INTERACTING COMPONENTS

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Introduction

Since my entrance into the architectural area at the end of the eighties of the last century and more intensively after I was appointed professor from practice at the Faculty of Architecture at the TU Delft just after the millennium shift, I have written and edited a vast number of essays and books[1], securing to have the theory as directly as possible connected to hands-on practice. Our practice ONL (Oosterhuis_Lénárd) has been since its foundation a platform for the fusion of art, architecture and technology. Hyperbody has thrived at the forefront of interactive architecture until its self-selected abolishment in 2016. The name Hyperbody is the logical extrapolation of Hypertext and Hypersurface (Perella, 1994). Hyperbodies are consistent embodied vehicles that live simultaneously in physical and digital space in real time. In a programmable Hyperbody, non-physical and physical changes can be performed by jumping from one mode of operation to another. In this essay I will look briefly back at some key components of our combined theory and praxis, and then quickly peer into what I believe is looming ahead of us.

Building relations

Key components in building up my theory and praxis are adequately understood by reading the titles of paragraphs in my introduction to the proceedings of the GSM II international Conference[2]: "Space is a computation", "The building becomes the installation", "Quantum theory", "Real time behavior", "Swarms of building components", "Personal history from synthetic architecture to swarm architecture", "Implications for the daily practice of architecture", "Swarm Architecture from research to practice", "Uncertainty and unpredictability", "Top-down styling interventions and bottom-up swarm behavior". Currently I am writing a new book entitled "The Component ", compiling what we have done and speculating on the times ahead of us based on the mutual relationships between real time interacting components. Much of our work is ubiquitous atomic in its initial condition, building universes from a dynamic point cloud of reference points. My realized buildings are without exception based on a coherent series of reference points in space, while my nanoscale, mesoscale and macroscale thinking often is referring to swarms of such communicating points. The core principles of bidirectional relationships are at the basis of the collaborative design games we have designed at Hyperbody over the years between 2000 and 2016. Every component in the design game is parametrically connected to its neighboring component, while families of components are connected to other families of a different nature. We simply adopted the natural principles of complex adaptive systems. Not just to be studied and analysed as observers, but to be performed in real time as actors. In our thinking and doing we lived the Internet of People and Things. Both People and Things are actors in a level playing field, playing with the same set of rules.

Robotics

The robotic painting project entitled "Machining Emotion"[3] successfully established a direct link between the analog intuitive gesture by the artist Ilona Lénárd and the ABB robot arm. The intense collaboration between artist, designer-programmers and robot arm meant a novel procedure to produce works of art, whereas the artist, the concept designer and the programmers collaborated to find an output that was equally exciting for all involved. Machining Emotion is by no means an automation project; intuition and logic went hand in hand, people and machines were immersed in a recursive input > processing > output process. For us it meant a look into the future of robotic architecture. Imagine a building site equipped with people and machines and ready to start to produce building components and assemble the parts to construct a building. There is a clear design strategy and a rule-based concept for how to use the means of production, i.e. a diverse swarm of robots. The spatial layout is not yet decided in greater detail, however there is a clear vision of the procedure of how to operate. The level playing field is then used to play the design to production process. Designers, programmers and robots work on the fly to develop the final configurations. This design to production process as foreseen is not an automation process per se, it deeply involves people – designers and programmers – during the whole process until the project can be declared done. Robotic machines may vary from CNC routers, 3d printing robots to deposit steel and concrete, to self-aware assembly machines. Basically all the machines on a traditional building site that are operated manually today can be easily converted into machines that self-operate. Like self-driving cars, they need to be equipped with sensors and actuators all over. Machines and their somewhat remote designers – like tele-operating surgeons – make major design decisions during the construction process on dimensions, shape and texture of the constituting components. Learning from 3D printing on Mars as proposed by, for example the IA SpaceFactory designers[4], the materials used and processed in the production of the components are to be found as closely as possible to the building site, thus reducing transports costs. More and more, also on Earth, it will be required to use local materials as much as possible, in combination with the most sophisticated design software and production methods.

Interacting components

Foreseeing what the future will bring can only be a personal view based on one's personal experience with building. My future is per definition the here and now. I am emphatic with available social devices and technologies and feed that knowledge into my design concepts. I will here in this essay share what I believe could be future steps to be taken and where they could possibly lead to, all based on the current state of things. As I prefer to design real-world constructs, that is not as some hypothetical construct in a distant future,

