TU DELFT – HYPERBODY - INTERACTIVE PORTALS

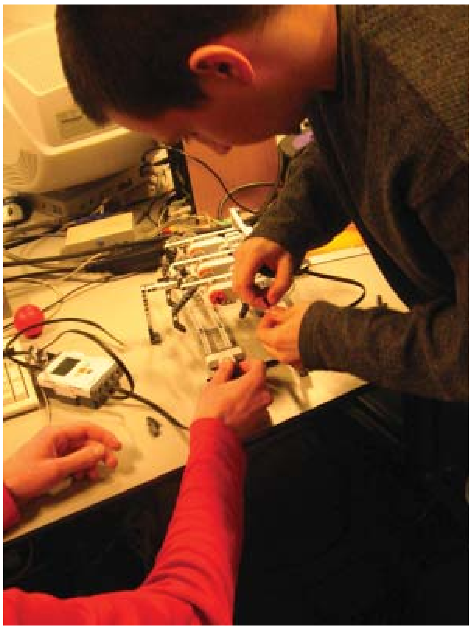
INTERACTIVE CURTAIN

Project and process explanation

by Marcus Chaidez

The Interactive Portals project implemented at Hyperbody, Architecture Faculty, TU Delft, is a design project at an architectural scale, which incorporates concepts of interactivity involving "users" and "networks" of systems. The project "Interactive Curtain", was designed and realized by a team of architecture students as part of the Vertical Studio in the first quarter of the Spring Semester 2008. The team had little prior experience in concepts involving Interactivity, embarking on a design exercise to explore ideas and create an interesting final design that functioned as part of a system of Interactive Portals. The following is a project description in detail, including: a log of the development of the project, illustrations of the materials and processes used in realization, and the various architectural concepts explored throughout the Studio.

The first day of the semester the project for an interactive portal at Hyperbody began immediately with a workshop exploring the use of reactive sensors in a built object. A task was given to the Studio; students were divided into groups and were asked to build a 'portal' out of "Lego Mindstorms" building blocks. The toy consists of plastic building blocks which can be attached to small motors and sensors (infrared, distance, button, color, etc) in order to create a dynamic 'machine' model that would react to different external factors being placed upon it. The sensors were programmed with patches using simple software ran through the computer and then uploaded to remote controllers to make the system work. The resulting 'portal' that the group constructed consisted of a series of gates connected to various sensors opened when a plastic ball was pushed down an improvised track. The model was by no means a grand success in its final product but informative as a simple exercise; in so far as we had begun to understand the process of design, construction, programming, and improvisation that would be needed to complete objective of constructing an Interactive Portal at an architectural scale.



