i+a: Explorations in Emerging Architectural Typologies and Design Processes

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Abstract

In this paper, we describe Internet and Architecture (i+a), a research and teaching program, started four years ago at Harvard Design School, to explore the possibilities that lie in the convergence of a physical with a virtual architecture. The approach starts with the analysis of everyday verbs and the changes that occur in the virtualization of everyday situations, and moves on to critically rethink existing architectural typologies and develop new architectures that combine physical and virtual components. This paper describes our experiences with the approach in the year 2001-2002. We present samples of design projects as illustrative examples of new architectural typologies that combine the physical and virtual, and describe how incorporating technologies for virtual collaboration into the design process can enhance architectural practice in the broadest sense.

1 Introduction

One of the most persistent challenges facing the theory and practice of architecture today is the paradigmatic shifts that are occurring because of the emergence of information technologies on all levels of culture and experience [Schmitt 1999].

Physical architecture has evolved over many centuries, accumulating rich traditions and typologies. Virtual architecture has a history of maybe a decade, whereas the design of the convergence of the physical and virtual is a relatively new field in architectural design; we are only beginning to understand what the challenges and opportunities are.

There is clear indication that interconnecting technologies are reshaping the way we perceive and interact with our built environments [Mitchell 1998]. Very few elements of traditional architecture are not affected by these changes. Virtual spaces, being qualitatively different from physical spaces, are nevertheless contained in the physical world we inhabit. As networking infrastructures become more and more part of our built environments, virtual and physical elements start to merge in many ways. What used to be the boundary of material, its terminus, nowadays often becomes an entryway to virtual architecture. The difference between architecture's first level of communication (the architecture itself that is transformed into an object of information) and its second level communication (i.e. information technology systems that rely on screens that are accessed through the building) starts to blur [Friedberg 1993]. Architecture as a whole becomes a communicative vector and architectural object at the same time. This potentially leads to new typologies in architecture: information spaces with components of both, the physical and the virtual realm, as well as new design and communication processes [Huang 2001].

In this paper, we describe Internet and Architecture (i+a), a teaching and research program that explores the possibilities that lie in the convergence of a physical with a virtual architecture, and addresses the need for a new design and a new design process. In this paper, we will focus on i+a 2001, our most recent work within the framework of i+a, where we used an experimental physical/virtual classroom setting to explore the boundaries between physical and virtual realm along

seven everyday verbs, where performance and efficiency were secondary to cultural and social enrichment and diversity. The aim of this experimental project was to discover how to incorporate technology into the practice of the built in the broadest sense of practice.

The remainder of this paper is organized as follows. The next section gives the background of i+a, and describes the setting of our experiment, including the tools we used and our approach to the subject. Then, we present examples of the verbs we explored, and discuss results and reactions from participants. Finally, we conclude by discussing the lessons learned from this experiment and give an outlook for future work in this area.

2 Internet and architecture

2.1 Background

i+a was conceived in the summer of 1998 by Jeffrey Huang, at the height of Internet euphoria. It was motivated by the question: what is the role of architecture in an increasingly virtual world?

To address this question, i+a originally focused on two tightly interconnected topics: (1) information architecture: the application of architectural concepts like spatial configuration, proportional systems, circulation, scale and texture to the design of virtual or Internet space, and (2) architecture as interface: examining the possibility of physical architecture and architectural elements, such as walls, ceilings, floors, doors and furniture to act as elements of connectivity and mediate between the information world and everyday physical activity.

The pedagogical objectives of i+a are that students (1) gain a basic conceptual understanding of the implications of new Internet-based concepts on architecture and vice versa, (2) learn about how to contribute to the design of new Internet-based spaces that combines the virtual and the physical.

