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Hive Systems:
Explorations into the Possibilities and Consequences of Behavioral Programming in Architectural Spaces

by

Logan Ray

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

Master of Architecture

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ABSTRACT

HIVE SYSTEMS:

Explorations into the Possibilities and Consequences of Behavioral Programming in Architectural Spaces

by

Logan Ray

A series of research projects were conducted into the possibilities of creating life-like intelligence within architectural spaces. Various methods for applying behaviors to physical environments are explored, culminating in the design and creation of a mutually interactive website and physical installation. This installation allows users of the physical space to affect the experience of those entering the space virtually, and vice versa. Custom programmed script allow web visitors to manipulate the atmosphere of the physical space, and experience the effects through multiple views of streaming video and audio. The installation attempts to give a glimpse into the future of integrating information systems with architecture.
ACKNOWLEDGMENTS

Many thanks to all those who lent a helping hand or words of advice on the project: David Brown, Luke Bulman, John Casbarian, Cemre Durusoy, Kevin Guarnotta, Gunnar Hartmann, Lars Lerup, Steve Maynard, Sven Zbinden, and especially to Omayya Kanafani, whose help and companionship made the good times better, and the hard times not so hard. It would not have been possible without all of you.
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Preface

This thesis began with the intention of being a joint project between myself and my good friend Gunnar Hartmann. Over time we (or maybe just I) began to see divergent interests, and we split up to pursue different courses for our own separate thesis projects. There were (and are) many things we were both interested in: the value and joy of contrasting pure conceptualism with harsh reality, the importance of seeing things in front of our eyes, and a passion for intense discussion and experiment in formulating our approach. There were certain things I knew I wanted to do, however, that I knew could not be done in our partnership, at least not to the same extent: to focus on designing form, to focus on technology, and to delve into evaluating and implementing these systems within their contexts.

The language and concerns in the early research portion of this thesis document are truly those of both of us. As the project developed, the projects I developed and chose to pursue, however, became of course very different from those that Gunnar chose, as is evident to anyone who looks and compares this document with his (which should be on the same shelf). But looking beyond the specific focus that I took, the underlying interests were developed in large part through two or three key projects we undertook together, and I believe that we truly influenced each others thinking tremendously. So it is for these reasons that I believe Gunnar deserves a special mention in this document which marks the end of what we started together, almost exactly one year ago.
Research / Experimentation
Intentions
August 20, 2000

This is a project whose vision is to make visible an intersection between two worlds. These worlds are: 1) the world of media and information, and 2) the world of physical things as experienced by our bodies. What will happen at this intersection is yet unknown. There could be a crash. The two could pass each other by without notice or incident. Or maybe there will be a slow drawn-out scraping interference, which will produce some interesting noises.

In order to look at how these two realms can meet, we propose a series of projects. These projects will be dealing with the middle ground, with one foot in the virtual, and the other on solid ground, but hopefully in such a way as to allow room for interpretation of the movement in between.

Such a broadly defined area of interest requires some framing. What exactly do we mean when we say we are interested in the intersection of the physical world with the world of information, the virtual? At present, both of these areas have clearly defined boundaries, at least to the average person. The surface of the computer screen, our "information portal", separates the virtual, pure information, from the physical, pure substance. It is easy for anyone to see where the virtual stops and the physical begins. If any crossover takes place, it is in the mind. By this we mean that the method of thinking, the interpretational strategy of one will occasionally influence the other, but traditionally the two remain separate
entities, each with their own unique sets of possibilities, navigational tools, and methods of interaction.

Increasingly, however, information is working its way into objects. The virtual world is slowly creeping into the physical. Logos and trademarks (embedded information) have been steadily increasing in importance as a requisite part of objects in modern cultures. Is Tommy Hilfiger selling t-shirts or walking billboards? Irons are equipped with information on a chip, which automatically shuts off the power when sitting face down and stationary for too long. Phones display who is calling before we even lift the receiver. Lamps sense motion and illuminate backyards. Information, which before was considered unnecessary, is now being stuffed into and layered upon physical objects (which were already functional) in an effort to increase convenience, awareness, safety, and a variety of other concerns.

While we have used mostly appliance-like objects as examples here, the spread of information goes further than just into smart gadgets. Our entire environment is having additional layers of information slapped on, and at an alarming rate. Jetsons-like automation is not so far away for the average suburban house. Urban traffic is being monitored like blood flow, posting route changes and detours, expected delays and trouble spots. Advertisers are now commonly using a “behind-the-scenes” approach to making ads, appealing to our own sense of cleverness and love of information.