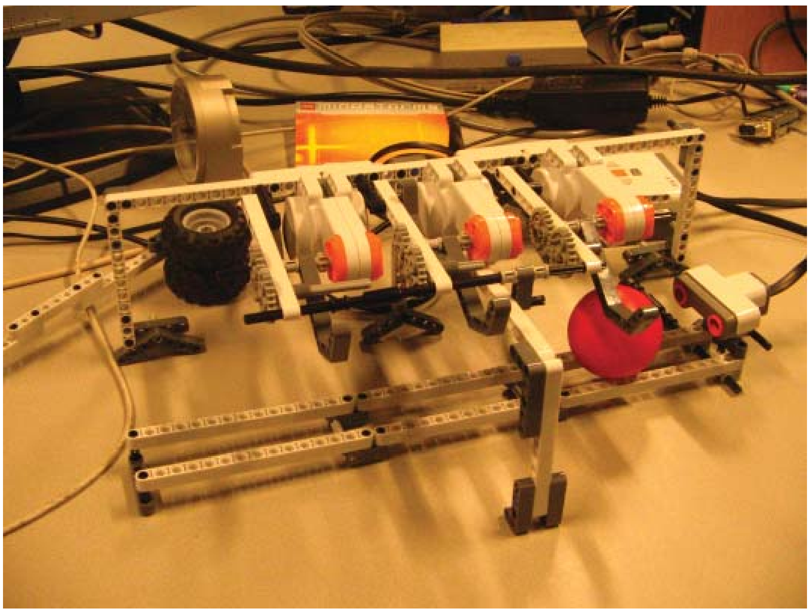


Fig. Pictures of the Initial workshop building with Legos "Mindstorms" Blocks

After the first exercise, the task at hand was to quickly come up with a successful design solution for an Interactive Portal that could viably with constructed by the team on a very limited budget within an 8 week time frame of a quarter. The final Portal, if successful, is to be included at an exhibition on Interactive Portals this September in the city of Seville, Spain. The exhibition will consist of four portals, made by two groups in Hyperbody and two groups in the Faculty of Industrial Design at the TU Delft. The 'interactivity' of the project would consist of various methods of 'linkage' between the four portals through programmed data exchanges and through each portal's interaction with people at the exhibition. In continuing the design process, the goal was that to complete the initial design concept by the end of the first week of the project. The week consisted of intensive two-a-day meetings with the tutors in which the group brainstormed in both formal design ideas along with general concepts as to a definition of what the actual meanings of a 'portal' and 'interactivity'.

By the end of the first of the first week, we began to have some concrete design ideas. The main concept evolved into an idea of the Portal, being materialized as a 'wall' that sensed when it was approached by a person, automatically creates an opening to allow passage. The wall would consist of a series of strings that would be moved and/or retracted to create this opening. The initial spatial strategy was that the Portal would act as a 'transition gateway' between two different spaces written in a simple formula as 'A - to - B - to - C'. The distinction meaning that 'A' is one space, 'B' is the space contained within the portal, and 'C' is another space which one enters when leaving the portal. The space 'B' in the portal would be a 'room' of these wires where people could 'meet' in an enclosure of a free-flowing polystyrene shape. With reference to interactivity, the idea of a 'game element' was envisioned in which the wall would allow or refuse certain users based on specific traits or by data being supplied by the other portals in the system. The aspects of use or the 'mood' of the Portal would then be transmitted as data back to the other portals. A presentation was given of these initial concepts to the Hyperbody team including Kas Oosterhuis and Henriette Bier at the end of the first week. Some praise was given to the concept of the 'sensing' wall while the idea creating an enclosure space was critiqued on the basis of viability along with the lack refinement in our first visualizations of the polystyrene support structure. There was also a realization within the team that the interaction aspects of the Portal were still at an infancy of development.