Final projects in i+a explore the possibilities of designing physical and virtual spaces in conjunction with each other to transform the practice of a particular everyday activity. Each year, we select a series of verbs that form the starting point for students' investigation. Over the last four years, we have explored seven everyday activities/verbs each year:

- i+a 1998 (Jeffrey Huang w/ Spiro Pollalis): learn, buy, pray, punish, express, work, operate
- i+a 1999: (Jeffrey Huang): judge, operate, teach, trade, sell, brainstorm, heal
- i+a 2000: (Jeffrey Huang): travel, create, play, vote, learn, shop, work
- i+a 2001: (Jeffrey Huang w/ Thomas Schroepfer): amuse, pretend, love, discover, attract, encounter, fantasize

2.2 i+a 2001: Experiment setting

i+a 2001 was set up as an experimental project over the course of 12 weeks. The project had 60 participants. We chose not to approach the project with traditional methods and tools of architectural design, but to explore the potential of alternative processes, making simultaneous use of virtual as well as physical components.

We met as a group twice a week, once physically and once virtually. Physically we met in a classroom and virtually using the software Groove. The physical meetings were enriched by a series of guest lectures. The project's explorations were initiated and accompanied by a series of readings on project-related topics such as identity, cyberspace, new typologies, decentralization, place identity, convergence, and interface in virtual and physical architecture [Goffman 1965, Foucault 1967, Donath 1998, Lessig 1999, Kelly 1999].

2.3 Verbspaces

Students were asked to share and discuss their thoughts on each of the readings on a public web board. Over the course of the project, students then formed teams and collaborated in successive steps on the exploration of basic human activities –-“everyday verbs” like amusing, traveling, pretending, discovering, attracting, shopping, trashing, wedding-- and their physical/virtual architectural re-articulation.

Students investigated the current practice of the verbs, researched examples of both physical and virtual architectures related to the verb and wrote case studies discussing the spatial qualities inherent in their examples. The resulting concepts were published as “verbspaces” and discussed online during “primetime”, a certain hour of a specific weekday when participants were highly likely to be online and interacting with their personal computers.

Themes and contents of each verbspace were announced on the public web board before primetime to give students an overview of what to expect of each verbspace before entering it. The following are two examples of such web board announcements for verbspace:

Verbspace “Amuse”
We have 3 case studies to discuss. *1.An informative, historical look at the Colloseum in Rome that raises important questions regarding architecture and entertainment venues.* *2.A thought provoking study of "fashion" as architecture and its ability to define space in creative and "amusing" ways.* *3.A completely subjective rant regarding architecture that could be considered ridiculous and silly and hence "amusing".* *Please join our discussion if any of this sounds remotely interesting to you. If not, please come and let us know how ridiculous and amusing we actually are.*

Verbspace “Love”
We construct and inhabit the space of love, or a stimulator, a place of transitory convergence of architecture and love, situated between dare, demur and sensual experiences, in which the mind and the body can boldly go wandering along the paths of imagination and desire. *We are on bizarre terms with its definition; it most catches us by surprise in our very manners of thinking and being. If the love space is not completely specified by fixed qualities, it is because it is prior to any qualifications, so smooth that fixed qualities do not stick to it, are always slipping off it.* *We identify it as architecture, and then take ownership of this environment in order to locate ourselves within it, and therefore simultaneously exist in several built worlds of the physical, the sensual and the virtual.* *We exaggerate the antithesis, in our effort to express oppositional feelings of seduction and damage, fascination and fear, clarity and mystery, contentment and despair.* *We develop intimate relationships with (in) it, desire being the motive power of this process, it activates our personal fetishes, obsessions and unfulfilled dreams. It appeals to our consciousness of sensuality, bespeaking intimacy.* *And thus, we find it sexy.*

Figure 1. **Screencapture of the webboard announcing an event**

2.4 Groove

Student's collaboration as well as the presentation and discussion of the verbspaces were based on Groove. The software allowed decentralized group collaboration outside of official class meetings. It enabled direct communication and collaboration among dispersed individuals and teams.

