete with the calculation speed of the computer. You must see them as friendly open extensions to your brains (exo-brains), where you can have access to in the way you want it and when you desire to do so. Sometimes ultra fast,

sometimes very slow and filtered. Sometimes immediate like lightning and sometimes as blurred and fuzzy as can be. By the year 2050 the information content of architecture will have multiplied. **All building elements will behave like intelligent agents, they will know one another, they will know you.** And you will know them. Together with the architecture around you and in you, you will find new ways of dealing with the information flow. Even in the year 2003 many people are still worried about information overflow. **Don't. Information flow is like a warm deep sea of data engulfing your body and brains.** You will learn how to swim, you will learn how to enjoy the abundance and redundancy of the multitude of data flowing through the built environments. Like you would enjoy the richness of a rainforest. You do not know all the details, but the experience of the richness of the jungle is overwhelming and that feels good.



MUSCLE [ONL 2003] Programmable Building. Organic bodies have muscles to move the body over the surface of the earth, to fly in the sky, to swim in the water. Productbodies typically use explosion engines to move their bodies along scheduled paths along highways, through water and air. The building industry produces servomotors to move pumps, doors, sunscreens, windows, elevators. Buildings typically do not move themselves. Yet you are on the threshold of the era of programmable buildings. Programmable buildings can reconfigure themselves mentally and physically, probably without considering to completely displace themselves like the Walking City [Archigram 1964]. Programmable

buildings change shape by contracting and relaxing industrial muscles. The Festo company [www.festo.com] has developed programmable muscles and applies them in a programmable inflatable structure, which is responsive to changing windloads in realtime. The programmable MUSCLE applies the programmable muscle technique in a large and soft programmable prototype. The MUSCLE programmable building is a pressurized soft volume wrapped in a mesh of tensile muscles, which change length, height and width by varying the pressure pumped into the muscle. The balanced pressure <> tension combination bends and tapers in all directions [Ephemeral Structure, ONL 2002]. A series of Muscles put together actuate the complex programmable structure in realtime.

17 Distributed Project Database

You connect to numerous distributed project databases through your brain and through your computer connected to the Internet. And you want to be free to swap from the idiot to the savant in the way you connect to these data. There are project databases in each computer worldwide. The user wants to be free to choose to what extent to connect to it or to exclude the self from it. The wiring inside your head and the information flow inside the computer are two connected networks connecting to the distributed project data, and they influence one another. Each design project creates it's dynamic evolving databases both inside your own head and inside your computer. **Connected swarms of datasets are literally flocking around the globe.** There are many different views possible on the project data. One view is the stereometric view in the perspective of a 3d model, another view is the flat 2d cut of the section and the plan, a third view is a table just containing numbers. Other possible views are the physical tactile model, the smell, the sound. Each view is another way of looking at the same set of data. The numbers represent the same thing as the 3d model. Only the shell around the data is built different as to generate a specific view on the data. One can change the data through all the different views. If you change the 3d model, the data change. If you change the data, the 3d model changes. If you change the plan, changes are seen in the 3d model and thus in the data. And on top of that, **when the data change, you will see something different next time you log in.** This dynamic omni-directional concept is crucial for dealing with parametric design, artificial intuition, realtime behaviour,

active structures, multiplayer games and transaction spaces. All this is based on the awareness that it is data-driven.



Flocking Cars Intelligent Agents. Flocking cars can be regarded as intelligent agents once you include the driver. Neither a car as a stand-alone body neither the driver alone can act as an intelligent agent in the complex adaptive system called traffic. The road <> car <> driver system absorbs information in realtime from the road, from the signs, from neighbouring cars, from the weather, from the immediate environment, from the radio. The driver starts the car, steers the car, programmes the car to go places. If you take the cars out of the system, the drivers can not go anywhere. If you take the driver out, the car does not know where to go. If you take the road out, car & driver are stuck in the mud. In the traffic system the car <> driver combination acts as an intelligent agent. They know each other. If the car had a device to send and receive signals to the other cars, the driver could become a guest, which is driven by the car to the desired destiny. Then the car body is a true intelligent agent in itself, more accurate then the car & driver duo. Automated traffic systems allow existing roads to multiply their capacity. Redundant traffic jams and globally spreading digital communication techniques are building the critical mass needed for an evolutionary step in transportation systems.

18 Data-driven Process

Information technology offers designers the platform to communicate with other disciplines. Working together in a data-driven process of collaborative design and collaborative engineering the stakeholders behave like birds in a swarm. **The stakeholders behave like free particles dynamically socializing in the transaction space, exchanging information in the flow, developing a hive mind.** They are the swarm. All members of the swarm are data-carriers in disguise. Every

member is a node in the information flow network, in their characteristic disguise, playing their specific role. In the end it all comes down to exchanging data. **The players are distributed beings, absorbing, processing and distributing data.** All these data processing vehicles [yes, also people are vehicles, and as you will see later, buildings are vehicles too] operate in swarms, and all these swarms exchange information with other swarms. There are swarms on all social and physical levels and on all time-scales. Marcos Novak shows us how data and algorithms form the genetic drive propelling architecture. His proposals convince in every voxel of the displayed result. They show an unraveled consistency by virtue of the procedure of generating 3d models using math programmes with visual interfaces. Marcos discovered that, given enough practice, the mind could even learn to anticipate the 3-D results of 4-D behaviors when 3d models are warped into 4d math space. Novak's process of the making of architecture is data-driven in it's purest form known so far. When the 3d models are built following rules, processing if > then procedures, running scripts, and importing realtime data for the parameters in the formula's, then we can start a proper process for collaborative design and engineering in realtime. Then you can start to play. You play by the rules, and **knowing the rules thoroughly allows you to develop your intuition to play.**



Trans-ports [ONL 2001] Open source architecture. Transports is a programmable construct changing shape and content in realtime. Think of ADA for available techniques of the interface. Think of game structures for the transactions. Think of the Festo muscles for the changes in shape. Think of broadcasting information content for the electronic skin of Trans-ports. Add all together and you realize that Trans-ports sets up a new paradigm for architecture. Architecture is no longer a style, like postmodern, decon or liquid. Architecture is no longer animated just in the design process. The paradigm shift is caused by the realtime swarming behaviour of all constituting elements of the building.

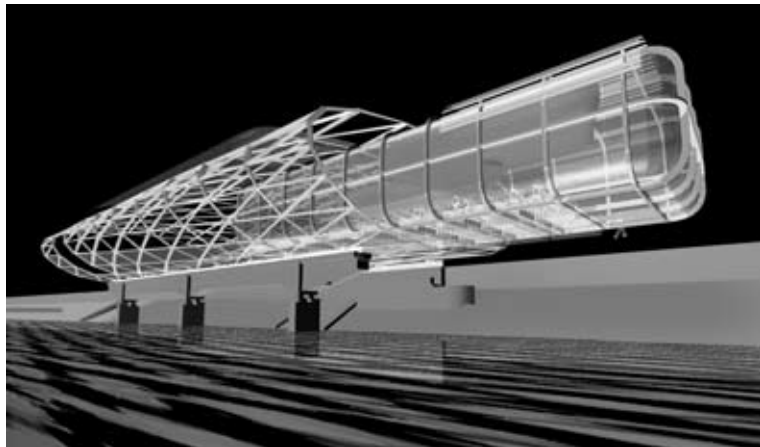
Trans-ports is time-based architecture. The local and global environment including the actions of the users produce the parameters playing the lines of code. Trans-ports is open source architecture. The code is available for developers to take future steps. Open source architecture is strongly connected to the local and global environment, including both professionals and random passengers. Their influence on the structure and the behaviour of the building process and the realized environment is validated through e-motive qualifiers. Trans-ports is e-motive architecture.