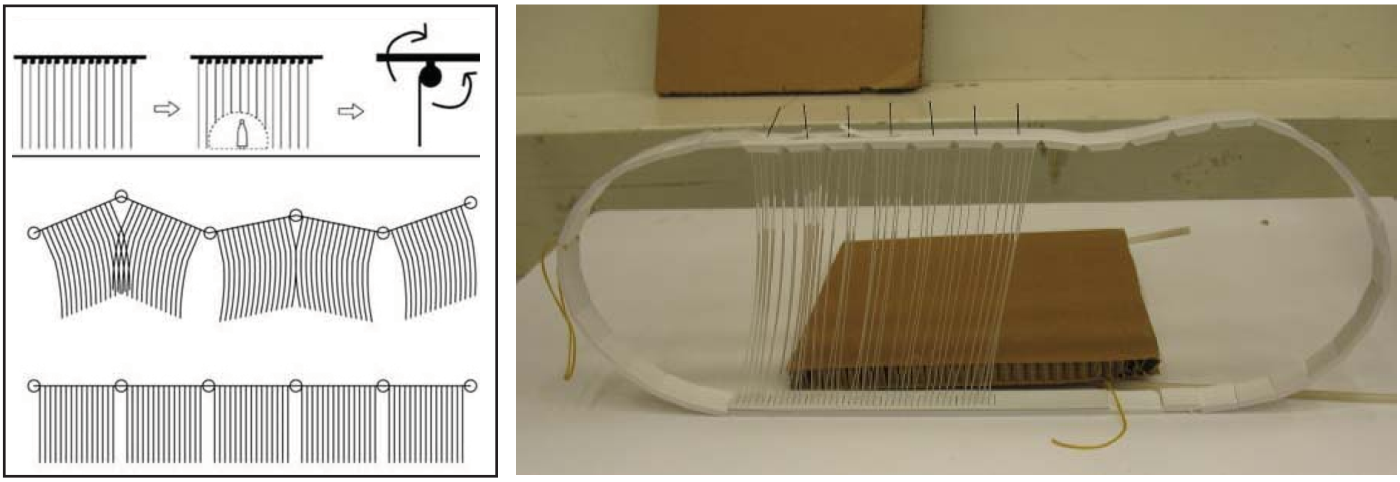


Fig. Diagrams showing the 'wall' of strings the moving components, model of the system testing the panels.

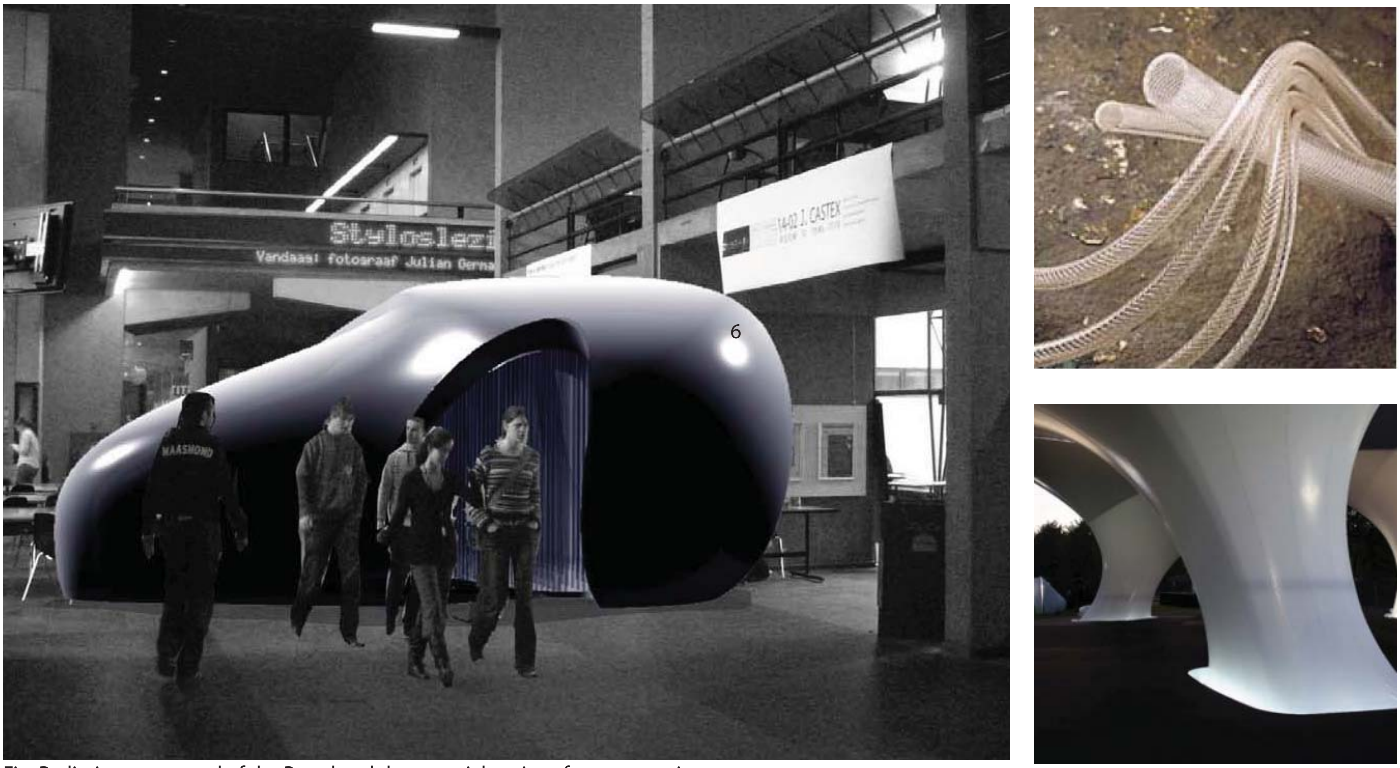


Fig. Preliminary proposal of the Portal and the material options for construction