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much of it depends on whether I will have the pleasure to find an enlightened client who will allow me to do what I would need to do to further develop my vision on architecture in practice. Our work has never been futuristic, always firmly based on the here and now. This pragmatic attitude was for the first time crystallized on a larger scale in the notorious Saltwater Pavilion project completed in 1997. We took the world by surprise with a radically designed sculpture-building with an interactive programmable interior. Clearly the next step will be to realize a fully programmable building body, allowing the body itself to be interactively tweaked by its users. Right now we have all the necessary expertise to do this. Yet not one enlightened client came to us to commission such a hyper-building. There would be nothing futuristic about such an enterprise, because we can achieve it using existing state-of-the-art technology. Many of the necessary techniques we have already tested at Hyperbody[5] over the years, designing and executing 1:1 scale prototypes for interactive environments, involved our master students and PhD candidates. At Hyperbody we educated a crowd of people who would be able to team up with us and just do it. With my office ONL, I proposed schemes for fully programmable bodies, the interactive installation Trans-Ports 2000 at the Architecture Biennale in Venice in 2000[6] featuring an interactive arena to virtually change on the spot the shape and the content of the 360 degrees projected building body. The public was deeply immersed in the very making / tweaking of the hyperbody and the content on the hypersurfaces shaping the body. A second important step towards fully programmable bodies was our bespoke NSA Muscle installation at the Centre Pompidou in 2003, the physical embodiment of the Trans-Ports paradigm of a programmable body. The Trans-Ports project appeared on the front page of the Libération daily newspaper in France[7]. After having realized these interactive indoor installations, the focus of ONL went to the realization of large scale buildings like the A2 Cockpit in Utrecht, the Bálna Budapest and the Liwa tower in Abu Dhabi, none of them offering an opportunity for further developing my concepts for programmable buildings that change shape and content in real time. The radical concept of real-time adaptive architecture somehow lost its momentum, and only recently have I encountered renewed interest, yet mostly from the academic side and not yet from practice. At the "Alive!" conference at the ETH Zurich in 2013, not surprisingly co-organised by my PHD candidate Tomasz Jaskiewicz whom I promoted in 2009[8], I met many like-minded researchers in one way or another involved in building interactive installations. Yet the projects that were presented were disappointingly small-scale, in none of the cases catapulted to the larger scale of building. To implement the paradigm of fully programmable buildings into the structural fabric of a substantially large building one will need to rethink its use and modality. As in physics, everything single component behaves in space and time, nothing is an isolated object, all components live in relation to each other, to their immediate neighbors in the first place. The condition to consider for a truly "alive" building is that a number of key components can be programmed to change shape. That would include the entire structure, the complete skin, and the overall interior spatial development. Structural components would become actuators, possibly in the form of electronic pistons or shape-changing materials, all of that existing technology. When we design the structure to consist exclusively or perhaps only partially of actuating pistons, the spatial conditions can be programmed to dramatically change over time. I made a radical proposal in that direction commissioned by a South-Korean exhibition developer with the design for a Digital Pavilion (2008), a programmable environment for a real time educational gaming environment unfolding in an existing structure. We envisaged the structural components to be mutually connected electronic pistons, while the surfaces spanned between the triangulated structure would have been made of stretchable fabric to project upon. Unfortunately, it was not selected to be built. The road ahead is clear though. The technology is there, the concepts are there, but the societal urgency, represented by motivated clients, has not yet emerged.

Ground Zero

The most radical concept for a large programmable structure was our Ground Zero proposal, invited by Max Protetch Gallery and exhibited in early 2002. The radical eradication of the Twin Towers required in my view an equally radical response. My response was equally critical on the dramatic act itself as on the devastating response by the American president. The tragic event redrew the global political sphere into stubborn black and white positions, without the much needed in between nuances. After condemning the attacks, I also criticized the USA for striking back unproportionally. I noticed that – as in Hollywood movies – the "good" typically kills more people in revenge than the "bad". Max Protech called me and kindly requested to soften my tone in the project description for the exhibition catalogue[9]. With the inconvenient truth of the inconceivable destructive act and the disproportionate revenge in the back of my head, I proposed a fully programmable building, to be programmed by international users of all faiths and beliefs, to be modified after their own preferences. We visualized our concept in 12 radically different scenarios[10], one radically different mode of operation for each month of the year. The built structure—which we animated to take on radical different configurations using actuators for the internal structure and sensors for the flexible exterior skin—responds to events taking place in that particular time of the year. For January we proposed United Nations Mode, February was for Valentine's, March for the transformation economy, April for international Art, May for Love Parade, June for Doomsday, July for Independence featuring the structure disguised as the American Flag, August was for the Body Snatchers, September for the 911 Memorial reconfiguring the structure into two separate twin towers,

01 | Trans-Ports on cover page La Libération, 2002

02 | Ground Zero | design Kas Oosterhuis / ONL | invasion of the body snatchers mode, 2002

October for Theatre, November for the NY Marathon, December inevitably for X-mas. It could be any other mode at any other time as well, to be decided by the public. We designed a multitude of buildings rather than offering a proposal to rebuild Ground Zero with one fixed spatial design concept as the other invited designers / architects did.