When we wrote before about the crossover possibility between the physical and the virtual being in the adoption of methods or modes of interaction from one world and transplantation into the other, that is exactly what is happening at present. Slowly, slowly, bit by bit, the
information saturated environment of the internet is creeping into the physical world, in order to match the decreased attention spans, the need-to-know sickness, our hunger for brain food, 24-hours a day, 7 days a week. We are becoming used to having information, the virtual world, accessible to us, on-call, at any time, and it is changing our expectations we have from our physical surroundings. The attitude and methods of the virtual are becoming the attitude and method of the physical.

We are getting used to being know-it-alls, and it is infecting everything around us. As Marshall McLuhan has said, “the message of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs.” The information age is here. How will our environments react to it? How will the physical world respond to its melding with the virtual. Literally.

In order to explore the emerging possibilities of this intersection we have developed a working method, which allows us take advantage of being two people working together rather than one. This method involves research (including presenting book summaries and case study analyses to one another), discussion, and experimental actions, or projects (see attached list). All three components, research, discussion, action are to be carried out simultaneously and continuously for the duration of the thesis. (and beyond?) Through our working method thus far, several terms have emerged out of our research and discussions. The first is an expanded notion of the term landscape. We are interested in the term landscape because it brings up several issues that we feel are pertinent both in the physical and virtual worlds, and also to this thesis project. The first issue the term landscape brings up is one of vision, both literal and in the creative sense. Perceiving a landscape is
a literally visual experience, eyes straining to see past the horizons. But the other meaning of vision, the ability to visualize, or construct in the mind, a scenario is also something we strive to do through our writings and projects. The other connotation of the word landscape we found interesting is the idea of something beyond the full grasp of the senses. A space whose full image has to be formed in the mind as it cannot be sensed. These issues we feel are relevant to both the proposed projects, and the conception of the thesis itself.

A second working term, or binary pair, we have developed is the idea of live space/dead space. Similar to Marshall McLuhan's concept of hot vs. cold media, these terms were useful for us to envision (as an easy-to-understand duality) an intersection, which is normally mind-bogglingly vast, intermingled, and dispersed. The world wide web, our information network, is full, dense. It is easy to envision as infinite space, and yet the only part of that information space which we can see is that which has been used, which is filled in. Houston, on the other hand, our physical environs, is by urban standards virtually empty. We notice the abundance of space in between, at least for a city, and it is the parts that are filled in that we cannot see into. It is a figure ground relationship. Can this relationship of opposites, of live space vs. dead space, be worked into a strategy for experimentation and intervention? If we think of space as full of possibility, and density as full of information, how does this relationship effect us as city dwellers?

Both of these working terms will hopefully become more clear to the reader in the following sections on landscape and in the the proposed projects list.
Initial Project Sketches

September, 2000

Hotboard

Hotboard is hot-linked to a website, and updates instantly to show the latest input. Users must fight for this urban space, protecting their message from others who would come and change it. (Perhaps in this way alliances or coalitions are formed to get a message through.) Feedback Rating: see it, use it, see it (full loop)

Necessary equipment: web site, programming for live update, electronic message board, visible location to place board.

Is about: equal opportunity in the visual landscape. Also hyper quick change: Making our environment around us as flexible and easily changed as our thoughts.

Urban triggers (stickers, boxes, small objects)

Small objects placed throughout the city give the location of a web address. At the specified address, the finder can report where he/she found the object, and attach any sort of message or information to the physical tag. How is this different from just a sticker for any web page? The web site is just a collection of information about these actual places. A new virtual city begins to form, built from parts of the larger whole.
Illustrations of HiveTags concept.
Alternatively the tags are placed by the user, who is leaving clues for a specific person. Motivation? What if a person is mailed one new trigger for each response they post under their username.

What if the sticker user can add links to other websites. Businesses can use the stickers to direct users to their own web sites., people can arrange meeting times, link to message boards about a neighborhood, or people who live there.

Is there a way to connect tag-to-tag? Object to object? What would these connections be about?

Designs for Hivetag labels. One difficulty in considering the actual production of the adhesive-backed tags is how to mass produce them, and still be able to have unique numbers on each. Proposed numbering methods included stencils, smaller stickers, or simply entering the digits in permanent marker within a given area or boxes.
Necessary equipment: stickers, printing (dad), web site, seed the field (placing the first hundred or so ourselves), perhaps advertising.

Possible methods: i.d. numbers which can be entered on a website to pull up the information from a database. E-mail addresses which can deliver to the users. Bar codes which can be scanned and used to access pages.

What about the new commuting student stickers that rice has. Each one has a specific bar code. Where were they printed? Were they expensive? What type of equipment is necessary to read them?

Is about: Tagging. Putting your own message on the world around you. Making a small visual imprint, or change (a small sticker), but a big change in terms of the information context of the object (connecting it to whatever other information the sticker-placer wants to). Adding layers of information to objects. Making the world a big database, making places bookmarks for memories, objects into triggers for thoughts and connections. (which they already are, but expanding the connections to those of other people, too)

e-shirts

This project is about instant personal feedback. The shirt contains a website address, and a number or code, which is specific to each shirt. Any person who sees this shirt can log in to the web site and either: a) rate the person wearing
the shirt in certain categories b) send an e-mail to that person c) report a sighting; indicating on a map where the person was seen.