19

Communication

People communicate. When they talk they produce output in the form of spoken language. When they move they produce output that will influence other people's movements. When people write things down they store the output in a buffer which may be activated later. People communicate with other people, with animals, but can people communicate with buildings? What sort of language must they speak to achieve that? And how will different elements of the same building body communicate? And what sort of language will they use to establish the communication? According to Mihály Csikszentmihályi [Flow 1990] humans are able to process 126 different unit's of information [operations of the senses] per second. This shows how limited people are in processing data. It is measured that to listen to someone talking we need 40 unit's of information per second. Computers are much better trained in processing data, a parallel computer would be able to handle many different tasks in a non-linear way at the same time. **The way to support the communication between men and machine is the exchange of many small packages of data,** handled by a network of smaller and bigger computers, processed there to be combined, grouped and routed into meaningful information for specific views on the data. First in the interface it is transformed into english, spanish or chinese for humans to understand. Translated into drawings, renders, sounds, graphs, and other similar communication tools for the designer. Communication in it's raw format is pure information flow. Information flow is the ephemeral flow of packages of data. **When people communicate with people the information flows from brain to mouth through air to ear to brain.** When building elements communicate the information

may flow through wires, or even wireless through the ether carried by the microwaves constituting the molecules. The sender sends the signals, the receiver absorbs a partition of those signals. Our building bodies are wired. Our cities are wired. The wired infrastructures bring in fresh data, and carry out data in concert. Very much like the blood vessels and the lymphatic system of animated bodies. **The e-motive interactive architecture of the hyperbody aims at establishing a two-way communication between the people [users, actors] and the environment [house, office] they live in, between the building elements acting as intelligent agents, not to forget between people and other people.**



Graphisoft Slider [ONL 2002] Programmable Structure. Why should buildings or parts of buildings move anyway? It is obvious why doors move, and windows, and why you turn the switches for the light. But moving and transforming complete building volumes? What the Monument for the Third Nationale started back in the beginning of the 20th century, the Graphisoft Slider Building reinvents in the dawn of the 21st century: a fully programmable complex of interacting structures. Where the Tatlin Monument has a fixed structure supporting the 3 rotating elements, the Graphisoft conference centre in Budapest has no fixed structure. Seven explicitly different building elements [photovoltaic cover // cage // sunscreens // box // kitchen cloud // sanitary cloud // media box] gently slide in relation to each other, activated by a script which produces different values for the speed and the extent of the movements in realtime. A fascinating play of elements sliding back and forth, up and down at different speeds creates an endless variety of

configurations, connected to a variety of usage. Not a single person will ever experience the same Graphisoft building.

20

Senders & Receivers

Some swarms may move very slow like geological processes, other herds configure themselves with the speed of light. **Swarm architecture is based on the idea that all building elements operate as intelligent agents**, as data-carriers and data-processors, and that they are active members of a swarm. In a swarm the members keep an eye on each other. They monitor their mutual positions, they measure distances towards their neighbours in realtime. **Members in a swarm are always calculating.** They are calculating citizens. Now imagine that all building elements are members of a swarm. The building is the swarm. Each individual element [sheet of metal, piece of wood, chunk of glass] monitors the other. Each element is aware of the other. They send signals to and receive signals from each other. They communicate. Each element is member of a multitude of different groups. Some members have administrator rights, others are guests. Some members propose changes, others just read data. Some members are more intelligent than others. Don't worry, they all have something to add to the system. As long as they communicate they are family. A modern car has over 50 embedded computers communicating with the environment, each other and the driver. **Since a building is much bigger than a car and is constituted from many more elements, a modern building could have thousands of embedded computers.** Sooner or later in the millions. **Each individual member of the swarm of building elements is and must be relatively stupid.** Like an individual bird is relatively dumb when executing the programme to stay in the swarm. The bird operates a number of limited tasks in a realtime parallel process. This flocking behaviour can be adequately described in 3 simple rules: 1] Cohesion: Fly towards your centroid of your local flock mates, 2] Separation: Keep a certain distance away from nearest flock mates, 3] Alignment: Align your velocity vector with that of the local flock. You might add two more rules for a more precise parametric control



over the flock. 4] Evasion: Avoid occupying the same local airspace as your nearest flockmate. Evasion is a localized form of separation, 5] Migration: Fly towards a pre-specified location [Craig Reynolds 1995]. Now apply these or similar rules and develop your parameters driving the formulas to your architecture following your own imagination. Architecture will not be the same anymore. **Architecture goes wild. Thinking of an architecture in realtime – a time-based architecture – implies a major paradigm shift.** Think of an architecture where all building elements are intelligent agents flocking the herd, [re]configuring themselves in realtime. Building elements behaving like boids. You may call them building boids [the word is coined]. Swarm behaviour of building boids is evolution in progress since the immersion of digital life into our daily lives and into the very fabric of building materials. **Building boids are senders and receivers of information**, exchanging data, processing incoming data, and proposing new configurations as the outcome of the process. People communicate. Buildings communicate. People communicate with people. People communicate with buildings. Buildings communicate with buildings.



E-motive House [ONL 2002] Moods and Modes. What mood is your house in today? Isn't it feeling well? Why is your house behaving so strange lately? Perhaps it needs to see a doctor? Did you care enough for your house? Is your house boring you? Are you neglecting your house? Should your house suggest that you might be boring in the perception of your house? These would be the sort of social conversation topics between the inhabitants of e-motive houses. The e-motive house is a fully programmable muscular construct, designed to be able to change shape and content in realtime. Responsive to urgent needs and whimsical wishes of the inhabitants, they also act for themselves, they surprise their users, they are fooling them, they play games with them. The e-motive house is programmed to behave within predefined emotional bandwidths of emotional modes. And within the modes [entertainment mode, relax mode, educational

mode, commercial mode, sports mode] the house is free to act and to develop a personal mood. The house is built as an interface to the inhabitants and relates to the world through the Internet. Numerous impulses are streaming in, digested and interpreted by a complex set of e-motive filters into specific moody actions. Some of the moods the inhabitant may not like, and they may resist to it, they may try to tame it, try to change its mind. In other words: the house is a social semi-independent extension to the human bodies of the inhabitants. The e-motive house is a complex adaptive system.

21

Sensors and Actuators

People have senses. Buildings have senses. You know about sensors for climate control, the thermostat. You know about weatherstation to control the interior climate in a warehouse. Modern cars have sensors to measure the conditions of the road, to measure the functioning of the brakes on wet surfaces, sensors to detect raindrops on the frontscreen, sensors to measure the weight of the driver, sensors to measure the distance to other cars. When the sensors are connected to actuators – devices that execute an action – then that vehicle is said to be intelligent. That vehicle displays responsive behaviour. Like responsive cars, responsive buildings are reactive to changing conditions. Changing weather conditions, changing conditions caused by the users. **When the behaviour of a building is controlled by a sensor > actuator system then that building is known as a smart building.** The quicker the response, the more it's behaviour feels like alive in realtime. Realtime can be accurately described as many times per second. For the human body something feels like realtime when it is as fast or faster than the human brain and body system can process. But for the theory and praxis of the hyperbody, responsive architecture is not the ultimate goal. **True hyperbodies are pro-active bodies.** True hyperbodies actively propose actions, they act before they are triggered to do so. Hyperbodies display something like a will of their own. They sense, they actuate, but essentially not as a response to a single request. They sense and actuate because some internal force is driving them, hyperbodies are data-driven constructs. Information flow is the driving force making the hyperbody tick. Nothing may stop the flow. That information flow may be teasingly slow and weak, or that flow



may be violent and strong. But nothing would stop the flow. Nothing may kill the animated body. **Do not freeze the swarm of building boids.**



WTC 911 [ONL 2002] E-motive City. Invited by the Max Protetch Gallery in New York to submit a proposal for Ground Zero ONL, decided not to come up with a static building, but with a time-based programmable city block on the ambitious scale of Manhattan. In the accompanying statement, ONL pleads for an e-motive architecture as a vehicle to fight both dominant cultural arrogance and their activist counterpart. How close to politics can architecture be? Time-based open source architecture has no secret agenda and broadcasts content through its skin. Since it connects to a continuous flow of unfiltered data coming in from all parts of the world through the global Internet, the programmable hyperstructure is owned by a unilateral flocking multitude of owners and played by a swarming multitude of players. The lean flexible structure responds to inner forces [proactive moods rating a multitude of conflicting input] and exterior forces alike [weather, people on the street, local and global users]. The proposed Ground Zero structure is a complex adaptive system, includes whimsical input by humans, senses unpredictable environmental conditions, resulting in seemingly irrational structural transformations. As experienced from the point of view of one person, it seems to act out of control. There is no top-down control. But there is a balancing act in realtime between nature and products [new nature] in the complex adaptive transaction space.

