

# REPRESENTATIONS OF LIGHT IN DESIGN: Light, Computation and *Praxis*

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Submitted to the Department of Architecture  
in partial fulfillment of the requirements for the degree  
**Master of Architecture**  
at the Massachusetts Institute of Technology

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January 19, 1996

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Thesis Advisor

Accepted by

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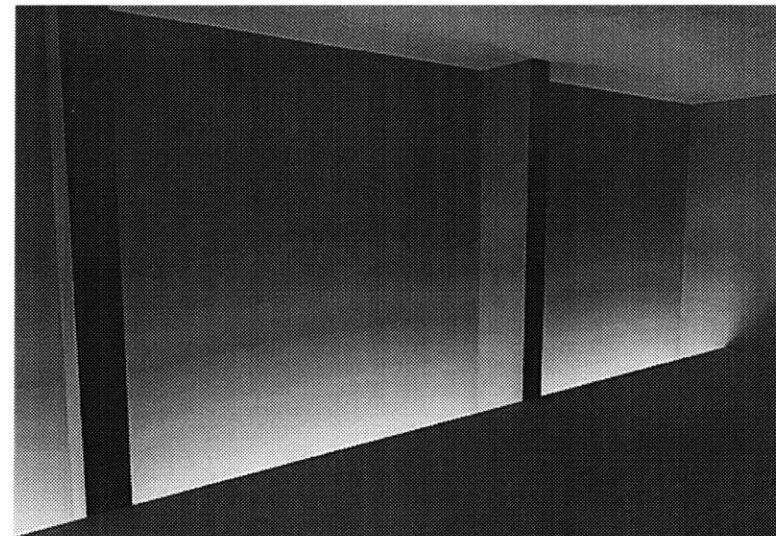
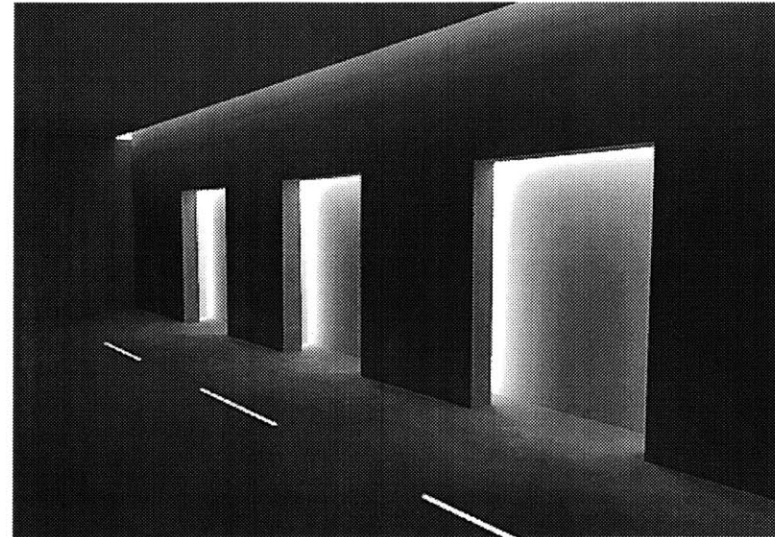
Submitted to the Department of Architecture on January 19, 1996 in partial fulfillment of the requirements for the degree Master of Architecture at the Massachusetts Institute of Technology.

**ABSTRACT**

Sophisticated computational tools for accurately representing both natural and artificial light are now available. These tools may serve to facilitate the designer's ability to understand the fundamental spatial and architectural experiences in a given design proposition. This thesis seeks to enunciate a design *praxis* that utilizes computer visualization as the primary exploratory method for understanding the relations of light to form. The design of a small library in Boston serves as the grounds for developing a critical understanding of such a design *praxis*. The library type provides a wide variety of circumstances demanding the control of light as well as a rich set of precedents in which the use of light is paramount to the spatial experience. Within the scope of the design problem, this thesis seeks to articulate a critical understanding of how design process may be facilitated by computational methods of exploration and representation. In particular it explores the relations of light to form in architectural design, and how decisions of space and form may be made based upon the desired qualities and effects of light.