Multimodality The "where we are now" and "where we are going" using available technology and social resources would not be complete without mentioning the concept I recently developed for Multimodal Accomodations for the Nomadic International Citizen (MANIC)[11]. Building upon my fascination of iconic projects like the heroic New Babylon project of the Dutch artist Constant Nieuwenhuys, and the ironic Continuous Monument project by Superstudio architects, I developed the concept of a Ubiquitous Booking system for the new nomadic citizen. Earlier I had already developed the concept for the Pop-Up Apartment, a Hyperbody project in collaboration with and funded by the Rotterdam-based project developer Blauwhoed ("Blue Hat"). I envisaged a 50m² apartment that could be programmed to be either a 50m² living room, a 50 m² sleeping room, a 50 m² kitchen or even a 50 m² bathroom, or any combination of the above. The ultimate configuration is the 50 m² empty space, a Zen-space to be filled with thoughts and the absence of thoughts rather than with furniture. The Pop-Up Apartment offers the luxury of a spacious apartment in the compact envelope of a standard classroom. As always, my design projects start with a simple calculation. I underpinned the Multimodality concept with a simple equation. I contemplated that, although the interactive furniture would come with a stark increase in cost for the furniture, the reduction from a 100 m² into a 50 m² built-up area would lead to a substantially cheaper luxury apartment. The formula was: A + 3*F < (B + F), where A represents the costs of a 50 m² apartment, B for the 100 m² space, and F for the furniture. We assumed that programmable furniture would be 3 times more expensive than normal refurbishment. As we assume that A = 100k EUR, B 200k EUR and F 20k EUR, then the equation would be 160 < 220k EUR, which is true and obviously competitive. We further developed the Pop-Up Apartment concept for the MANIC research. Now that we had imagined the spatial building components, the classroom cubicles and the interactive furniture components, we proposed a 24-hour building structure hosting 200 of such programmable units. They would be contained in a rather straightforward tower with the units at both sides of a large atrium. The atrium would be criss-crossed by bridges, stairs and elevators as to provide for a maximum of possible communication lines. We developed the Ubiquitous Booking system. Each unit can be booked for shorter or longer periods of time, ranging from a 2-hour time slot for private dinners or business meetings.

01 |

Ubiquitous booking app The furniture configurations as needed and other preferences can be pre-programmed using the Ubiquitous Booking app, for which we designed a simple mock-up.

03 | programmable Pop-Up Loft / MANIC, design Kas Oosterhuis / ONL, 2014-2019

04 | Interactive stage GSM III Conference, design Kas Oosterhuis / Hyperbody, 2016

| 03

| 04

Longer periods can stretch all the way from weekly to monthly to virtually permanent, while the methods of payment can vary from prepaid by credit card to leasing contracts. Thus a diverse community would be established facilitating the nomadic international citizen. Naturally, the lower regions would be dedicated to social gatherings for larger groups, grand café-restaurants, lounge spaces, conference rooms, as to enhance a thriving vibrant community. We are currently looking for clients to adopt the MANIC concept in the Middle East region. The MANIC project shows that the structural idea of building relations is not confined to the design to production process itself but needs to be extended to the operation of the venue. The principles of mass-customization invade every inch of our society, from design to production to assembly to operation. Building of the here and now must respond to changing circumstances from within and from without. They respond via their adaptive facade membranes to changing weather conditions. They respond via the interior envelopes of the working / living spaces including the interior face of the facade membranes to changing preferences of the individual user. The MANIC concept is definitely something we can do in the here and now, in its aspects of building and operation.

Merging multimodality with complex geometry

Having realized both buildings as a natural outcome of the parametric design to robotic production process and having developed programmable installations and concepts for a radial multimodality, there seems to be a contradiction in combining the two approaches. While interactivity does not have a specific relation with mass customization of the programmable components themselves, and while parametric design does not have a specific relation with complex geometry, both ONL and Hyperbody however have aimed at merging interactivity with complex geometry from their very inception. The ultimate example until now has been the design for ProtoSpace 4.0, developed with Hyperbody master students in 2010. I asked the students and ONL / Hyperbody tutors to design a full-bodied single-space building, whereas floor, wall and roof are one coherent system of as large as possible complex building blocks. Eventually we produced 20 of such components (out of the 200 constituting the complete building) on a 1:1 scale using robotic hot wire cutting to shape the components. The components were assigned different performative qualities, ranging from components with window openings, components containing climate control elements, and interactive programmable pop-up components performing the interaction with the users. Each component has a definite unique shape, while following the same design to production procedure and sharing the same principle for the connection detail. The components are designed to be "dry" assembled, as to be prepared for a second life, as we did before with the design of the Web of North-Holland becoming the iWEB lab for Hyperbody. The ProtoSpace 4.0 components were re-used to form the interactive stage for the 3-day GSM III conference at the Faculty of Architecture TU Delft, after which I effectively left TUD having reached the involuntary retirement age of 65 years and 5 months. One of the grey polyurea coated components interacted with the public through a light program, disseminating the pulses through the veins between the components. The other interactive component was the lecture desk. Before each speaker the lecture desk would fold up in three hinged parts and fold down again afterwards using actuators, electromotors and hinges. The re-assembly of the components formed part of Hyperbody's master course program[12].