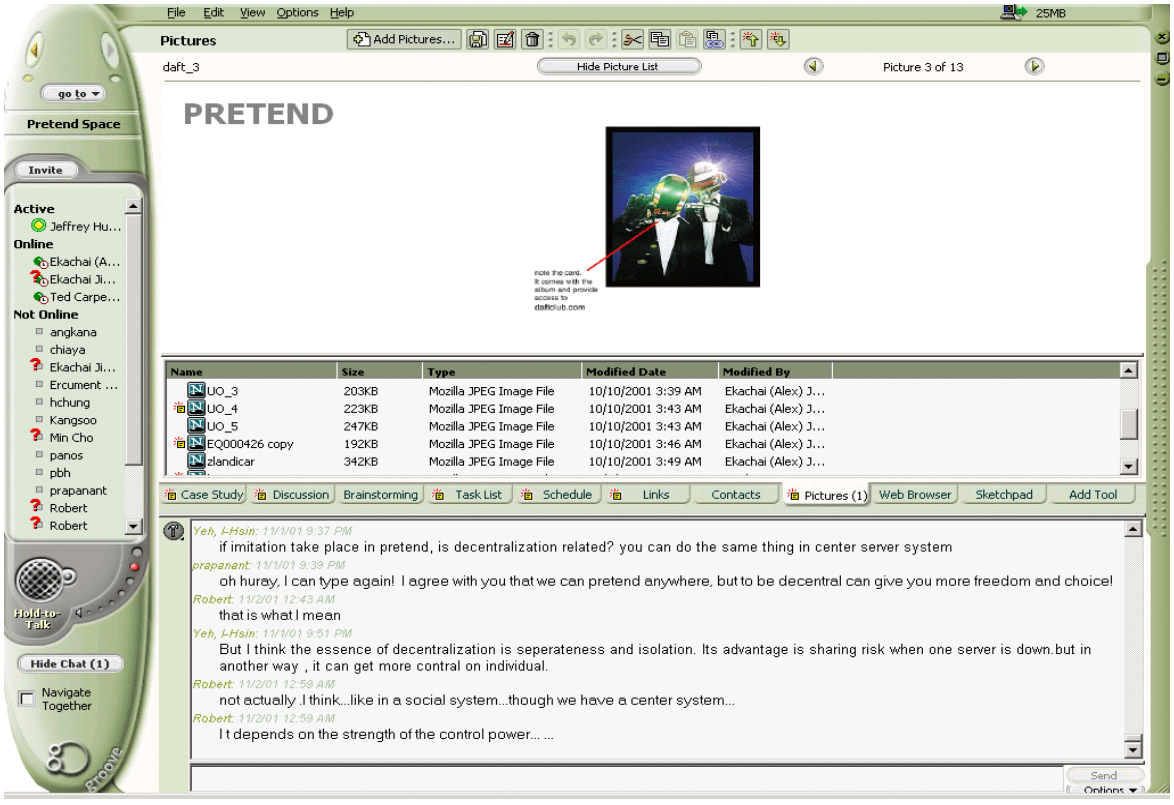

Figure 2. Example of Verbspace (Screencapture from Groove)

Through Groove, the project teams were able to make immediate and direct connections to perform a variety of activities – working on their projects, brainstorming, discussing issues, sharing drafts and proposals. Each space showed the online status of all members, so that when two or more team members found themselves in a shared space at the same time, they were able to take advantage of the situation and work together in real time. Likewise, single users were able to glance at a view of all shared spaces to see if there were any "active" members. Students were able to know who was currently and actively working on certain parts of the projects.

During primetime all project participants were able to virtually go from (Groove-based) verbspace to verbspace to discuss the work and ideas of other participants. The concepts were enriched by a public discussion using multiple communication channels.

2.4 Final Design Project

The readings, the class discussions, and the verbspaces' investigations eventually led to final projects that attempted to develop new architectural typologies combining physical and virtual space: Over the last 4 weeks of the project, students developed either individually or in groups a converging architecture for one of the verbs. As a first step, they proposed storyboards that were posted on i+a's web board. Students clarified why they propose a converging architecture for their verb, who will be the users of their project as well as how, where, and when their architecture will be used. The following is an example for such a storyboard:

Verb "Conspire"

Storyboard: The Conspiracy of the Everyday - The Corporate Workplace and Virtual Realm
Group: Teman Evans and Teran Evans