22

The Swarm

In the design swarm the designers exchange information with their clients, and with the other stakeholders in the process of building their vision. They exchange information with other disciplines in the collaborative design process, they may operate together with visual artists, composers, graphic designers, planners, publishers, broadcasters of information, with other architects. They exchange information with construction engineers, installation engineers, project managers and process managers. And they want to establish

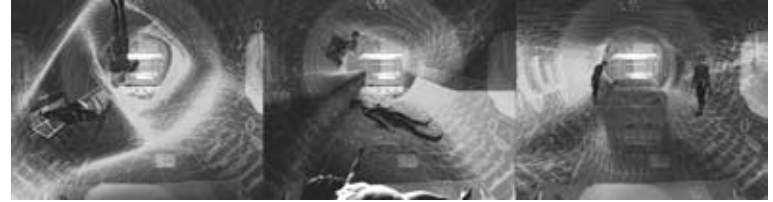
spiraling feedback loops, because they want to learn from each other. They feed upon data from the other experts. **In the swarm there is a constant flux of data.** Nothing may stop the data flow. That would kill the project. Members of the swarm do not refer their positions to a XYZ coordinate system as is used in the building industry. The members of the swarm position themselves relatively to the others. After all the XYZ coordinate system is a mathematical construct, it is purely referential, it has nothing to do with reality. It is designed as to describe positions in an imaginary space. But do these XYZ axes represent 3 spatial dimensions? No way. The XYZ system of coordinates as experienced by humans is one system, and may thus claim for only one dimension. The way humans register things takes place in a very limited bandwidth of the endless spectrum, the human view on reality is at it's best a highly subjective interpretation of reality. Everything people see through their instruments to see into macro- and microworlds [telescopes, infrared, microscopes, scanners, which are constructed with their assistance] are possible views on information space. In other words, humans should not claim reality. Neither can product life, nor can digital life. **What is usually called reality is a temporal and local condition, relative to other conditions.** Virtual reality is a natural extension to this arbitrarily demarcated reality. But VR is closer to information space, and therefore probably more real than reality. **Virtual reality is hyperreal.** This attitude towards the real basically means abandoning the false antropocentric view on information space. You must realize that there are many other possible viewpoints as seen by other organisms and constructs, which are designed in a different way as humans are. This awareness forms the basis for the construction of a protocol for collaborative engineering in Protospace [Kas Oosterhuis, Delft University of Technology & ONL, 2002], where it is acknowledged that all stakeholders have a different view on the process of the growth of the project in realtime. And yet they are able to swarm together and make decisions. Because they share a common language and run a common script. They can work together as long as they do not block the other views, as long as they stay in the swarm. To be able to make this procedure into a practical and applicable working environment one must socialize with the built environment-



in-progress and respect it as an independent identity. No one of the stakeholders owns the building model, it is owned by itself. **The project model is an entity with it's own rights to be.** This proclamation of rights for the project model promises to form the background radiation for the genetic engineering for any e-motive building. An e-motive environment exists at a particular moment in space and time, and develops it's own unique character through the design process, the subsequent building process and the full life-cycle of the e-motive character connected to society at large.

How could the interface between the group design room and it's users look like? Imagine a space big as a regular schoolroom [50m²] with a 360 degree projection of the active world the group is designing [Protospace, Delft University of Technology 2003]. Imagine a multitude [say 100] of pressuresensors in the floor, like the intelligent tiles developed for ADAspace at the Swiss World Expo [ETH Zürich, 2002]. Pressure sensors are sensitive to pressure, and know the difference of heavy and lightweight people [for example grown-ups and children]. Walking around in the transactions space means something like walking over a keyboard and triggering all sorts of programmed instructions [commands] for changes in the active 3d world. Imagine camera's mounted from the ceiling tracking the patterns of people in the transaction space. The technique of bitmaptracking can be used to make interpretations of the movements of the people in the sensorial space. Imagine the people in the transaction space using cellphones to send yes or no choices, or to submit values using the numpad. Imagine people using a wireless glove such as seen in Minority Report to browse through the visions of the Precogs [Minority Report, Stephen Spielberg 2002]. Watching the movie is like pre-experiencing Protospace. **The people inside Protospace use the transaction space as an instrument.** Like the pianoplayer uses the keys of the keyboard to evoke a mood over a period of time, the Protospace player uses the sensors/keys to evoke a mood over a period of time of the proposed design. The Protospace player builds up geometry and maps textures in realtime, acting like a keyboard cowboy. The Protospace player must

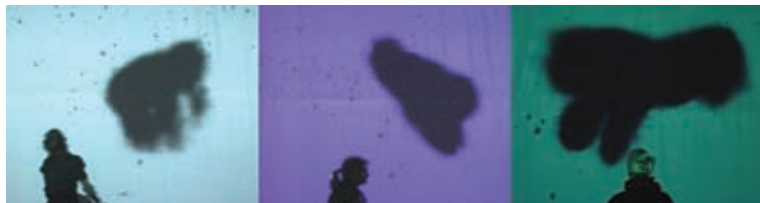
know the rules of the game, like the pianoplayer knows the rules of the music [s]he is involved in. **If the player changes the parameters of the rules, [s]he is a performer. If the player changes the rules also, [s]he is a designer or engineer.** The group design room Protospace is the transaction place where designers and engineers negotiate. They play the game and propose changes for the rules of the game at the same time.



Space Station [ONL 1998] Programmable skin. In a hyperbody building the programmable skin is subject to the principles of publishing. The architect no longer chooses an inert texture material for the finishing. A publisher broadcasts the realtime content of the electronic skin. An entire new market will emerge for start-up companies [information architects] providing private and professional clients with realtime content. Content-providers create links to information flow in realtime. The content varies from commercial content, breaking news, holiday pictures, electronic postcards from friends, educational programmes, actual sportvenues, scientific research. People now checking their email and surfing through websites are the early adapters to consume and produce realtime content of programmable skins. In the Space Station project the programmable skin turns the interior of the modular unit of the Space Station into various modes: play mode, home mode, meeting mode, sleeping mode. In this case the information flow hosted by the electronic skin is edited and published by the space agency.

In the group design room the members act in the design process in realtime. **They are inside the process, they design while running the process.** Realtime design inside the process is fundamentally different from having the design look like a process or look like the result of a process. Design in realtime is much more true to the nature of processes. You do not start a process to kill it. You want it to continue. Don't stop the process, let it run, and make sure it

can develop over time. To constitute a true hyperbody building the designer realizes that the 3d model evolves. Hyperbody architecture is time-based architecture. **The 3dmodel evolves into a distributed being.** It spreads out into the connected brains and computers, it's spreads through the Internet. The 3dmodel of the hyperbody is a being with rights to live and to educate itself. The process of evolution of a digitally connected 3d model does certainly not stop with the design process. **In the ephemeral 3d model of the hyperbody the processes are designed to run.** And in the materialized physical 3dmodel these processes continue to run. The same scripts driving the position of the nodes of the connected building swarm in the 3d model continue their operation in the 1:1 scale project. They keep driving the coordinates of the programmable structure. They keep connecting to databases hosted by the Internet. They keep evolving their formula's as to improve performance. A hyperbody building in action keeps changing the rules as a result of the interaction with other hyperbody buildings and as a result of the interaction with the users. The process never stops. Naturally the hyperbody eventually dies. But since the processes are linked to other processes, the information is not lost. New 3d models are generated and evolved, the information flows from hyperbody to hyperbody. **And that information will tend to be always more complex with each step it takes in evolution.** The fascinating thing is that human beings are right now the witness of one the deepest evolutionary processes the known universe has ever experienced. **Humans must be proud to be part of this evolutionary process, playfully assisting in the increase of the global information index.**



Handdrawspace [ONL 2000] Interactive Painting. Particles are being emitted in realtime in the Handdrawspace world. The Handdrawspace world is one the

3 modes of the Trans-ports installation for the Venice Architecture Biennale in 2000. The space of the Biennale installation is a shared space. The visitors walk in freely into the interaction space and trigger some of the 16 sensors hanging from the ceiling. Triggering a sensor means effectively switching on an action in the realtime Handdrawspace world game. The center point of the transaction space triggers the background colour. The middle ring of sensors trigger the scale of the 3d sketches [the geometric vehicles for the particles] and activate at the same time soundsamples connected to the geometry of the sketch. Scaling the sketch results in a dramatic increase in the size of the particles. The activated particles cluster together as to form a sort of vibrating inkblob. That oscillating spot lives for a number of seconds and dies. Like all particles live and die in the Handdrawspace interactive painting in a lifespan of some seconds. The outer ring of sensors trigger the panoramic view on the Handdraspace world. Handdrawspace is a painting, which lives and is experienced in realtime. The visitor becomes the co-creator of the painting, playing the rules as set by the maker. The Handdrawspace painting never exactly rebuilds a configuration it has been in before.