Thesis Advisor: Julie Dorsey

Title: Assistant Professor of Architecture



**Top and Bottom:** Prototype studies of displaced and reflected light for West facing edge of site.



## Acknowledgements

There are many people to whom I owe thanks for their help and support during my time at MIT:

My parents and brothers, Eric and Perry, who supported this move in my life path and who are always there and willing to engage in what I am trying to do.

Julie Dorsey, for coming to MIT at the right time with something new needing to be taught and a willingness to engage a demanding student in enriching explorations. Fernando Domeyko, for the most exceptional studio experiences of my career. Bill Porter, for his trenchant design criticism and ability to succinctly cut to the core of the problem. Tom Chastain and Renee Chow, who got me started on the right path and although gone are not forgotten. Phil Thompson, for answering all off my many computer related questions over the years and providing a rich source of knowledge throughout. Ben Black, an ally in the ongoing battle to teach about, practice and understand design.



To Linda for her love, support, and perseverance, without whom nothing could have been accomplished.



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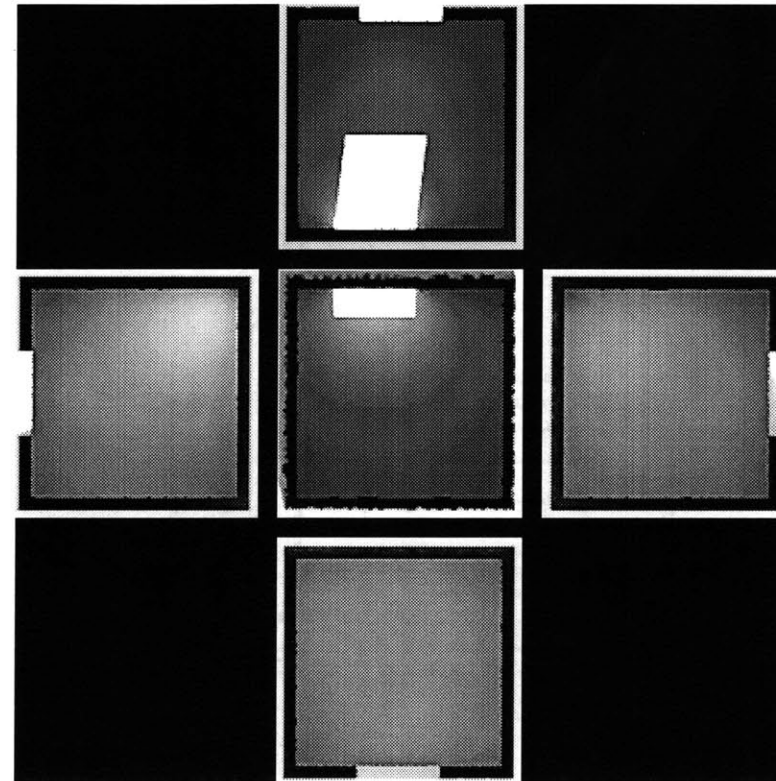