The verb conspire is extremely versatile in nature. This word immediately implies an illicit act… a coming together in secrecy to plan or commit a wrongful deed. At the same time however, the act of conspiring has a less perverse connotation, suggesting the notion of cooperation and working in concert towards a common goal. The act of conspiring is not reserved solely for discrete places. The reality of the matter is that we are privy to and partake of conspiracies that occur every single day right out in the open in broad daylight. The moment we engage in the exchange of information with another human being, we are conspiring. We conspire in everyday conversation on our cell phones and at our computers. The very success of the corporate workplace is based upon conspiracy, because without it the average workplace would fall into chaos and cease to function. Boardrooms are the cradles of conspiracies. This act is so essential to the well being of the workplace that every measure is taken to ensure that it occurs in real time. Office intranets, voice-mail, and inter-office e-mail systems all serve to foster conspiracy. Even the challenge of physical separation by large distances and time does not serve to thwart the intentions of would-be conspirators. Video-conferencing and instant messenger programs ensure that even co-workers separated by 6 hours and 6,000 miles can still engage in real-time conspiracy.

At their best, however, these systems exist as poor substitutes for face-to-face communication. They attempt to simulate the subtleties of real-time physical interaction but are essentially only homogenized streams of text. As such, they two-dimensionalize the experience of the conspiracy. There is no bias to the information that is relayed. Even video-conferencing, with its information time lag, is static, not to mention the requirement that conspirators stare blankly into a camera.

What we propose is a virtual workplace: a space for conspirators to meet to share and exchange information, even though they may be separated by thousands of miles. Essentially the system would consist of a flat electronic tray (or tabletop) that the user would pull files (texts or images) onto by plugging the system into their computer. The information however, would be biased, because the user would be given the choice of placing the information within different "containers" on the tabletop. The opaque cube is reserved for private information (only to be revealed at the user's discretion), while the transparent cube is dedicated to information for immediate public access. A translucent cube on the tabletop is meant to hold limited access information to which only certain individuals are privy. The user can have as many of these containers as he/she feels necessary. Once they have dropped their files into the necessary cubes on the tabletop, they are presented with a plan and perspective view of the information they have organized. This information is instantly navigable. To access a specific image or text file, the user need only move inside of the appropriate cube of space by touching either the plan or perspective on the screen. They are constantly aware of where they are in the information construct by means of the plan. When the user is ready to exchange information with another conspirator, he/she meets with that individual (who would also have a tabletop module). Once they make contact, their information constructs are both visible on the tabletop. With the use of headsets, the users can talk to one another as they navigate through the information spaces. Dialogue might occur in this manner:

User A: Where is that document for our new client?

User B: Walk into that cube to your left and it should be the second one hanging on the wall.

The users can pull each other into private spaces or establish galleries where popular information files can be displayed for quick access. This virtual environment truly is a workspace where that conspiracy can once again thrive. Data becomes a three-dimensional, occupiable construct and an information architecture is born.

The i+a experiment ended with a public physical meeting of students and critics during which each project was presented and discussed.

3 Verbs: Sample projects

For i+a 2001 we had a total of 26 final projects. The following table summarizes the projects in relation to their verbs of origin.

Internet + Architecture: Final Projects

Verb	Authors Title	Authors	Description
accompany	Accompany/Amuse	Ekachai	Betalounge, online electronic music site
collaborate	Collaborate	Ted	idealized physical/digital collaboration space
conspire	Conspire	Teman, Teran	virtual workplace, space to meet
discover	Discover	Ki Hong	new type of pavilion for online art
discover	Discover/Fantasize	Minqu	re-experience subway
discover	Discover	David	developing a new 'user interface'
entice	Amsterdam	John Ross, Aziza	red light district in Amsterdam
encounter	Encounter	Marlene	devices for global urbanism
encounter	Encounter	Han, Kangsoo, Sang	physical video shop, booth system
heal	Heal	Noah	Internet heart monitor
influence	Influence	Steve	virtual community with real-life meeting space
experience	Olympic Commuter	Peter, David, Bryan, Anu	amplify experience of Olympic Games
learn	Learn	Matt	hybrid form of virtual high school
love	Love	Ercument	redefinition and survival of love
marry	Virtual Wedding	Soojung, Prapanant	globalized, time and cost saving wedding ceremony
party	Party	Hanson, Sefa	nightclub with virtual social interaction
pray	Chapel	Imdat	convergent highway chapel
pretend	Movie Studio	Angkana, I-Hsin, Robert	conquer the gap between the viewer and player
restore	Virtual Space	Ghyelaine	restoration design for WTC
shop	Shop	Alan Locke	evolving virtual mall
touch	Online Bookstore	Ian	online representation of books that allow flip through
transact	Retail Experience	Julian, Jim, Ying-Chih	sensory experience in retail
transfer	Transfer/Exchange	Elisabeth	encounter engine
travel	Travel	Chris, Yasunori	connectivity for passengers
watch	Baseball Game	Tae	broadcasting/visualizing information collected
work out	Physical/Virtual Gym	Jason, Min-Cho, Sophia	virtual space to facilitateoutdoor experience