The critique from the preliminary presentation helped solidify a direction towards the further development of the Portal. The next week focused on design and research into the form of the portal, aspects of interactivity, and the technical issues to the realization of the structure through the use of drawings, scale models, and 1 to 1 mock-ups. Through the intensive meetings, a preliminary form of a singular 'loop' shell 7m wide and 2.5m tall was proposed. The shell was to be made of smaller panels that would be actuated by pistons in order to create openings in the wall. Mock-ups of different materials were made of the panels and strings in order to find the best solution based on viability of construction, cost, and aesthetics. At this point, the consensus was that the shell should be made up of polystyrene while the strings would be composed of thin sheets of transparent Perspex plastic cut in 10cm strips. Further developments on the interactivity of the Portal with the system included differentiating certain movements of the strings of the wall when reacting to specific influences: the automated door based on the presence of a user, the 'flowing' or graphic movements programmed or influenced by data sent from the other portals, and A 'ghost' door created by movement tracked in the other portals. A scenario for the location of the portal within the BK Faculty was chosen and analyzed with diagrams and renderings were presented at the end of the week to the Hyperbody team.

In the following weeks, with a basic system and a general formal concept agreed upon, the next task was to develop the technical solutions further. Major issues and concerns were expressed on the actuation of the panels using pistons and as to the probable success of the openings using the plastic strips attached to the panel and the floor. Many iterations and design ideas over these technical issues were explored in close collaboration between the team at Hyperbody and with the aid of Jan-Willem Breider from the Civil Engineering Faculty at the TU Delft. After many different design variations of panel sizes, number of openings, actuation, and support systems were analyzed, a viable construction system was found. The use of pistons for the actuation of the panels was abandoned in favor for a system of cables where each panel would have a structure above that is connected to a small motor (similar to those used in windscreen washers). The motors in the block will wind the cable which would in turn pull on the structure and panel, pushing it down onto the strings and creating an opening in the wall. Because the cable system is not self-supporting, the idea of the thin plastic Perspex strips had to be abandoned in favor of PVC pipes that could support the weight of the panel and the structure overhead but still bend in order to create the 'door' openings. Many iterations of the panel and cable system were painstakingly tested in mockups until the team was confident that a working solution was found: By connecting steel break-cable with a structured enclosure to a pyramidal frame, the panels could be sufficiently actuated to create 'door' openings. The structure supporting the cables on the top of the panels was constructed of a composite system after number variations. A 3d model of frame was tested and refined in Rhino until it was ready for production. The resulting pyramidal structure was constructed out of fiberglass poles (from tent structures) and small steel connection pieces which were produced with the gracious help of Kees Baardolf at the Metals Workshop in the Architecture Faculty.

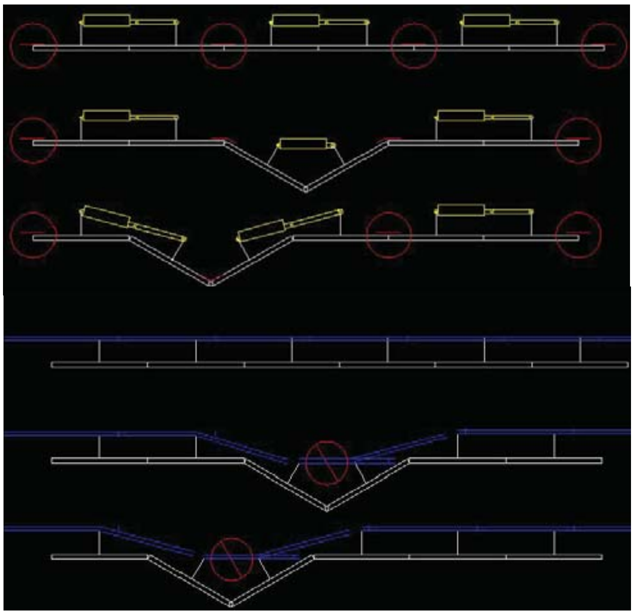


Fig. Drawings of system failures using piston or muscle systems, picture testing the mockup of the 'cable' system