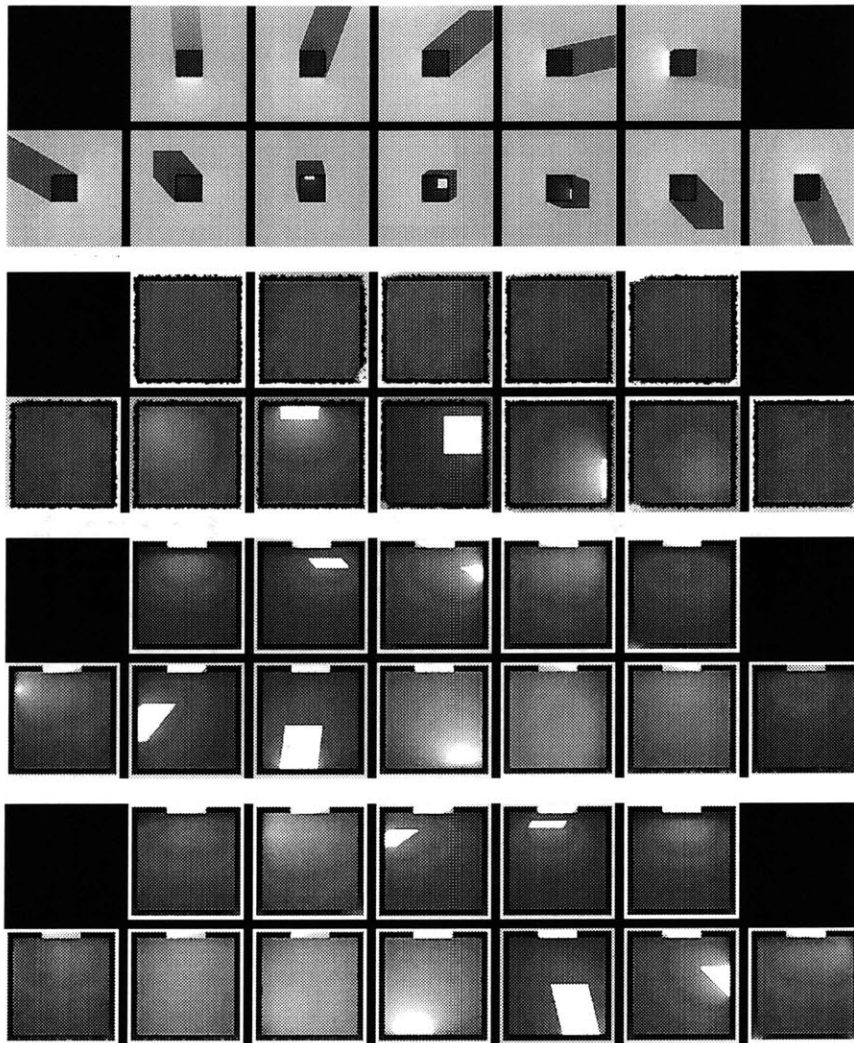
### Light and Computer Visualization

The relations between light, material, form, structure and space may be clarified and enunciated by computational methods of visualization. A variety of sophisticated tools for visualizing light and space are now available. These tools significantly impact the ways in which the architectural designer can understand and represent light and space. The designer's critical understanding of how light builds space through material, form and structure can be elucidated by such methods of exploration and representation. In particular, the understanding of the building of territorial definitions and intensifications through various "effects" or "qualities" of light may be further articulated through computer visualization.

The effects of light in space are built through material, form and structure. Our perception of light is primarily determined by the interaction of light and material. Material generates certain qualities or effects of light in space. Form and structure are deployed in materials. They demarcate the change of light over time, activating territorial definitions. Territorial or spatial definitions may be claimed for a variety of uses. The building of territorial definitions with a certain capacity for use requires understanding how form, material and structure can be utilized to control and intensify space through light. The performance of light is "seen" or "experienced" though material, form and structure, and thus architecture and space are activated for our own individual experience.



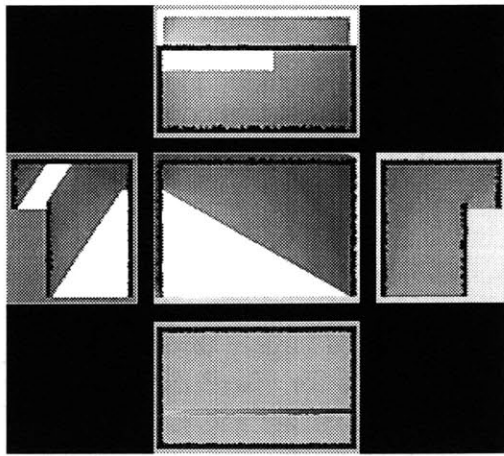
Multi-section light-cube diagram, June 22, 10:00 am, Boston longitude and latitude. The center image is the plan section, with the images top, bottom, left and right representing the unfolded vertical sections. Daylight enters through a square opening in the roof.