Figure 3. Table showing titles, authors and descriptions of final projects

In the following, three sample projects are presented as examples of typical outcomes.

3.1 Experience (the Olympics)

Experience explored the possibilities of virtual projection to inform spaces of the Madrid subway system during the Olympic games. Athletes and commuters would see real time/real scale broadcasting of the Olympic events in “event spaces” that are carved through the subterranean circulation systems of the subway, altering the existing condition as well as the daily procession of the commuters. The project would allow the viewer to reestablish a physical and scaled connection with athletes and events. Commuters would encounter the Olympic games throughout the city with a renewed physical perception, enabled through a convergent physical and virtual architecture.

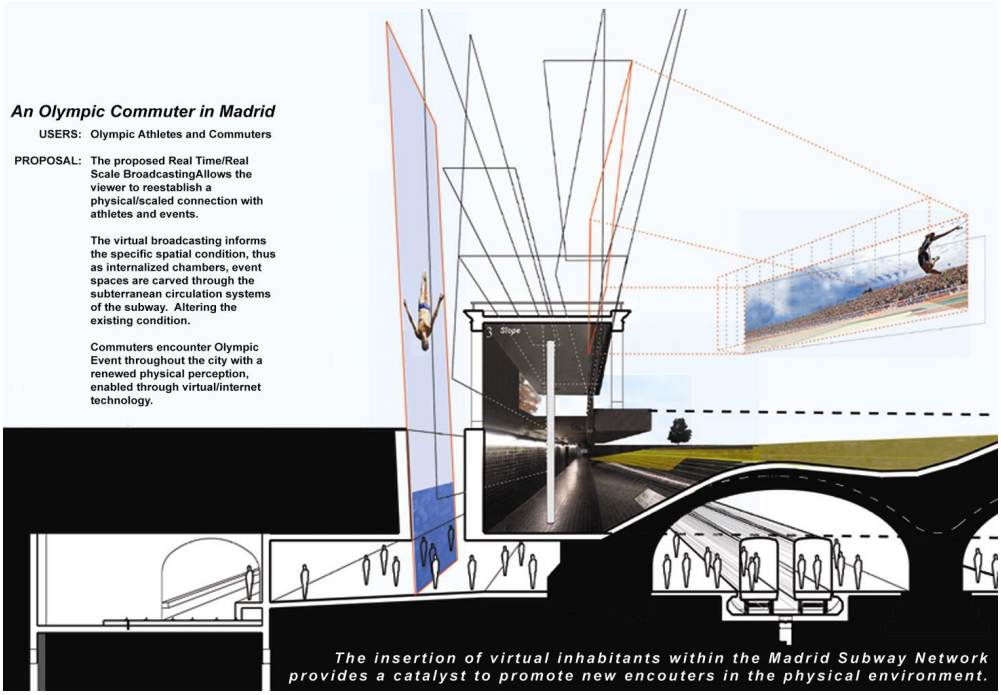

Figure 4. Experience (Project by Bryan Young, Peter Braun-Himmerich, Anuraj Shah and David Chun

3.2 Entice (in the red light district)

Entice proposed a hybrid of two building typologies: transit hotel and brothel. The project was inspired by Michel Foucault’s text “Of Other Spaces,” one of the project-related readings we introduced earlier in the semester. Here Foucault defines brothels as heterotopias, “spaces of illusion that expose real space”. The brothel is seen as a space, which is denied by society but which actually materially, exists. Its very essence incorporates virtual and physical realities that seem incompatible. Thus, Foucault defines the brothel as a “placeless place”.