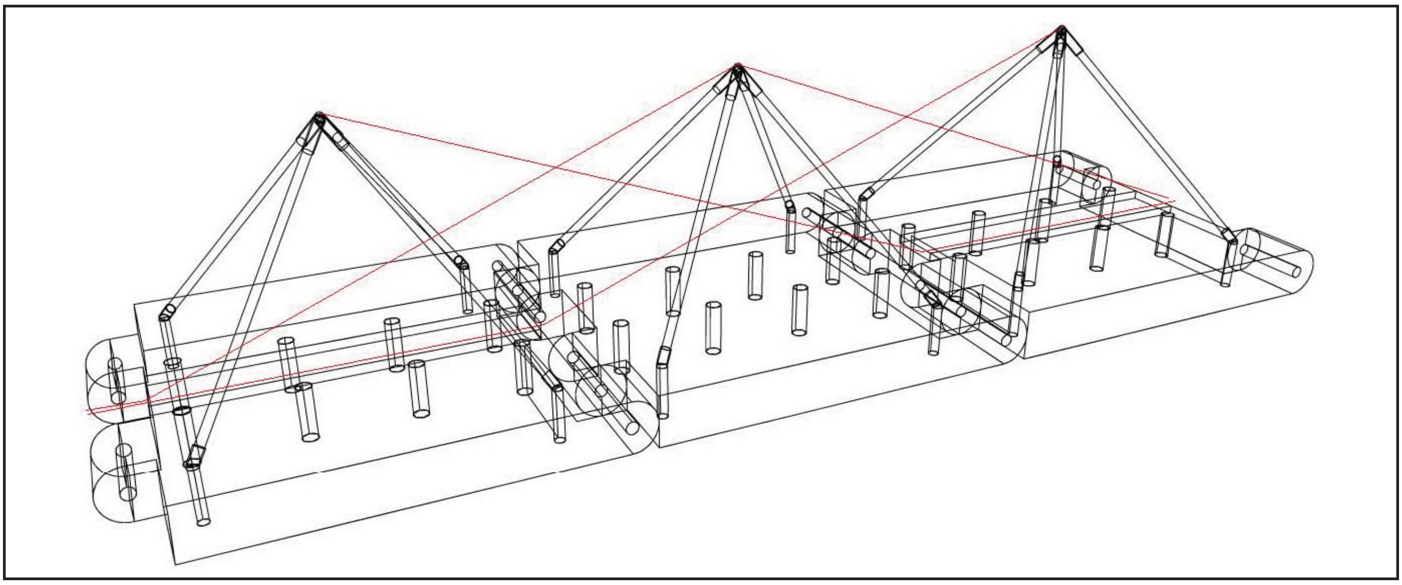


Fig. 3D drawing of the panel system with the pyramidal frame

The overall shape of the 'loop' was continually refined until an appropriate design solution was achieved. The resulting shape is an asymmetrical form which, in conjunction with the plane of the wall, re-introduces the original idea of a 'space' in the portal by including benches that emerge on either side of the shell. The benches allow a user to actually occupy the Portal along with passing through the wall. Upon completion of the design of the form, the technical aspects of construction were investigated further. As stated, the preliminary idea was to construct the shell out of polystyrene with a fiberglass covering, a common way of working with complex shapes such as in boat-building. A workshop on the process of fiber glassing techniques was given to the team by members of the Industrial Design Faculty. Meanwhile, the team also explored the option of obtaining assistance from Polyproducts, a manufacturer familiar with constructing polystyrene structures on an architectural scale. After much discussion about the economic feasibility, lack of experience of the team, and time constraints in collaborating with Polyproducts to create the polystyrene shell, the method was abandoned in favor of a more traditional method of framing with wood and MDF with cladding. The framed structure that would also allow space for the cables and motor blocks that would be used to actuate the panels to be placed within. The structure was produced by constructing the framing in a computer 3D model using Rhino and' unrolling' the surfaces onto 2D planes where they could be printed and used in templates for traditional sawing techniques.