Necessary equipment: web site, database programming, printed t-shirts (e-shirts), perhaps advertising or free giveaways to start the program.

Is about: random communication with strangers. "I like your hair. Where did you get it done?", "I have seen you at both of the music shows I went to last week and wanted to know if you would be interested in sharing some mp3s?" Benefits: make new friends, be surprised by random communications, be aware of when people are aware of you. Downside: you can be contacted by anybody. Including creeps and wierdos that you do not want to get to know. At least you are only giving them an e-mail and not your address.

Houston hive

Web site: an urban community. People can use this site to share news about their area, events going on, tips on places to eat, park, do laundry, etc. Would allow people to link together their e-shirt listings with their hive tags and buzz event listings. Sub groups could form, based on shared input: users who live in the same area, who like to eat at the same kinds of restaurants, who like to hang
out at the same bars, who frequent the same clubs. Users can pick which other
users they want to see postings from.

Requirements: a web site, extensive database linkages and programming, adver-
tising, and users.

It is about: sub community, sharing information, adding new connections and layers
to the urban strata.

Prototype for Houston Hive info-networking site. Intended as a place for citizens of a dispersed
city such as Houston to share knowledge of events, places, and things that they otherwise might
never find. The site was also meant as a platform enabling and sharing many of the other projects
on the list.
live space/dead space

What if you built a totally enclosed box, on a vacant lot, in Houston. The only way to see inside this box is with a live web-cam. How does this change the way one thinks about an urban space. This space is open to the public, perhaps more open than most buildings in Houston. How is visual occupation different from the physical. Are there other types of occupation that can take place in this space?

Necessary equipment: box (building materials), telephone connection, web cam, web site.

Is about: looking critically at what the term public space means in our age of media. Does a space have to be accessible physically to be deemed "public"?

architecture store

The architecture store is just what it sounds like. It is an on-line store of architecture projects that you can buy and build. It is like a book of 101 house plans that you can get at Home Depot, only it is not just homes, it is a listing of all sorts of urban projects. The difference is that most of the projects are site specific. In this project, the client is the urban situation, and the person who actually pays for the project is reduced to the level of a simple consumer. Is this desirable? What makes this project appealing?

Necessary equipment: web site, advertising, and lots of speculative projects to put up on it.
urban bulletin board (Hotmap)

This project is to create a map of Houston, on the internet. The user, who logs on this site, can use his cursor to pick any point on the map, and then write his/her own message, that will thereafter be accessible to anyone who looks at the site. It is a second version of the city to which can be attatched stories, myths, instructions, inventions, experiences, and other informations. The real city is in turn reshaped by one's changed perception.

Is about: a forum for urban legends and other information. This information in turn affects the way the reader views the city the next time he or she looks at it.

density Shift

The world wide web is full, dense. It is infinite space, and yet, the only part of that space we can see is that which has been used, which is filled in. Houston, on the other hand is virtually empty. We notice the abundance of space in between, at least for a city, and it is the parts that are filled in that we cannot see into. It is a figure ground relationship. Can this relationship of opposites be worked into a strategy of densification for Houston’s urban landscape and an opening up, providing a broad openness for the internet. Give it a sense of empty space. Do others feel the same way? If we think of space as full of possibility, and density as full of information, how does this relationship effect us as city dwellers? Can it be improved?
Hypersurface

When speaking of the possibilities which emerge at the intersection of the real, physical world and its virtual counterpart, there are no simple answers. It is not a simple impact where the resultant forces all ricochet off in one direction. The resulting questions, or modes of interaction, fly off in directions quite varied, and with disparate speeds and masses according to their current popularity.