25

Connected Hyperbodies

People on earth are connected. Although there are billions of people it is known fact **that any person is connected to any other person through no more than 5 links.** The person across the street who you do not know knows [1st link] someone who happens to know [2nd link] someone who happens to know [3rd link] someone who knows [4th link] someone who knows you [5th link]. This social law is called the six degrees of separation. It's a small world. Albert-Lászlo Barabási [Linked 2002] calls these links the weak links. According to Barabási weak links are the binding ties in society. Weak links are sort of hyperlinks, they do not represent a physical bond. They form the social bond for institutions, offices, countries, parties. Now apply this concept to the concept of the hyperbody. **Hyperbodies have sectors with strong links within their bodies.** Strong links are like family ties. In society people cluster in a variety of clusters with a variety of sizes in a variety of strength. Intelligent building agents [the building boids] will cluster in a similar way. Some are very closely related to each other, as to form a region with a specific task and character. Other building boids are not so closely related, but the synthesized design of bigger and smaller clusters together

form the supercluster of the hyperbody. And the hyperbodies are related to other hyperbodies, they are connected through weak links. Somehow one hyperbody will know another hyperbody through a very limited number of links. Some hyperbodies will have many more links than others. These are called the hubs. Hubs tend to attract a multitude of links. They are the big communicators. They facilitate many connections. The hyperbodies hubs [the hyperhubs] are the backbones of the swarm of hyperbodies flocking the earth and the stratosphere. **Hyperhubs are the gateways of the hyperbody community.** Much more information is tunneled through hyperhubs than through a single hyperbody, which is connected with only some links to other bodies.



Tatlin Internationale [Tatlin 1919] Kinetic Architecture. Kinetic structures move mechanically. Bridges moving up and down are kinetic structures. The roof of the Kuwait Pavilion [Sevilla World Expo, Calatrava 1992] is a delicate kinetic structure moved by the wind. The mobiles by Calder, Rickey and Emery are kinetic structures moved by gentle breezes of air. The waterfountain at the square to the side of the Centre Pompidou by Jean Tinguely is a kinetic structure, moved by water. Kinetic art is a serious form of art since the sixties in Europe. An early and most outstanding example of a kinetic structure is the Monument for

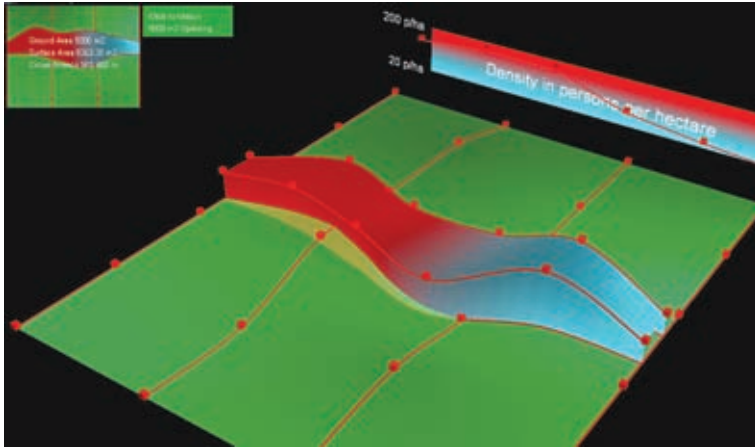
the Third Internationale. Prismatic prismatic volumes rotate along the vertical axis within the impressive spiral steel structure. The volumes move at specific speeds. The cube houses conference rooms and revolves 1 revolution per year. The pyramid contains the administration offices and performs a monthly turn-around. The cylinder in the top completes 1 revolution every 24 hours, and is open to the public as an information center. The Tatlin tower is scheduled to be a full 400m high. Many revolving restaurants have been built since, but not a single proposal even comes close to the bold scheme of Tatlin's Monument.

26

Instrumental Hyperbodies

The building designers and the building users exchange online information with the producers of building components, with the producers of digital instruments. They exchange information with their computers, they work together with their embedded digital instruments to build new possible realities in realtime. **The designers are players in the input > processing > output game.** Each one of the players operates in their own personal distributed swarm, and all swarms are connected. Swarm architecture is naturally based upon parametric modelling and on genetically evolving behavioral patterns. Swarm architecture is based on the genetic algorithms processing and evolving the communication within and between the smart hyperbodies. Architectural vehicles are needed to carry the data and to tunnel the information flow, these vehicles are designed to synthesize the connections. Dawkins proposed the theory that a chicken is the vehicle for an egg to make another egg [Richard Dawkins, *The Extended Phenotype* 1982]. In a similar way **the building is a vehicle for information to evolve information.** Information uses vehicles to flow. Architectural hyperbodies are like the unibodies of automotive vehicles. Architectural vehicles are e-motive vectorial bodies. The hyperbodies are hyperlinked integrities, which are built and equipped to process and evolve their parametric formulas. The parameters are submitted to and extracted from dynamic distributed databases in realtime. Here is the full definition of a hyperbody. **A hyperbody is a connected superclustered time-based vehicle of swarming intelligent buildings elements reconfiguring it's multiple shape and content in realtime processing a continuous dialogue with it's locally and**

temporally distributed inhabitants. A hyperbody is played as an instrument by its users. Since the hyperbody is a time-based instrument, the associated users form an intrinsic part of the hyperbody. Like the driver of the car makes the car. A car has no meaning at all without the operation performed by the driver. Car and driver are one system. The highway has no meaning at all without the operations performed by the cars on the highway. Highway and cars are one system. In the same way **the hyperbodies and their inhabitants are one system.** Inhabitants may operate on the hyperbody while physically present at a certain spot on the skin [inner or outer skin] of the hyperbody or just as well by a distributed presence through the Internet. **The hyperbody is a complex adaptive system.**



Participator Nesselande [ONL 2002] Collaborative Planning Tool. Who owns the parametric 3d model? Let us suppose the 3d model is an independent being, a being with [birth]right to exist. A being, which attempts to be evolutionary successful, and wants to be alive. The possible transactions on the 3d model of the interactive planning tool Participator Nesselande is described in the game script. Besides that there are additional mental constructs in the minds of the designers, the players and the observers. But focus on the most compressed schematic form the project can assume, the script. The script operates on the database of the project, which may be viewed in the disguise of a 3d model. The participators in the planning game are the stakeholders representing different views on the status of the proposal. They pursue their own interests, and experience together with the other stakeholders the immediate consequences of

their choices. The people involved in the realtime collaborative design process deciding on the values for the parameters are the activators of the script. Who owns the script for the planning tool? Who sets the rules of the game? Are the 3d model and the script slave to the designer? Would the co-designers playing the game also rightfully claim owner rights? Collaborative design opens architecture to the concept of open source. Suppose that the 3d model and the script are not owned by anyone, but that they are owned by themselves. Like people are of themselves [as proclaimed in the bill of human rights. When 3d models are no longer static but alive and develop in realtime, it is consistent to acknowledge their individual rights to live, to raise them carefully as a good parent, and to let them go in due time, and to work with them.

27

Transaction Spaces

Swarm architecture is a true transarchitecture since it builds new transaction spaces. Swarm architecture is at the same time e-motive, transactive, interactive and collaborative. Swarm architecture feeds on data derived from social transactions. Swarm architecture is the hive mind of the new transformation economy. **Swarm architecture is design, construct and operate in realtime.** Architecture becomes the discipline of building transactions. That is what architects do: they build transaction spaces. As a matter of fact, they always did. All buildings are framing transactions. What's new is that the information flow is no longer tunneled through entrances, doors, windows, pipes, wires and radiation, but that this information flow is now digital and orchestrated as swarming data connecting the very building elements. **Architects are becoming conscious of the fact that they are the designers of intelligent vehicles, which execute a game of life and death.** Think of that young boy, the son of the architect, that infects the skyscraper with its violent game. The skyscraper's installations start to behave like a killer machine [Philip Kerr, The Grid-Iron 1995]. Architecture has no longer as a hidden agenda to resist to external and internal forces. Architecture now becomes the science of dynamic structures and environments processing their behaviour in realtime. Architecture goes wild. In the meantime the other stakeholders in the collaborative design process are experiencing the coming-out of the swarm architecture of the hyperbody. Swarm architecture manifests itself as the inevitable evolution of architecture into

hyperbodies, recognizable as the selfish genetic step in the non-stop evolution of the building industry.