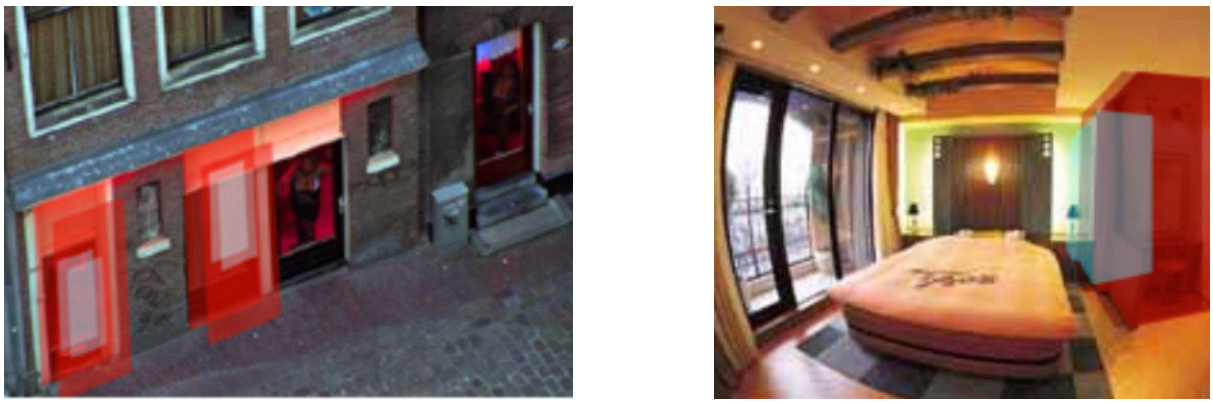

Figure 5. Entice (Project by Aziza Chaouni and John Ross)

The project studied not only how virtual interfaces related to brothels could be integrated into a physical space but also how the different meanings of the verb “entice” could be enhanced. The project proposed a combination of transit hotel and brothel with a “parasitic” virtual as well as physical architecture, similar to Japanese love hotels, enhanced through virtual components.

3.3 Pray (Highway Chapel)

Pray redefined a type of mosque that has emerged over the last decades in Turkey. The highway chapel serves travelers providing them with a tranquil place in the vacant landscape for their religious needs. The project converged physical and virtual realms in a symbiotic relationship between the Ka’ba, the holiest sanctuary in Islam and the physical praying space of the chapel.

Figure 5. Pray (Project by Imdat As)

The physical enclosure is a simple box in the form of the sanctuary, an 11x11m cube made of stone. The basic shape of the box has symbolic connotations and meanings in Islam. Pray proposed an interior with interfaces for the projection of a web stream of the original Ka’ba. The chapel is equipped with interactive tools that use Virtual Reality technology, responding to the movement of the person in the space. The interface provides data such as how many prayers were practiced, how many missed, etc. To reinforce the community aspect of praying, the project proposed to show how many people are present at any given time as well as to provide communication between the Ka’ba and the chapel.

4 Observations on Learning Process

4.1 Virtual Affinities

The course consisted of virtual sessions in Groove and physical meeting in classrooms. It was interesting to observe the different dynamics that developed across the physical/virtual settings. Unlike the typical situation of hybrid collaboration where participants would meet physically first, shake hands, get familiar in a face-to-face setting and develop trust that can be translated for future remote collaborative situations, in our experiment, many "first encounters" happened virtually on Groove. This meant that affinities developed based on content and interest only.

An interesting moment in the course occurred when we posted the print-outs of the first Groove conversation on the blackboard during one of our physical meetings. We realized then that many students didn't know each other. In that moment in the classroom, they came to know for the first time who they were discussing their homework with. Many students spontaneously shook each other's hands and immediately referred to previous online discussions.

Because of the relatively large class size (over 60 students) and the rigid classroom layout of the physical classroom (half-horse-shoe with fixed seating), it was difficult for students to communicate with each other during class time. Groove helped to overcome the limited interaction possibilities in the physical classrooms. Consider the following quotes by students:

"I believe that our experimentation with hierarchy in Groove went very well. The informal invitation and lack of hierarchy between creators and recent joiners to the space allowed participants to feel that they were equal. This part of the space's architecture encouraged contribution because it allowed all to contribute without restriction."