One interpretation of this intersection is that of the so-called "hypersurface". This term, coined by Columbia Professor Stephen Perella ten years ago, first emerged out of the amazement seen at the unveiling of the technique of "texture mapping", used in 3-D modeling softwares. Texture mapping, put simply, allows the modeler to take any image and use it as the visual "skin" of a modeled object. For instance, one could scan in an image of sheep grazing in a field and apply it as the surface for a model of the empire state building. Texture mapping allows the layering of one set of visual information upon another, with or without congruence. It is a tool that can be used either for heightened realism (mapping a close up photo of apple skin onto a model of an apple) or for total juxtaposition (a gravel surface on a taxicab). Technology has moved ahead, so that we are now able to use texture mapping not only with still images, but also with moving images, or video. A video clip can be applied as a surface to a computer model, giving not only another layer of visual information, but also a sense of change over time. As most technologies do, these amazing modeled spectacles of animated buildings, and texture-mapped objects have generated their counterparts
in the real world. One has only to go to New York or Tokyo to see that building surfaces can be visually animated, such as the giant wrapping video screens in Times Square. It is also now common to see buses with full color advertising shrink-wrap graphics. A real life, texture-mapped model driving around the city. What all this means is, Objects do not have to look like what they are anymore. Architecture, specifically, if it so chooses, does not have to be a static object. This is one resultant vector of the collision between the real world and the virtual. The hypersurface. Another resulting set of questions comes not out of the possibilities of 3-D modeling software, but of new developments in communications. Teleconferencing. Streaming live video feeds. Webcams. Chat rooms. All of these things allow us to extend our presence into places unknown. Our persona is translated into a representation, which can travel far beyond our physical bodies, and interact with other such representations along the way. A direct reversal from the previous example, in this case, the virtual world is trying to translate ideas in from the physical world, instead of the other way around. The virtual world wants to simulate direct face-to-face communication between two people in a physical space. Interfaces for this purpose are being designed with the intention of providing ever more feedback from one’s virtual representation, or avatar, as they are called, to the referent human being. These virtual representations, or avatars, are our own specialized pioneers. They are our identity within virtual realms, and we are placing greater and greater demands upon them. As pioneers, we want our virtual representations to be skilled at tracking (searching for information), navigating, diplomacy, all of the skills necessary for venturing into new territory, and we want them to be able to communicate back to us what they
Our most tangible representation of Perella's concept of 'hypersurface', Times Square, New York City. The information is dynamic and becomes the true material of the facade.

find. A relatively new, possibility, however, is that of going through the wires and coming out again. By this I mean a human being controlling another physical entity across a great distance. In this case, the avatar is physical, and as such can be used to explore physical space. The remote controlled Mars Rover is a good example. These stand-ins for our own bodies attempt to gauge and send back information about a place just as our direct sensed feed info back to our brains. It is like a new organ; attached to us by an umbilical cord of wires, satellite signals and infrared waves. Maintained by others, perhaps, but controlled by us.

RSA Lounge Installation
Issues relevant to Hive Systems RSA Lounge Installation:

Make possible the behavioral autonomy of sensing spaces.

Environments, when equipped with sensors, video cameras, electrical appliances, are able to detect events occurring in and around them, and also to react in some fashion. A person may therefore determine a set of “behaviors” for a given space. A nasty space could be created, which tries to shoot you, or make you uncomfortably hot, or kick you in the shins each time you walk through the door. Or a pleasant space can be set up, which recognizes you and greets you, perhaps automatically turning on your reading light and drawing the curtain, should you so desire. The possibilities are endless, but the bottom line is that there we now have the possibility of setting up spaces with reactive attributes, or “behaviors” which once set up can act independently of any further instructions. If a room is given (programmed with) the behaviour of opening a window every time two people enter, from then on, each time two people enter that room, the window will open, no questions asked, with no one telling it to do so. These programmed, or hard wired attributes give architects a whole new palette of tools with which they can shape a spatial experience. In addition to spec’ing a child’s room with pink paint and a walk in closet, the architect can now also specify a homework lighting system that comes on when the child sits down at her desk, and shutters that open and close automatically based on the time of day. These events are simple, but they are examples of the dynamism and flexibility that is now possible.
Networking of behaviourally enhanced spaces only multiplies their abilities. Say this nice child's room can also send a message to her parents nice room that announces little Sally has gone to bed once she has turned her lights out and deep breathing is detected. It can also send a signal to shut out the lights and heater in her playroom down the hall and record the time in a log that her teacher or doctor can look at if he/she thinks Sally might not be getting enough sleep.

Or perhaps spaces could fight. Maybe Sally's playroom decides to flash the lights and slam doors in the whole house when it has not had an occupant for 24 hours. Or a kitchen bemoans the fact that no one uses it in a pre-recorded tone to anyone who will pause long enough to listen.

These are all examples of pre-programmed, simple, responsive behaviours. What will really be interesting is when spaces can learn. When a space can learn your habits and make predictions, when a house can shut itself up when it expects a rain storm, when behaviours are adaptable and change based upon experience—then we have true animism.

This may sound far-fetched, but slowly and steadily our attitudes about what we expect from our architecture are changing and will continue to change. We have all come to expect indoor plumbing, and then electricity, and central air and heat. We have come to expect these things as integral, continuous within our building systems. Likewise, behavioural attributes will in time pervade our architecture. Just as there are loud and soft personalities for people, so I believe there will be
loud and soft personalities for spaces, or buildings. Some rooms may just quietly adjust themselves spatially, for lighting, and for temperature, without drawing much attention. Just the barely audible hum of a wall sliding into a different place behind us, or the gentle almost imperceptible dimming of overhead lights as the sun slowly comes out. Other spaces might be much more dynamic, or even confrontational. But I believe our expectations will change, and the attitudes and consideration of these systems by architects must precede these expectations if their value is to be truly understood and meaningfully incorporated into our society. Increased knowledge of usage patterns for a given space, which in turn will allow for better, more efficient use of resources: electricity, hot water, heating/cooling, security

Improved ability to share direct experience of a space (If a person learns a city better by having to find his/her way around better by him/herself, then it follows a person would be able to understand a space (including virtual space) better if they are allowed/encouraged to manipulate it.