Sculpture City [Attila Foundation 1994] Navigating Information. A building can be a sculpture, a sculpture can be a building. That is the one-liner understanding the Sculpture City project. The manifestation Sculpture City is archived on a cdrom. To access the files on the cdrom an interactive interface was designed and programmed. To open a file [image, video, soundbyte, text] the navigator behind the computerscreen has to catch a butterfly. The styling of the butterfly is based on the genetic material from the genepool of 2d and 3d sketches for the sculpturebuildings of Sculpture City. Clicking on the butterfly brings you to one of the files. All files are flagged [tagged] in 10 descriptions and validated choices. Is it an image? Yes/no. Is it created during the Sculpture City Workshop? Yes/no. Is it a realized project? Yes/no. And each file is validated with a rating between 1 and 7. Is it very good? Rating is 7. Is it very bad? Rating [as given by the makers] is 1. The script examines these flags and values and shops from a randomly selected pool of max 50 files [out of 800] each time a new choice is made [a new butterfly is clicked]. From the hidden toolbar of the entropylevel the navigator chooses the strength of the relations between the actual file on the screen and the other 799 files during the next selection. The values in the entropylevel vary from 1 to 16. Level 1 means a very strict selection of only exact matches to the type and character of the active file. Level 16 is the generous way to make the selection. By making choices through this interface the navigator browses her/his own unique non-linear way through the information.

28

E-motive Bandwidth

To what extent the e-motive building acts fast or acts slow is up to the designer and up to the user. **E-motive architecture explores a much wider bandwidth of emotional states than traditional architecture.** The intriguing part is also that e-motive architecture - since it is programmable - can be programmed to be either more static or more dynamic than traditional architecture. Imagine a highrise building in stormy weather. The traditional skyscraper

would bend with the wind, the top would be displaced several meters. Like the WTC towers did. The programmable structure of an e-motive building would be able to actuate it's structure as to lean against the wind. As a result the programmable skyscraper would stand straight up without any deflection at all. This is extremely intriguing. E-motive architecture can lead to either higher or lower emotional levels. E-motive architecture effectively broadens the bandwidth of our experience of spaces, in both directions of our emotional spectrum. The designer and the user are free to choose the superstatic condition. They can program the building to freeze. Not as a final end condition, but as a temporal condition in the bandwidth of all possible states. The designer could programme a freeze-mode. Like [s]he could choose a crazy mode, an celebration mode, a commercial mode, a stand-bye mode. **One single hyperbody is effectively a multitude of buildings.** Performing a multitude of emotional states, exploring the full e-motive bandwidth.



Times Square Nasdaq Billboard Realtime Flow of Information Content. What is the nature of information? Information is more than raw data. Raw data are meaningless in themselves. When human beings see a dataflow and perceive that as information, then that information must be organized from both sides, from the side of the provider and from the side of the receiver. The data are organized according to specific rules, understood by the sender and the receiver. To be able to see the information you need an instrument catching the data, in the case of living beings that is the eye > brain system. To be able to broadcast



the information you need a vehicle or carrier, for example an electronic billboard. Information flows through the information carrier without affecting the physical nature of it. Broadcasting information does not change the construction of the LED's of the electronic billboard. It does change however the state they are in [on or off, strong or weak]. The individual LED does not understand the meaning of it. It is the information content displayed through all LED's of the billboard that changes. Information is ephemeral, it is a mental construct. From the billboard information is broadcasted in all directions [the nature of light] and at all times [frames per second], the meaning of it is recreated in information processing devices like the brain of humans. In the concept of the hyperbody it are the senses of the building body, which catch the information flow. The information processing department of the hyperbody [distributed processing units] makes interpretations of the incoming signals and eventually transcribes them into information in another disguise [sound, text, movement, colour].

29

The Nature of the Game

The concept of collaborative design and engineering is facilitated by building a game, which opens up the design process of architecture and building in realtime. It is extremely relevant that the designers not just talk about the process, but that they actually make it work. **You must run the process, and work in the process.** First then you see and feel how beautifully complex the procedures are, and how precise and intuitive you must think and act to make it work for you. You must think as a programmer writing code. You must move innocent and tricky like a child playing a game. The designers must deal with the simultaneous development of the design and the communication with the other stakeholders in the transactive design process. Game development software [Virtools, Blender, Quest 3D] offers the tool for the design of architectural in realtime. Resolution and rendertime are no issues anymore, **it is all about framerate.** Animals like to play. Humans like to play. **Playing is an evolutionary tool to learn how to act and react in new situations.** The game, whatever it might be, is not matter [Huizinga, Homo Ludens 1938]. **A game is highly structured information in a state of flow.** If the game has been supralogical in the evolution of animals and humans, why shouldn't it be beneficial to the evolution of intelligent buildings? Why wouldn't exactly an embodied game structure be essential for the next step in the evolution of smart

buildings? Buildings must become playful. While processing the information flow the e-motive vehicle builds it's playful state of mind. Playfulness is acted in realtime. The playful buildings will develop a whimsical will of their own. They will develop realtime behaviour. Buildings start to behave unexpectedly and surprise like the weather. They will fool us, encourage us to react to their actions, and then act again. **Only when both users and their environments are active, there can exist a true interaction.** As we have seen before, these buildings will be more than responsive, they will become pro-active. Casa ludens. What a thrill.



Drip Painting [Jackson Pollock 1950] Procedural action. When people walk they execute a script of staying upright, of not falling, of balancing on two feet. When people paint, they follow a set of personal rules, and validate their own paintbrush movements during the act of painting. For the Drip Painting series a strict procedure is invented for dripping the paint on the canvases, which are placed horizontally on the floor. While painting Pollock physically executes a simple script existing of only a few lines of code. Put the brush in the pot, take a step aside, bend over the canvas and make a pre-programmed movement with the arm holding the brush. Then repeat the same script but one step to the right. For each new layer in the painting Jack The Dripper applied slightly different parameters for slightly shifting rules. In the background of the painter in action Pollock's wife Lee Krasner [a painter herself] controls the scene. She comes up in 1943 with the initial concept for working according to a similar strict procedure. The result of the transactive procedure is a rich multi-layered action painting, fractally pleasing by virtue of the endless selfsimilar variations caused by the in realtime produced parameters in the execution of the drip programme.

30

The Rules of the Game

According to Huizinga, the game creates order, the game is order. The game unfolds within the limits of it's own playroom. The game is played according to it's own set of rules. The challenging issue here is: who sets the rules for the playroom?

building? What are the boundaries of the playground? Who decides what formula's are used? Who writes the procedures? Who fancies the scripts, who writes the genetic code? And **who is authorized to change the rules of the game?** MIT research associate Michael Schrage [Serious Play 2000] urges us to look at promising prototype. He persuades us to position the time-lapse camera inside the prototype to capture it's environment. And then track all the conversations, collaborations, consultations, arguments, negotiations, debates, budget fights, and brainstorms that go as the prototype evolves into an innovative product. Schrage asks himself which point of view best captures the nature and value of serious play? **Developing the prototype is a serious game.** The prototype is a complex set of rules and choices. A complex set of formula's and parameters. The process of interaction, communication and collaborative design is a parametric game. The designers design the rules of the game, and at the end of the project, they play the game. They design the design. **Playing the parametric game of architecture is experienced by the players as a form of serious fun.** The design is the formula, the playing of the game means setting the parameters. The players realize that when you connect the 3d model of the architectural design to the databases [tables, arrays], the essence of the architecture is not one arbitrary choice of how the environment could look. The running project will actually be a multitude of viable architectural schemes, all just as valid and beautiful as the other ones.