The most difficult and painstaking process in the realization of the portal was the design and construction of the movable panels that were actuated by the system. The panels had to be lightweight and easily and firmly connected the PVC tubes on which they would be supported, strong enough to handle the forces from the pulling of the motors on the steel/fiberglass structure connected to the cables that the panels support, and last but not least they had to be aesthetically pleasing, they would carry out the main task of movement of the portal. A design of interlocking panels using the metaphor of a 'watch band' was developed. Previous mock-ups of options included an option in wood that was prohibitively heavy, an option of cardboard that was torn apart by the forces of the cables, and an option in hollow plastic that could not support the forces applied to the pyramidal frame. After these series of failures, it was decided that the panels should be constructed out of fiberglass.

Fiberglass has the positive traits of being lightweight and extremely strong which lead the team to find it as the ideal construction method for the panel. As we had learned in the workshop, fiber-glassing can be accomplished in many ways, from hand-laying to vacuum techniques all using a wide variety of different material densities of fiberglass and resin types. The team first embarked on a process of discovery in fiber-glassing by building a mockup of the panel using the hand laying system on a positive mold of Styrofoam. The technique proved to be a cumbersome and time consuming process that did not give a 'smooth' surface covering to the panel, which was a crucial visual affect. After a series of tests on variations of this method, the team realized was that it would be impossible to finish the 12 required panels within the required time and achieve a positive aesthetic result.

The final solution was to construct molds and use the vacuum system of fiber-glassing carried out with the assistance of the Composites Lab at the TU Delft campus. Theoretically, by having a mold that can be re-used over to create all the panels, an enormous amount of time and effort would be saved. In this process, more effort is spent in preparation for an easier production process. The system is commonly used to make high quality products that are reproduced in high numbers as part of a series. Many iterations of preparation can be experimented to create a perfect product output. Our team's situation was a bit different in that we needed a relatively small series batch of 12 and that we did not have ample time to go through many iterations of the process. Through many trials and tribulations two members of the team worked diligently and learned the painstaking process of using the vacuum mold technique of fiber-glassing to produce the panels. The panels were created using molds that broke unexpectedly and needed to be recreated after each individual panel was completed. A tremendous amount of effort was put into achieving a perfectly smooth finish with varying degrees of success. After the completion of all the panels, the system was assembled and the fiberglass panels worked exceptionally well.

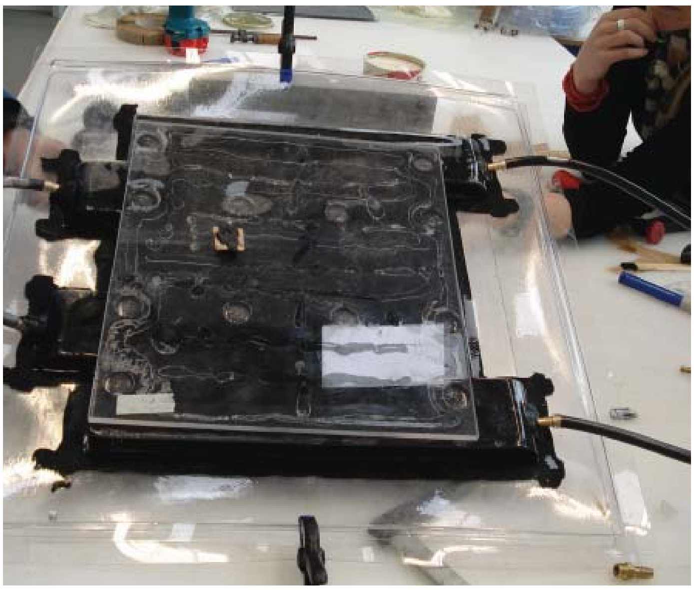
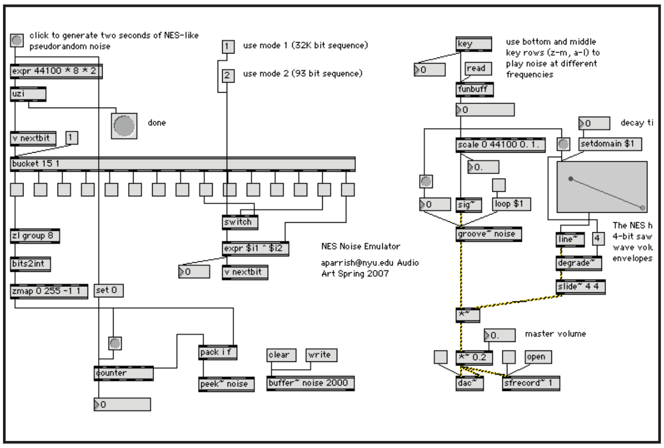