Things to look at:

1. Behavioural qualities of a space (responsive, active)
2. Non-local interactions with the space. (Networking, Telepresence)

What do these new or developing architectural attributes bring to the table? How will they resolve themselves within our public and private lives?
Process: Constructing an Interface

The construction of the Hive Systems RSA Lounge installation began with the clearing out of the existing space. Although used almost every year for a thesis project, the architecture school lounge always manages to fill itself up with crap at an alarming rate. Once the space was clear and I could get a better idea of what I was working with, we took a thorough set of measurements.

The lounge was chosen as the site for the installation for several reasons: It was already wired with an excellent T-1 connection, and several ports, it had a certain guaranteed amount of foot traffic passing through it, and perhaps most importantly, I already had permission, and easy access to the space on a daily basis.

I had already performed a few simple experiments and demonstrations for the thesis committee, displaying how I could hook up a simple web interface including several lights, which could be turned on and off, and a web cam which posted pictures every ten seconds or so, showing evidence of these manipulations. With the lounge installation, I needed to take these kinds of manipulation to another level. It was desired also to create some kind of physical manipulation of the space, a mechanical interface, which turned out to be the most difficult part. The first creation was the light wall. The wall (9' tall x 16' long, was framed out in a day, then wired up with sixteen outlet boxes evenly spaced on one circuit over the next two. With the help of a few friends, the wall was lifted, banged,
View of interior of installation during early phase of construction, showing internet chat station/programming base (1) and recently sheetrocked light wall (2).

squeezed, and then nailed into place, creating an unusual corridor behind, but giving a linear sight line to the main entry.

My friend from New York, Jonathan Hickman, who happened to be visiting one week-end, helped me with the sheetrocking, which went very smoothly, and taught me the importance of precision in the cutting of the holes. With the wall up, I taped and bedded all of the sheetrock joints, and continued to look for a computer I could use to interface with the world wide web, and send and receive the X-10 commands.
I planned to use at least three web cams, which presented a problem. Most of the good new web cams on the market use USB connections, which most inexpensive old computers do not have. Nor, for that matter, do they have the memory and processing power to withstand processing and sending an image every fifteen seconds via FTP to the hive systems server without crashing. Eventually I chose to order two cheap Pentium 166 Mhz PC's from a used computer surplus dealer in Pennsylvania -- $100 each -- which I would then outfit with cheap network cards, and USB ports.
Ceiling mounted networked workspace unit. Includes florescent overhead lamp and retractable, internet controllable power sources (1). These retractable cords can be used for pull down task lighting, or to power other rolling furniture units within the installation.

With the computers on the way, I needed a place to put them. One would go near the door, and serve as a chat/interaction station for those using the physical space. Here physical users could type messages back and forth with the virtual users of the space, and manipulate certain things which were usable only from the internet. This computer would also have one web cam hooked up to it, which could show the chatting person's face to those on the internet, and give an overall shot of the interior of the installation.

The second computer, however, needed a home. This was the machine which would be running constantly as the X-10 / Internet interface, acting as a server
for the html pages which had the embedded controls, and then sending and receiving the actual X-10 commands through the wiring of the room. I decided to wall mount this piece, so that in a sci-fi kind of way, the physical user had a greater awareness of the hardware actually enabling the interaction. When it was finished, the machine was placed inside without its case, allowing the visitor to see the green flashing lights of the computer processing, hear the whirrs of the fan and the hard drive, see the glow of the data connection port. HAL revisited.
Close-up view of internet controlled motorized track wall panel showing drive motor (1), speed-reducing belt linkage (2) operating lights (3), which warn those in the room prior to movement of the wall, and power supply cords (4).

With the brains of the installation in place, and the chat station under construction as well, next was the design and implementation of mobile units. These were included in the installation partially because I have an affinity for electronic furniture, and partially because there was a need for flexibility within the physical space. Throughout the process of designing the installation, my advisor, David Brown and I had several discussions about the importance of trying to blunt the simple one to one relationships inherent in digital programming. We are all used to having a switch or a button that we flip or push and something happens. We do it again, and we get the opposite condition. No surprises, no flexibility. In design-
Mobile Networkable Electric Unit under construction. All wiring and interior painting had to be completed prior to gluing the top and bottom surfaces together. X-10 signals allow all of these outlets to be networked and internet controlled.