31 The Scale-free Networks of Buildings

Consider the information flow in a house. You will quickly find out that some parts of the house are tunneling more information than other parts. For example the door frequently lets people in and out. People who are the vehicles for carrying information. People interact with many knobs and switches in the house. They transmit information to various parts of the building. There are also tunnels of information not carried by people. Like the water and gas supplies, the electricity and the data lines. Just like the people's entrance these information tunnels are hubs in the building network. **A network featuring nodes with many more**

connections than other nodes is known as a scale-free network [Barabási, Linked 2002]. Scale-free networks are the dominant form of networks in our society. Biologic food-chains are scale-free networks, but also is the Internet, your brains, the cell, the car, the aviation network, the network of relationships of any group of people. They all have a large number of nodes with only some links to other nodes, and just a few powernodes with many links, the hubs. Google is a large hub on the Internet. **The door in your house is a big hub in your house.** The door facilitates many connections. And so is your ADSL connection, from where you can connect to billions of IP addresses. Essential to the architecture of the hyperbody is that it is a scale-free network. You might map the relations between the nodes in your house, and you might label the hubs. The hubs are the great communicators of the house. But they could not function without the large number of other nodes, which are relatively deprived from communication. Some of these nodes may find themselves confined to the very boundaries of the network, and be linked to only one or two other nodes.



Ephemeral Structures [ONL 2002] E-motive Urban Game. The interactive city landmark collaborates with a few dozen agents and thousands of e-motive qualifiers to calculate its motion and emotion in realtime. Imagine an inflated structure, which is wrapped in a programmable constructive mesh. The members of the mesh are programmable muscles, which are capable of changing their length. Each individual member can be addressed to change its length. Each

individual member is connected to other members like birds are connected in their swarm. If one member wants to change, at least all neighbouring members must cooperate in order to perform that change. By changing the length of one side of one of the inflated muscular arms, that side becomes either longer or shorter, making sure that the whole arm swings into that direction. The data steering the muscular arms come from the agents, attached to buildings distributed at strategic places in the city. The agents collect and process the pulses coming from the qualifiers. The qualifiers are mass-produced bracelets worn on the lower arm by the public. The bracelets send their coordinates to the agents in realtime. Just by walking the people in the street change the coordinates, and thus change the data input into the agents. Once the people realize that they actually have influence on the agents and hence on the shape of the landmark structures they start to play the game consciously. The Ephemeral Structures project is a concept for a complex intuitive and interactive urban game, played by the citizens.

32

Bi-directional Connectors

Another equally important aspect of networks is the direction of the links. Are the links one-way streets like the links from one webpage to the other? Or are the links bi-directional, like in the aviation network? You can always fly back to the place where you come from. But very often there is no link back from the webpage to the page where you came from. Which makes the Web a directed network. In your house some networks are directional, like the water supply and drainage system, other networks feature in principle two-way connections like the electricity network. It does not happen often yet, but you can deliver electricity back to your power supplier. You can do so if you produce electricity from photovoltaic cells while you do not store the power in a local battery but deliver it to the community network. **The house is a node in a scale-free network of smaller and bigger powersuppliers.** Scale-free networks are the most robust forms of networks known in both old [carbon-based] and new [digital] nature. The door in the house is a hub, which links in two directions also. You can come in and you can go out. But now look at the hyperbody as the actual realtime evolution of the house. In the hyperbody house there are many nodes implanted in the skins and the structures of the house. These nodes are linked to each other [microwave talks to refrigerator talks to vacuumcleaner talks to user talks to car talks to garagedoor], to the users of the house, probably through wireless

sensors and gsm/gps cellphones, and to the exterior worlds [refrigerator talks to grocery store]. Some of these embedded microchips are poorly linked nodes, they have only a few links. They operate in the periphery of the network. Other nodes are the hubs of the hyperbody, they attract many links. When one of these nodes starts attracting and establishing more links, it will be even more attractive than ever and will attract even more links. The winner takes it all. These successful hubs are the preferred attachments of the hyperbody. The open pipeline to the Internet community sure is one of these hubs. As demonstrated by the Hyperbody Research Group at the Delft University of Technology the e-motive qualifier is candidate for being another attractive hub. The e-motive qualifier is the superlinked node that receives and sends signals from and to both people and embedded devices. The e-motive qualifier monitors and builds the emotions of the hyperbody [or parts of the hyperbody]. It builds it's state of mind. **The e-motive qualifier processes the pro-activity of the hyperbody.** It produces the apparent free will, living proof of the unique identity of that particular hyperbody.



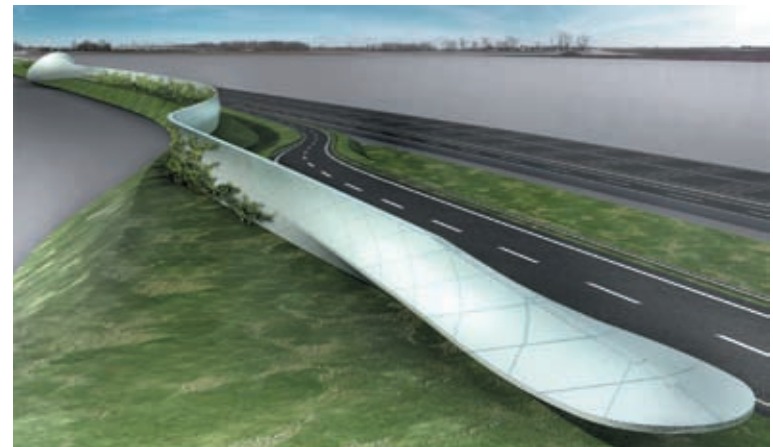
Protospace [ONL 2002] Group Design Room. The WEB will host Protospace, the transaction space for collaborative design and interaction design. What the importance is of labelling Protospace as a transaction space? Embedding ICT in built environments implies that all building elements are behaving like birds in a swarm. They exchange data in realtime. They are aware of each other, they communicate with each other. Each building element is seen as a sender,

a processor and a receiver. The embedded swarming intelligence is physically nano and as a consequence hardly visible. Which means that hyperbodies are not showing off technique as an exhibitionist structure. Hyperbodies process the experience of spaces and actuate the transformations of spaces. The swarming hyper building elements are exchanging small packages of data. Exchanging packages of data is extremely energy-efficient. However communication between the building elements is not the whole story. These building elements behave like intelligent agents, and communicate with the users of the building. E-motive architecture builds upon the alliance between people and the building actuators. Protospace in the WEB is the testbed for environments with swarm intelligence. The interactive transaction space called Protospace installed inside in the shell of the WEB functions in essence different from existing CAVE's. In Protospace you can move freely, you are not connected to heavy wiring, gloves or helmets. But you are connected to the space by using sensors, bitmap tracking camera's, numpads of cellphones, speech recognition. Protospace is a big open multi-player room where a multitude of disciplines can work together on the same project, each of them having their own authorization to make the changes in the field where they are the experts. Thus Protospace is the ultimate instrument for collaborative design and engineering and for direct democracy [non-professional clients are experts also]. Protospace is the vehicle for open source architecture. Protospace is a transaction room with a flexible 360 degree projection, the users can move in an out freely. The multiple screens can be viewed from both sides, allowing the 250m2 space of Protospace to be used by 5 individual workgroups, as one collaborative design room or as a space for linear lecturing and hands-on workshops.

33 The Scale-free Networks of the Design Process

Like a game and like the hyperbody, also the design process creates order. **The design process feeds on structured information.** The design process is orchestrated movement, giving shape to the information flow. It is productive for a full understanding [and useful for students and practising architects alike] to find out what form of scale-free network the design process might be. What types of nodes does the design process create? The designer in action takes part in a complex process. And [s]he is much more connected to ideas, peoples, institutions, websites, informations flows, databases, knowledge bases than one would realize. **The network of connections, most of them invisible and wireless, constitute the scale-free network of the design process.** The

designer is neither a passive consumer, nor the boss of this process. [S]he goes with the information flow, and slightly adjusts the mainstream direction of this flow. In the design process one collaborates actively with other actors. Even the design of an autistic genius would be connected to the world through extremely active hubs. The design process connects the architect and the other stakeholders in the collaborative design process to the world of design. You may picture these worlds of design as large swarms of free radicals interacting with each other. Some interacting according to weak forces, other strongly linked. It could very well be that an idea, which the designer is very critical about, exactly for that reason forms a strong connection, simply because that idea is always on her/his mind. **Love and hate of concepts and ideas form the hubs for the design process.** They are the big attractors, they are the winners that tunnel the information flow.