"*Implementing the dichotomy of virtual v. physical has the capability of revealing something about others and us within the class. There is definitely a difference in conversation technique, style, personality traits that becomes apparent in the virtual realm."*

"…the intellectual discourse between my peers and myself was stimulating. I do feel that because of the virtual parameters of the space, a different kind of conversation occurred, a conversation that may not have been possible under different circumstances and in a physical environment. The rules and boundaries of conversation were certainly proven to be of a different nature inside our virtual classroom of Groove."

The use of virtual spaces contributed to an "expansion" of the classroom. Ubiquitous and mutual access to verbspace prime time sessions as well as to the web board led to a virtual architecture of the classroom that added to the built architecture of the physical classroom.

4.2 Decentralization

Student groups were responsible themselves to advertise and host discussions around their chosen verbs. Typically each group would designate one member to host the "show" during "prime time," which would allow the other group members to wander about and visit freely other verbspaces and contribute to the discussions held there. Given the easiness of "zapping" from one verbspace to another, hosts had to compete for students' attention by smartly advertising the content of their discussion and keeping the discussion alive through skillful hosting.

This is in sharp contrast to the traditional classroom dynamics, in which discussions are centered around the teacher. Consider the following quotes by students:

"Groove was in a sense the "space" where everything culminated. It is exciting to visit the I+A Groove spaces (including all of the verb spaces) and watch them grow from a few items to a wealth of information."

"*I felt part of a group where we had to exchange information and different points of views in order to generate our space. We exchange this information both physically and virtually, and that was very*

important to notice the differences between the two types of exchange. Groove made me feel part and dependable of an environment that was our responsibility, therefore we tried to offer in it the best of our reflections and ideas..."

A critical issue was the decentralized nature of Groove: other than the web board, which was public and controlled by the instructors, Groove gave students control. The groups were able to decide who to invite to the discussions and how to host the prime time sessions in their verbspaces. Each space therefore had owners and only the owners were responsible for their spaces. We observed that this digital ownership of spaces was easy to organize. The groups' control was a powerful instrument to restrict or open the environment. This was an important psychological component in that it "democratized" virtual components of the class.

Students' exposure to such a reversed, bottom-up situation was instrumental in their learning about the nature of the Internet. Indeed many students took their understanding of the decentralized nature of the Internet as a starting point for their final projects.

5 Observations on Final Projects

5.1 Range of Convergence

The final projects uncovered the broad spectrum of possibilities for convergent architectures, ranging from physical to virtual:

- unaffected physical architecture
- new styles and forms that reflect the signs of the time, e.g., concepts of the information age like "liquidity", but without challenging existing typologies
- new typologies that combine physical and virtual components
- inhabitable virtual space where social interaction can happen, e.g., chatrooms
- pure virtual architecture (information architecture)

Our interest has been the middle ground, the exploration of new typologies that combine physical and virtual components. The spectrum above that resulted from discussions with students about the final projects proved to be helpful in providing the class with an orientation of the range of possibilities.

Seeing buildings as thresholds between the physical and the virtual evoked a generous array of new ideas. Architects and designers in i+a worked out many possibilities for interaction. Students felt that virtual space was in need of physical space.

5.2 Digital Consideration

We also noticed that the earlier students integrated the reflections about the possibilities of the Internet into their design the more profoundly they were able to rethink traditional typologies.

In the Madrid subway project, for example, the authors derived the design of the space and sections from their early consideration of possible projection areas for digital transmission of the Olympic events. Similarly in the highway chapel example, the concept of a distributed holy place derived from the author's motivation to explore the architectural potential of decentralized systems.

Another important aspect in many of the projects was the articulation of the integration of new technology into architecture. Should we superimpose the new and alien simply on the known and comfortable? Or should we totally abandoning the rich culture of the physical? Is there an opportunity for a new language?

We further observed how it became clear to many students that the Internet is both grounded in real

space and also virtual space and that the virtual can just be as constraining as the real. By structuring their virtual spaces students began to understand that there is a need for architectural considerations when it comes to bits and bytes just as there is a need for that when in the bricks and mortar world.