In this room we discussed ways of making the relationships between events less direct, and therefore more flexible and hopefully, more interesting. Having parts of the physical space which could be rearranged, and this rearrangement change the palette of options available to both the physical and virtual user was the plan.

This flexibility is made possible by the design of the equipment, and the accompanying technology. All of the mobile electric units contained long-lasting battery powered wireless motion sensors. These sensors, upon sensing movement or light changes within their line of vision emit an RF, or radio frequency, signal, which is received by a special RF base unit, plugged into an outlet on the electri-
Wiring the interior of mobile electric unit. Only two 110v. shocks in three months of wiring!

cal circuit of the room, the installation. Upon receiving this wireless signal, the RF base unit emits a corresponding X-10 signal, which then passes through the hard wiring of the room. The computer, in this case the wall mounted machine which is running the installation, receives this signal from the RF base unit, and then reacts accordingly, depending on how the software has been programmed.
This allows for a non-binary response from the motion sensor input in two ways. First, physically, the probability of the response changes with where the mobile unit is placed. If it is rolled up against a wall, the motion sensor will never go off. But if the sensor is facing the entry, it might go off every three minutes. That is one variable.

The second way in which the motion sensors can produce a non-linear, non-binary response has to do with the way the base unit, the wall-mounted computer which is running the show, is programmed. The signal coming from each x-10 device is unique, and can be set up to determine a unique response. For
example, when motion sensor A-4 is tripped, tell lamp unit L-4 to turn itself on. This is the direct correlation. Where programming the behavior of spaces becomes interesting is when the status of one unit begins to affect the way another unit behaves.

In setting up the main wall-mounted computer to run the installation, information on all of the X-10 units in the room is first input into the software. This allows the first degree of interactivity: if \( x \) then \( y \). With conditional programming, however, the complexity of behaviors goes way up, things get much more interesting. This allows a spatial programmer to say: if \( x \) then \( y \), but only if \( c \) is on. If \( c \), \( d \), and \( e \), are on, then turn \( y \) off after fifteen minutes. This kind of programming ability allows for a much more complex and interesting range of behaviors in a space. Instead of
mere knee-jerk reactions, we can create conditional, thoughtful, behaviors. Some actions programmed in might have a set of conditions which only occurs once every three years, for example. Or if the conditions for an action to occur (an X-10 signal to be sent out) are based upon other variables (which are conditional in themselves), the variety and complexity of the different possible interactions is mind-boggling.

For myself, within the limited time frame that I had to set up the conditional behaviors, things were kept relatively simple. Actions were usually based upon less than two or three conditions, and set off relatively major events, such as a programmed setting like “lights all red”. This means more bang for the buck,
Mobile units with attached wireless motion sensors, internal lights (controllable via internet), configurable outlets, and on/off switch. Designed to work in collaboration with the overhead ceiling unit which provides electricity via pull-down cords. Because they are mobile, behaviors attached to the wireless motion sensors can seem radically different depending on where they are physically placed.

but in the long run perhaps a simpler, but repeated module would produce more interesting results. This remains for another project, another set of conditions and physical materials to determine.

With the brains in place, construction continued on the mobile units (three small rolling stool-like units, and one larger work surface/table unit. All of the mobile electric furniture pieces had a place to connect to electricity, interior red lights, and holes for the light to shine through, the aforementioned wireless motion sensors, and outlets and switches, for practical use. To provide them with power,
View from the bridge into Hive Systems RSA Lounge Installation. Internet controlled sliding track panel open, and light wall set "all blue".

and to provide another layer of atmospheric control, a ceiling panel complete with lights, retractable cords for power supply, and x-10 controls was designed and hung from the cables passing through the drop ceiling in the space.

Made from an inexpensive shiny white tileboard, the ceiling panel had a bright white flourescent lamp, and formally was consistent with the cut-corner, angular theme running throughout the installation. The same material was used in creating the motor driven, internet controlled moving track wall. The glazed melamine tileboard was used as a sheathing for the sliding panel, placed on both sides of the 1" x 2" internal frame, much like the construction of your typical hollow
View from the bridge into Hive Systems RSA Lounge Installation. Internet controlled sliding track panel open, and light wall set "all red".

body door. This type of construction also allowed for wiring to be run internally in the sliding panel, powering two outlets, a flourescent fixture, and a wireless-transmitting video camera.