Cockpit in acoustic barrier [ONL 2003] Parametric Design. Collaborative design relies completely on the uncompromised parametric basis for the design. If not built parametrically you can not play with the parameters, and you are not able to interfere with it. You would not be able to communicate smoothly with the 3d model and the project database, neither in the design process nor in the life-cycle of the environment. Working with parametric models creates the communication space for the stakeholders in the building process to discuss the qualities of the proposed environments. It opens up the design process for collaborative engineering in the phase of the execution of the project. It opens

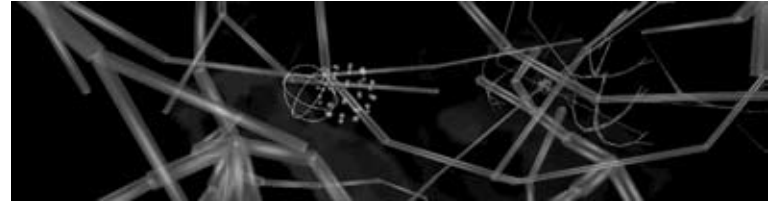
up the design process for a possible and meaningful interaction with the clients and the users. The concept for the Cockpit building as integral part of an acoustic barrier is based on a relatively simple set of related curves, describing the amount of m² for the commercial content of the building. The concept does not describe exact values, but parametric relations between height, width and length. Thanks to the strength of the concept the project is still alive after many times of new values set for the parameters, proposed by the different stakeholders involved.

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Build Prototypes

How can you deliberately design tools for the process of collaborative design, knowing that people have unspecified but very strong opinions about what is good and bad? How can you communicate with the other stakeholders when you cling to your preoccupations? The answer is that you need your intuitive opinions to be able to communicate anyway. It seems the essence of communication that we say things that are not scientifically weighed but are spontaneous and intuitive. **In the collaborative design process the project and other stakeholders test your hunch.** They sort of run a script checking the incoming data on resonance with their own experience. Some scripts might give counter-intuitive values back as an reply on the hunch. Basically saying: "Is that what you think? I think it is like this". Michael Schrage [Serious Play 2000] says that **the prototype drives the process.** You may imagine the prototype as a complex set of hunches, well integrated together as a working prototyped building block, but still a hunch. Schrage argues that the value is created in the shared space. If the prototype idea is successful it will attract attention, it will act as a magnetic field. In the feedback trial and error process of making statements and the testing of it in realtime in the shared space the prototype either lives or dies. If successful, the design process proceeds on the intuitively chosen path. In the shared space of the collaborative design process each idea, in the form of a valuable package of information, is a mini-prototype, a hunch. Again according to Schrage, **the issue is not just creative individuals, but creative relationships.** Ideas triggering a lot of attention are the hubs in the design process. They are the winners, they are cashing all the hits. The heart of the group design room is the building in realtime of virtual prototypes, and the on-line and

on-site testing of them in the swarm of flocking stakeholders. Not much experience has been monitored yet with this ultimate realtime form of interaction design. In the Protospace project of the Hyperbody Research Group at the Delft University of Technology prototype-tools for the collaborative design process are now being conceptualized, built and tested.



Virtual Operation Room [ONL 2002] Play > Learn > Heal. The Virtual Operation Room features a responsive geometry, responsive to actions of the players of the game. In the intro world the player can navigate through its avatar into the entrance space, a kneadable enclosure which reacts to the movements of the player. The vertex blob is a representation of your own body. Moving slowly towards the blob-shaped enclosure, the player deforms the blob without entering it. Moving fast enough, the player enters his own body, and is prepared to improve and heal the system. The hive mind controls the behaviour of the connected swarm of vertexes [Christian Friedrich]. From the body portal you can chose three different worlds to get into, using a joystick as the input device: the growing brains [Sven Blokker], the kidney purification plant [Chris Kievid] and the peristaltic lymphatic system [Michael Bittermann]. In each of these highly responsive and pro-active worlds the player improves and heals the bodily system by playing, acting, by pointing at sweet spots, by shooting cells, by killing cancerous growth. After having gained insight in the dynamics of the complex adaptive system of the sector by collecting points and thus improving the sick system, you are transferred to one of the other sectors of your body.

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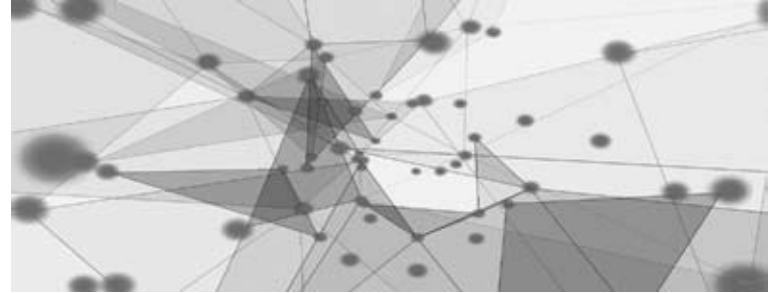
Direct Democracy

In the end the concept of interactive gaming technology for collaborative design and engineering constitutes a powerful tool for direct democracy. Now the designers can directly connect to the people they work for and they work with. Not only experts are participators in the process of direct democracy, but especially also the clients, citizens, friends, accidental users, passengers. Everyone becomes a player in the transaction space, either consciously as a dedicated



participator in the design process, or subconsciously as a passenger whose presence matters for the realtime behaviour of the transaction space. Think of the imaginary infamous fly that changed the course of history by virtue of it's irritating presence only. Trivial details may change the information flow of the design process dramatically. Like seemingly trivial details may change the public opinion about politics and politicians. Scientifically trivial details may be of decisive influence on the outcome of the processing of the information input by the stakeholders into the collaborative design process. In the realized Saltwaterpavilion for the first time in history the concept of the e-motive factor of the building was introduced. The incoming data were interpreted > processed > weighed by a script crunching the incoming data into midi-signals ruling the dynamic lights and sounds in realtime. The visitors experienced the outcome of the script as an emotive state of the building. **In the collaborative design process there must be an open channel for incoming raw data from the world around the group design room.** These raw data may come from people [citizens] making choices on a website, which is directly linked to the shared space of the group design room. The designers in the design room will experience immediately what the effects of the choices mean for the design they are working. Suppose one works on a complex city project where one single designer has no chance whatsoever to find the key to the solution. In these very realistic cases actual information keeps creeping in and never stops influencing the outcome of the decisions of the designers and politicians. The group design room builds an open channel to society, constituting a bi-directional information hub in the scale-free network of the design process. **Citizens become realtime participators in the design game.** Think of a continuous voting system allowing the citizens to influence the polls in realtime and hence influence the politics and the politicians in an election race. The important question here remains: who designs the e-motive filters interpreting the values produced by the continuous voting system? Who creates the formula's where the citizens provide their parameters for? Has the citizen influence of the very formula itself? Yes they could and must, because they are part of a complex adaptive system. **In the complex adaptive system the formulas**

evolve. The rules of the game evolve with the changes in the values of the incoming data. The opinions of the citizens subsequently co-evolve, together with the prototyped tools built by the designers and together with the responses of the surrounding world testing the prototypes.



Collaborative Design Process [Hyperbody Research Group 2002] Vertex swarm. Each vertex is an active member of the swarm. The interaction between the stakeholders in the collaborative design process is a dynamic process. The position of each stakeholder changes in time. The content and meaning of each stake changes in time. The strength of the links between the stakeholders change in time. How can we visualize the transaction process of collaborative design, what effect does it have on the way the project is represented, the way we imprint it in our brains? In what way does it affect the way data are stored? In the swarm view the project must be seen as one of the members of the flock, and not as a central base for data. The project is one specific member of the swarm that develops in time. Each time you update your private view the project has developed. Either by new input from other disciplines [represented by their stakeholders] or because it has evolved itself. This notion is completely new for the workers in the field. The traditional designer claims full top-down control over the newly born project. The modern information architect knows better. The newborn project develops from the moment it comes into existence a will of its own, installing itself in the connected minds and computers [extended brains]. Like a newborn child is owned by itself [universal birth rights] and develops absorbing and processing data from parents, teachers, friends, threats and comfort. Top-down is teaching from the outside of the body, bottom-up is learning from the inside. Top-down and bottom-up are developed in a adventurous equilibrium.