Fig. Pictures of the final panels being produced using the vacuum technique.

Another key to the success of the project was the actuation and interactive components of the system. The portal was designed with mounted ultrasonic distance sensors that would be able identify the location of users coming within a range of interaction with the Portal. This data is collected and interpreted in a computer within the portal and is used as an input through a patch created with MAX/MSP. The team was instructed in a series of workshops on how to implement the use of sensors and MAX/MSP software to create the desired programmed effects. The programming of the Portal allows for 6 independent openings to be created at one time, allowing six people to traverse the portal simultaneously. Another option is to create different degrees of an opening in the wall dependant on the distance of a user from the portal. Other effects include using these six openings are programmed to create visual effects based on input data received from the other portals. Data from the Portal would be transmitted to the others, would be things such as a tally on the usage of each of the six doorways, the number of people who merely pass the portal without traveling through the wall, and perhaps the amount of people who decide to sit on the benches.



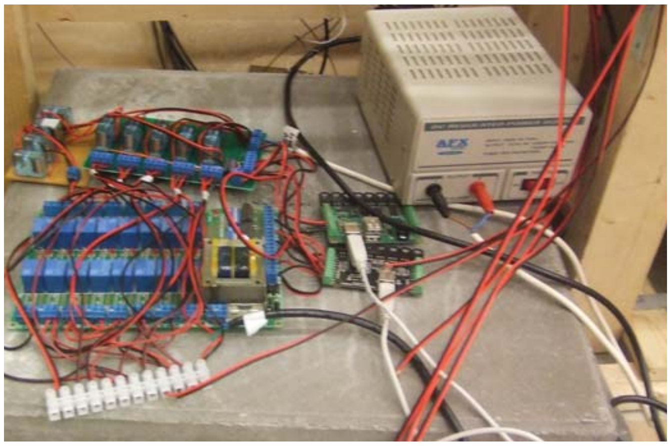


Fig. Screenshot of a Max/MSP patch, the computer system placed within the framing of the portal

The process of design and construction of the portal was an intensive fast-track design project that was extremely successful in teaching and inspiring the team as to the potential of using interactivity as a main design element within an architectural project. The project team worked intensely in collaboration with the tutors at Hyperbody. We think the Portal, "Interactive Curtain" is successful as an interactive object within the context of the exhibition and also could be perceived as a prototype for an interactive façade built on a larger scale, perhaps for an entire building. The learning processes and experiments developed during this project will serve as a foundation of knowledge to the members of the team. The project instilled the goal of being to use the knowledge gained from the exprience to create ever more sophisticated, experimental, and practical uses of integrated interactive systems within architectural applications. The portal can be understood as an entrance embellished with added meanings when passed through. The Interactive Skin is one way of applying 'dual' meaning to a common building component. The dynamic aspects of the Interactive Skin could lead to more interesting design solutions by surpassing the interest of a passive wall with a door and windows.

Fig. Pictures of the portal after erection

PROJECT CREDITS

PROJECT:	Interactive Curtain
REALIZATION:	2008
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