While the construction of the sliding wall panel itself was relatively uncomplicated; a few mitre cuts and copious amounts of liquid nails for the sheathing, the construction of the internet controlled motor linkage to move it proved quite a bit more difficult. After considerable searching, a suitable motor was found at a great place: Electronic Parts Outlet, at Fondren and Hillcroft, which has bins and bins of raw electronic components for the electronic hobbyist, as well as surplus used
electric motors, and parts for computer builders. I am not sure what application the motors I found came out of originally, but they were the only ones there which fit the bill: 110v AC power supply, and reversible. Having found them, however, was just the beginning. The wiring of the circuit to be reversible required an additional transformer, bridging the hot wires for both directions (something I did not include in the original circuit design) and the rpms they produced at full current were too fast for my application. Also how was I going to get the power from the motor to the panel? How would it know when to turn on and off, how could I keep it from slamming into the wall, or going off its track?
The design of the motor linkage had to solve the first two problems: reducing the speed and getting power efficiently to the wall. This was accomplished by building a box which supported the motor in a fixed position, and installing an axle mounted on pillow blocks in parallel, which could transfer the power via a rubber drive wheel to the underside of the sliding panel. Between the motor and the axle, power was transferred via a rubber v-belt and two pulleys. The one connected to the drive shaft of the motor had the smallest diameter I could find: 1 1/2". The pulley attached to the drive shaft had a diameter of 6", which provided a well-suited speed reduction ratio. At the other end of the drive shaft from the pulley, the rubber wheel was carved to a thickness that stood just 1/4" taller than the clearance between the base to the track and the underside of the panel.
X-10 in line control units. These are the drones of the hive, allowing remote switching. Singly weak, powerful in groups.

provided by the fixed casters. This 1/4" protruded in height was just enough to keep the drive wheel in constant contact with the bottom of the panel without lifting it so much that the fixed caster wheels at either end slipped out of their track.

The track itself was done with the cheapest material available to me: wood. The same 1" x 2" material used in building the inner structure for the panel itself, in fact, and when sanded a bit, and painted, it provided a well enough surface for the wheels to ride in. The difficult part was installation. The opening in which the track wall was to sit and slide back and forth in sits approximately thirty feet
above the gallery floor below; concrete with a thin layer of very dense rubber. Not a good surface to fall on. Punching 3" screws through steel corner bead one handed with a corded electric drill while hanging out over this dropoff is not something I would recommend. The results were satisfactory, however, as the track worked as planned, and kept the rolling motorized wall on a straight course.

To keep the track wall from slamming into the walls, or continuing to run when it should stop and burning out the motor was quite a challenge. In the end it was composing a script for the computer hub which allowed safe operation. This script sent an x-10 signal to the module controlling the circuit for operating the
Early testing of internet-controlled light wall.

motor in the chosen direction telling itself to switch on and allow power to the motor. Then after a timed and calculated interval, the computer was programmed to send another signal, this time for that module to shut itself off, and with it the power to that circuit running the motor. In theory, it works perfectly, but in practice, with the slow machines running the installation, and the incessant signals running back and forth to and from the box, the signals were not always sent at the specified time interval. Occasionally the computer would be working on responding to other signals, an would not send out the "motor off" signal until three or four seconds later than specified. For any other application this is no big deal, but in this case it means the track wall is either trying to pull its own cords out of the housing, or grinding its own drive wheel down to a powder,
Beta testing unit configurations and operation of wireless sensors.

trying to press through a solid wall. It is for this reason, the unreliability of the system, that the motorized track wall did not remain internet-controlled by the public for any length of time. It could not be trusted when left on its own to not destroy itself.

There are other programming concerns that were difficult and therefore quite interesting to solve, but I will leave those details for another time. Suffice it to say that there are still many unexplored possibilities in this field. There are people who are working on integrating simple information systems into architecture, but very few in a wholistic manner such as this, and even fewer doing so without strictly capitalistic motivations and constraints. It is for this reason that I chose the
Electric fetish.

project in the first place, because I believe strongly that integration of behavioral systems for architecture will come someday, whether architects take part in the revolution or not. For myself I choose yes, as I greatly prefer a limited involved capacity to a frustrated ignorance and complacency.

Upon completion of all of the major physical elements of the space, testing began as to what were interesting combinations of behaviors and actions, where were good places for the 12 wireless motion sensors, where should speakers be placed for sound, and many other configuration issues. Sound ended up coming from under the chat station, and pre-recorded mp3 files were set up to be triggered by both internet users and interaction with the space itself.
Greenbulb. The interior of the RSA Lounge installation was painted all white to allow for more drastic atmospheric changes in colour based on web user/sensor input control of colored lights.

The entire room was painted white, walls, floor, and ceiling, the only contrast being between matte and high-gloss finishes, which defined the projection screen at the far end of the room, and contrasted the mobile units with the walls and floor. Colored bulbs in rows replaced the simple white incandescent bulbs on the lightwall, allowing for more variance in mood and atmosphere. The chat room was set up and enabled through a java applet served up at the hivesystems website. The webcams were up and running, everything came together at the last minute.
Networked mobile electric units, powered by ceiling panel.