Murray Gell-Mann [The Quark and the Jaguar 1994] convinces you that the common feature of complex adaptive systems



[financial markets, animals, solar system, bacteria's] is that they acquire information about their environment and their own interaction with that environment. They are identifying regularities in that information, condensing those regularities into a kind of schema or model, and acting in the real world on the basis of that schema. Now consider democracy as a complex adaptive system. Consider the group design room as a complex adaptive system. **Consider the collaborative design process as a complex adaptive system.** Then you can start discussing the role of architecture in the information economy. Informed architecture in the network economy. **Consider the modern architect as an information architect.** Trained to sculpt streaming data, trained to allow the intuition to have influence on the logic. Trained to build prototypes for testing them in the real world, trained to build interactive tools for direct democracy. Trained to act in the shared space of a group design room. Trained to construct an interactive e-motive architecture in realtime to adapt to the parallel worlds around and the worlds within. That architect is prepared to act in the networked information economy of the 21st century.

hyperbody is a data-driven construct changing in realtime connected to environments changing in realtime • **e-motive architecture** runs and develops realtime behaviour • **hyperarchitecture** links through networks to other connected environments • **idiot savant** is a narrow-band genius • **transformation economy** deals with changing the client • **architecture goes wild** is the title of the book with manifest writings by Kas Oosterhuis • **dataflow** is the flux of streaming packages of data • **stakeholder** is a person or an object pursuing individual goals • **parametric design** formulates the relations between the objects • **direct democracy** is based on a continuous voting system to involve non-experts in political choices • **unibody** is the constructive shell protecting weaker substance • **automotive styling** gives shape and character to unibodies • **e-motive styling** gives style to data-driven constructs • **information theory** supposes that matter and ideas are disguises of informative waves • **information coefficient** validates the most compact form of formulating the project code • **second law of thermodynamics** points the direction of how humans feel time goes • **collaborative design** operates as a swarm in a shared information space • **collaborative engineering** is engineering in the hive mind of the shared information space • **swarm** is group of relatively dumb members

forming emergent intelligence • **hive** is the transaction space of the swarm • **realtime** is the ability of the operating system to provide required service in a bounded response time • **intelligent agent** is a semi-autonomous unit that seek to maximize its fitness by evolving over time • **flocking behaviour** is grouping together in the swarm according to a limited number of relatively simple rules • **multiplayer** is the presence of several players in the same game in realtime • **algorithm** is a recursive procedure whereby an infinite sequence of terms can be generated • **programmable** is pertaining to a device that can accept instructions that alter its basic functions • **voxel** is a unit of graphic information that defines a point in three-dimensional space • **interaction** is the tension field between at least 2 active parties • **bold** is one of a multitude of semi-autonomous agents constituting the flock • **body building** is the art of putting loose parts together to form an integrity • **building body** is a selfbearing construct distributing forces through itself • **transarchitecture** delaminates the physical borders of an object in space and time • **liquid architecture** is static architecture becoming supple under high data pressure • **open source architecture** reveals its source code free for all • **emersion** is the recreation of reality through the ephemeral • **immersion** is the free floating of the physical body in the ephemeral • **sensor** is a detection device that requires input energy from a source other than that which is being sensed • **actuator** is a device that converts energy into robot motion • **pro-active** is taking the initiative and the responsibility to make things happen • **responsive** is answering or replying in a timely fashion • **behaviour** is conduct in a shared environment in realtime • **feedback** is the return of a [processed] portion of the output, of an active device to the input • **virtual reality** is hyperreal byte by byte quantifiable and qualifiable constructed reality • **schema** is the most compressed form to describe a complex system • **project model** is the project database viewed through a 3d viewer • **flowchart** is a graphical and symbolic representation of a running process • **building block** is a selfcontained body of code or graph in the overall script • **graph** is a symbolic abstraction of the reality of a network • **interface** is the shared boundary between two operational units defined by specific characteristics • **group design room** is the shared transaction space for collaborative design • **group decision room** is the shared transaction space for open decision systems • **information index** validates the information level of the project • **link** is the logical connection between discrete units of data • **hub** is a device that accepts a signal from one point and redistributes it to one or more points • **backbone** is the high-traffic-density connectivity portion of any communications network • **synthetic** means fusing discrete elements together as to form a new whole • **formula** is a standard procedure for solving a class of mathematical problems • **database** is an organized collection of information • **bandwidth** is the difference between the highest and lowest frequencies that may be transmitted • **game** is a set of rules within a restricted playing field • **code** is a set of unambiguous rules

specifying the manner in which data are represented in a discrete form • **script** is a relatively short computer program that performs one specific task • **Autolisp routine** automates a series of commands • **language** is a system of relatively arbitrary symbols and signals that change across time • **scale-free network** is characterized by an uneven distribution of connectedness • **wireless network** or terminal uses electromagnetic waves • **prototype** is a working 1:1 model of a projected series of products • **intuitive** refers to the perception of the internal and external world through the unconscious • **counter-intuitive** ideas or assumptions seem to be contrary to what would be considered normal • **democracy** is government by the people in which the supreme power exercised directly by them • **qualifier** is word added to a corporate body to distinguish the body from others with the same name or title • **complex adaptive system** evolve through emergent control and order by intelligent agents • **file to factory** is the direct machine to machine communication • **IGES** means Initial Graphics Exchange Specification • **NURBS** means Non-Uniform Rational B-Spline • **webbased** applications are accessible and operational via the Web • **mass-production** is the running process of linear production methods • **mass-customization** produces series of unique elements for specific clients • **vertex** is a corner, point or node in a mathematical construct • **surfacemodel** is a surface tessellation using connected triangles • **fold** is an angular or rounded shape made by folding

Attila Foundation. Founding members Kas Oosterhuis, Ilona Lénárd, Menno Rubbens. Founded 1994 in Rotterdam.

Mission Statement. The Attila Foundation promotes the electronic fusion of art, architecture and technique. The sculpture is a building, the building is a sculpture. Artists and architects work together on the same scale, and deal with the same budget.

ONL. Founders and principals Kas Oosterhuis and Ilona Lénárd. Founded 1989 in Rotterdam.

Mission statement ONL. Once technology invades the body, the body will never be the same again. Technology evolves at a fast rate and uses our bodies as software for the technological bodies. Humans are not the final goal of evolution, technology is gradually taking over our prominent position in evolution and is evolving at a much faster rate than biological life has ever been able to perform. The technological extensions to the human body to increase the sensorial bandwidth of humans are now turning into a complex emotional environment whose behaviour is unpredictable. Technology is turning wild. Project bodies

are now the target of technological invasion. These wired bodies are a part of global networks. The bodies are connected to distributed databases and their behaviour and shape is the outcome of a multitude of running tasks. The body-specific scripts feed on data from databases upgrading themselves in real time. The project bodies are now literally animated. Architecture or art no longer has a static final image, it's visible form is becoming unpredictable as the weather. Projects goes wild.

Hyperbody Research Group [HRG]. Founder and Director Prof Ir Kas Oosterhuis. Founded 2000 at the Delft University of Technology.

Mission statement HRG. Architecture becomes a **game** being played by its users. And not only architecture will be subject to the forces of real time calculation. Also planning, construction, interior design and landscape design are ready to be developed as real time games. During the design process the game is designed by the architect and played by all parties involved. During the life cycle of the building and the built environment the game is played by their users, by the visitors and by the built environment itself. Visitors become participants in the experience economy. By playing the game the participants **set** the parameters. Each actor triggers an array of sensors writing the new data to a database, from where the building picks up the new data and starts reconfiguring itself, in shape, in content, or both in shape and content. Then the new configuration will **match** to the desired conditions. It is fair to say that the building will find itself in a state of continuous operation. The building, consisting of numerous co-operating programmable elements, will behave like a swarm. The building elements will show flocking behaviour, always keeping an eye on the neighbouring actor, always ready to act and react. Hence we propose the new motto for the discipline of architecture: **GameSetandMatch**. To be played over and over again.

Credit Projects Attila Foundation [Kas Oosterhuis, Ilona Lénárd, Menno Rubbens, Károly Tóth, Richard Tolenaar, Johan van der Kreijl]

Credits Projects ONL [Kas Oosterhuis, Ilona Lénárd, Niek van Vliet, Menno Rubbens, Andre Houdart, Oscar Rommens, Cas Aalbers, Sander Boer, Nathan Lavertue, Richard Porcher, Philippe Müller, Omar Resendiz, Chris Kievid, Michael Bittermann, Michaela Tomaselli, Rui Dias, Stephan Schneider, Christian Friedrich, Dara Burke, Titusz Tarnai, Gon Zifroni, Dimitar Karanikolov, Stephan Gustin, Tom Hals, Ines Moreira, Sven Blokker, Laura Aquili, Remko Siemerink, Jasper Eustace]

Credits Projects Hyperbody Research Group [Kas Oosterhuis, Hans Hubers, Matthew Nelson, Christian Friedrich]