Choosing direction

In conclusion, answering the challenge to write about the future of architecture, my point of view remains. There is only the here and now, the actual, the real time and the full scale. I have consistently been against making scale models because they communicate so much false information. Although useful to sketch out ideas in an analog 3d environment, I insisted my students at Hyperbody make 1:1 scale prototypes. Especially when developing interactive installations, there is only 1:1 interaction, can't be scaled down. Scripting and modeling is 1:1 per definition, although visually represented on a "flat" screen. Looking at 3d printed models gives the impression that the roofscape is more important than how the user experiences the space. Navigating using walk-throughs or using virtual reality is a much better way to check out the designs. The here and now per definition incorporates all accessible technologies and all available inventions in material science, geometry development and social interactions. Still one will have to choose

direction. As if dropped in the middle of an ocean with no land in sight, one still has to choose a direction, informed by the highest form of intelligence, which is intuition. Intuitively we know where to go from here, but this is something you cannot really share with anyone else since intuition is highly individual. The direction I have chosen is to merge complex geometry with a radical form of interaction, and to parametrically design to robotically build as large as possible components that fit together as the pieces of a 3D puzzle. No more manual plaster works as in the virtual designs of the ZHA's and Gehry's, no more disconnection from main structure and skin, no more scaffolding, no more waste at the building site, no more moulds either. The new building components must be designed, produced, assembled and interacted with close collaboration between people and devices. The future of my own direction in the vast sea of possibilities lies in working with an interactive swarm of robotic devices, sensors and actuators, operated during every step of the process in sync with the designers and programmers. We have done it, we do it, and we will keep doing this, learning from our peers, our students, our colleagues, our technicians, reaching out to the industry and learning from the industry. I could not have realized the Web of North-Holland and the A2 Cockpit (to name a few) without the intense collaboration with hands-on leaders in the steel industry. We at Hyperbody could not have done the Interactive Wall project without the intense collaboration with Festo, leaders in the process industry. The future is intense teamwork, involving students, staff, designers, programmers, technicians, material experts, producers, inventors, sociologists from scratch. This is of course common sense and shared logic, yet to be implemented at the scale of substantially large buildings.

NOTES

[1] Among others: Sculpture City (010 Publishers, 1994), Kas Oosterhuis, architect, Ilona Lénárd, visual artist (010 Publishers, 1998), Programmable Architecture (l'Arcaedizioni, 2000), Architecture Goes Wild (010 Publishers, 2002), GSM I [TU Delft Press, 2002], Towards an E-Motive Architecture (Birkhäuser, 2003), GSM II (Episode Publishers / Jap Sam Books, 2006), iA bookzine series (Episode Publishers / Jap Sam Books 2006-2013), ONLogic (Images Publishing, 2008), Towards a New Kind of Building (NAiPublishers, 2010), Hyperbody First Decade of Interactive Architecture (Jap Sam Books, 2012), The Component (forthcoming 2020).

[2] GameSetandMatch II, On computer games, advanced geometries and digital technologies, pages 14-28, (Episode Publishers / Jap Sam Books,2006).

[3] Machining Emotion, available at: http://lenard.nl/?page_id=114, Dubai Design Week, 2015.

[4] IA SpaceFactory, Marsha, 2019, available at: https://www.aispacefactory.com/marsha.

[5] Hyperbody design studios between 2011 and 2016: vhPARK, reRDM, reNDSM, multiMOD, cICO, 2628 Climator, I.P.E, M4H, RE, ex25, GSM, RBSE check http://www.hyperbody.nl/education/msc1/introduction/index.html

[6] Trans-Ports 2000 Interactive installation, Architecture Biennale Venice 2000, available at: http://www.oosterhuis.nl/?page_id=559.

[7] Libération, Cover page, 24 December 2003.

[8] Tomasz Jaskiewicz, Towards a methodology for complex adaptive interactive architecture, dissertation TU Delft, 2013.

[9] Max Protetch Gallery, A New World Trade Center: Design Proposals, 2002.

[10] Architecture Goes Wild, pages 004-027, Kas Oosterhuis, 010 Publishers 2002.

[11] MANIC, research project, Qatar University, 2019.

[12] GSM III, available at: http://gsm.hyperbody.nl/index.php/Main_Page.