6 Conclusions and Future Work

In this paper, we have given a brief summary of i+a, an exploratory seminar that addresses the intersection of the Internet and architecture. The course is predicated on our belief that the Internet will bring forth more than a new style that reflects the sign of the information age: we are interested in the possibilities of completely new architectural typologies that combine physical and virtual components.

We have presented what we believe is a possible starting point for the exploration: everyday verbs -- understanding the changing practice of everyday activities as a foundation for rethinking traditional architectural typologies. We have further presented a possible pedagogical approach to communicating the potential of the Internet on architecture: immersing students in a convergent physical/virtual classroom to help them understand the conceptual changes, such as decentralization, decoupling of bodies and identities, digital tectonics, etc.

6.1 Future Work

Our agenda for future work includes (1) the sharing of our insights into the different verbs with the larger research community, (2) moving gradually to a different categories of verbs where function and performance are secondary to emotional and social enrichment, and (3) building prototypical convergent architectures in real life to test emerging spatial and architectonic concepts in everyday situations.

6.2 Online Repository of Verbs

We are working on systematically storing and representing the results of i+a in an online repository centered on everyday verbs, that will be accessible to the larger research community. The database architecture will be open-ended so that it could serve as a basis for the industry to share experiences on new architectures that combine physical and virtual technologies.

6.3 New Verbs

Our first three years were concerned with the exploration of “basic” everyday verbs, including learn, shop, pray, punish, express, heal, operate, judge, operate, express, mostly “functional” verbs with an important transaction component, e.g. delivering a good or service from one person to another. Our current interest is shifting towards derivatives of these basic verbs, i.e., more “emotionally” driven verbs, like attract, entice, pretend, etc. which we will continue to expand upon.

6.4 Test convergent architectures in everyday life

In 2000, we created Convergeo, a spin-off company (Jeffrey Huang in partnership with architect Muriel Waldvogel), to test some of the ideas about convergent architecture in practice. Convergeo just completed the building of a first prototype convergent architecture in Boston, Massachusetts: a consulate for Switzerland that combines physical and virtual components. The physical/virtual space will act as a test-bed for exploring issues related to telepresence, remote work, distance learning. We believe that the building of real prototypes is important as it offers the only possibility to study the effect of new convergent architectures on everyday practice. We will start construction on two other projects this fall 2002.

7 References

Donath, Judith. *Mediated Faces*. (2001). In M. Beynon, C.L. Nehaniv, K. Dautenhahn (Eds.). *Cognitive Technology: Instruments of Mind*. Proceedings of the 4th International Conference, CI 2001, Warwick, UK, August 6-9, 2001.

Donath, Judith. *Identity and Deception in the Virtual Community*. (1998). In M. Smith and P. Kollock (eds.). *Communities in Cyberspace*. London: Routledge.

Foucault, Michel. *Of Other Spaces* (1967). Diacritics 16.

Friedberg, Anne. *The Mobilized and Virtual Gaze in Modernity: Flaneur/Flaneuse*. (1993). From *Window Shopping: Cinema and the Postmodern.* University of California Press

Goffman, Erving. *Introduction* from *The Presentation of Self in Everyday Life*. Anchor Books; page 1-16.

Huang, Jeffrey. *Future Space: A Blueprint for a New Business Architecture.* (2001) Harvard Business Review, April 2001.

Lessig, Lawrence. *Chapter 6: Cyberspaces*. from Lessig, Lawrence. *Code and Other Laws of Cyberspace*. (2000) pp. 63-84. New York: Basic Books

Mitchell, William, J. *Antitectonics: The Poetics of Virtuality.* from Beckman, J. (ed.). *The Virtual Dimension: Architecture, Representation, and Crash Culture.* pp. 105-117 (1998). New York: Princeton Architectural Press

Schmitt, G., *Information Architecture: Basis of CAAD and its Future*, Birkhaeuser, (1999).

Shedroff, Nathan. *Information Interaction Design: A Unified Field Theory of Design*. In: Jacobson, R., (ed.). *Information Design*. (2000). pp. 267-293. Cambridge: MIT Press

Wexelblat, A., and Maes, P., *Footprints: History-Rich Tools for Information Foraging*. (1998). In *Proceedings of Conference on Human Factors in Computing Systems* (CHI '98)