The installation ran, full-time, for only one month. There were many technical problems, the worst of which was the constant crashing of the computers which were set up to upload the web cam images. Also the x-10 triggers were not being sent reliably, my guess is because of unwanted static, trash signals in the wiring of the installation coming from the overabundance of equipment on the circuit. Should an installation like this be further developed, I would suggest seriously considering an in-line signal booster for better performance. Eventually
representatives from the university declared my unsupervised wiring as unsafe, and the circuits had to be shut down.

Although the end product maybe did not run as perfectly as I would have liked, for myself it falls into the category of a “beautiful failure”. With all of its faults, the end result still pleased me, and the process was fun, as every great project should be,
Lit mobile electric units. DETAIL. Motion sensor on side of unit (1) can be programmed to control the light on the unit itself, or to trigger a similar response in an installation in Japan. Such is the power of spatial networking. In this case, the signal from the wireless motion sensor travels to a RF receiver unit mounted on the track wall, which then sends an X-10 signal through the electric wiring which is received by the base unit computer. The base unit can then send a signal via e-mail or other protocols to another installation anywhere in the world. This signal can then be translated into any kind of behavior or action.

and taught me a lot. Hopefully as you are reading this now, I am somewhere out in the world continuing work along these lines, but even if it does not turn out this way, I am very happy for having chosen this subject matter.
Testing internet controls from installation chat station.

This account is intentionally informal, because I feel that the true value of this document is to help or perhaps inspire others who have similar interests, and to share some of the successes, difficulties and resources, so that the experience of the next person to walk down this path is maybe a little more fruitful, a little less bumpy, and is able to push on a little further.

Were I myself going to do a next project along these lines, I would incorporate most definitely more of the capabilities of networking into the mix. This project was singular, in that it was the creation of one entity, made up of a website and a physical space, which interacted with one another. To me, it gets really
interesting when it is not just one intelligent space interacting with itself, but many such spaces interacting with one another. As time passes, the costs of the technological components gets lower and lower, and these materials become more readily accessible to architects and architecture students. Commercial networks are already being established, that maybe with the right savvy or connections, the intelligent architecture student can tap into. Collaboration is key, because one thing I learned is that it is too much for one person to do alone. I achieved some degree of success in my own mind, but the possibilities are much greater for a team of people with a similar mindset.
Networkable pull-down power from ceiling unit can be used to power either the mobile electric units, or pull down task lighting.

It would be a great project type to consider in comparison with other programs such as cultural exchanges. What if instead of three students from Rice going to Tokyo for a year, and vice versa, the two schools invested the money into creating an experiment in shared space, both physical and virtual? Such a behaviorally enabled interactive space would provide inspiration for the whole school, not just three students, and could be used in collaboration with not just one other location, but any number of other collaborators who built a space with compatible technology. I know, it is not the same as travelling to another country, but I think it would be a very interesting project, with much further reaching implications than the standard academic visit. This is the benefit of networking, and its power grows exponentially with each addition.
Custom mobile electric unit.
For Those Who Would Continue
Bibliography

Abrams, Janet, ed. *If/Then Play*. Amsterdam: The Netherlands Design Institute, 1999.


WWW / Internet Resources:

More than any other place, the internet was where I gathered the greatest part of my research and information. The speed of access, wealth of material, and obvious leanings towards technological content were invaluable throughout the duration of this project. There were many more, but these are some of the sites I found the most interesting and/or helpful:

Inspiration

www.icepick.com

www.skim.com

http://userwww.sfsu.edu/~infoarts/links/wilson.artlinks2.html

www.ctheory.com

www.hungryfordesign.com

http://dir.yahoo.com/Computers_and_Internet/Internet/
  Interesting_Devices_Connected_to_the_Net/

www.rsub.com

www.thedesignersrepublic.com

http://bfws7e.informatik.uni-erlangen.de/~kinderma/musinum/InternetMusic.html

www.media.mit.edu

www.threeoh.com

www.disinfo.com

www.milk.com/barcode

Information Space:

www.cybergeography.org/atlas/atlas.html

http://tangible.www.media.mit.edu/groups/tangible/

www.mapplanet.com
Web Cams

www.camcentral.com/Strange-Unusual.html
http://www.teleport.com/~samc/bike/#Make
http://www.weirdlinks.com/WEIRDCAM.htm

Telepistemology / Virtual Presence

www.c3.hu/events/99/bump/content_description_en.html
http://ford.ieor.berkeley.edu/ir/
http://smg.media.mit.edu/people/Judith/

Technological Help / Information:

X-10 / Home Automation

www.x-10.com
www.x-10ideas.com
www.smarthome.com
http://ns.biap.com/datapig/mrwheat/x10.html
www.csi3.com/Beta_32.htm
http://www.spystuff.com/products.html
Home Site:

www.hivesystems.com

if this site is no longer running see also:

www.plikka.com

www.arch.rice.edu/working

Best of Luck,

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