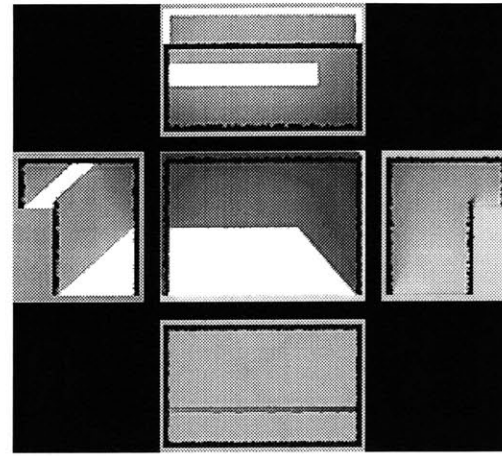
**Top to Bottom:** site plan, plan section, section looking Northwest, section looking Northeast. Each pair of strips represents a sectional-direction and time series from 6:00 am to 6:00 pm. The top strip is for December 22 and the bottom strip is for June 22, Boston longitude and latitude. The cube has a square opening overhead.

By using computer visualization within the process of the design activity, new strategies of design exploration and representation may be developed and further articulated. It is this learning and designing by application, practice, appropriation, and “doing” that leads to the enunciation of a design *praxis*, the very act and process of designing, that is the heart of this thesis. By using these visualization tools in the *praxis* of design, our understanding of the “qualities” and “effects” of light, may be clarified and articulated within the framework of a critical process.

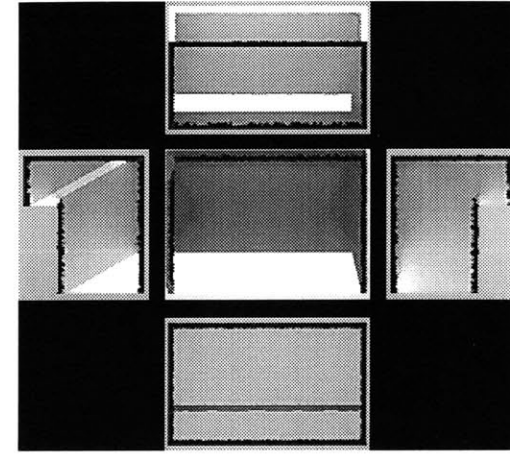
There are a wide range of fundamental questions that fall out from such an exploration, few of which can be dealt with fully in this thesis, but all which should be mentioned at this point. What types of representations now become useful in making design decisions? How are these modes of representation similar to and different from more traditional representations? How do these modes of representation offer fundamentally new insights into design and process? What types of representations and tools would further assist in the task of understanding and making design decisions? These questions can only be opened up through the activity of designing as proposed in this thesis. That is, that problems of representation and exploration are exposed only through design *praxis*, the activity, process and “doing” of design.



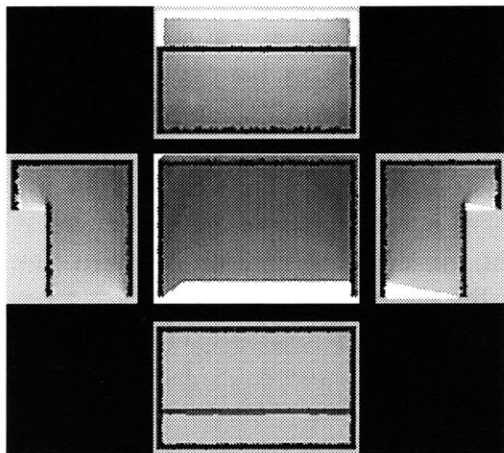
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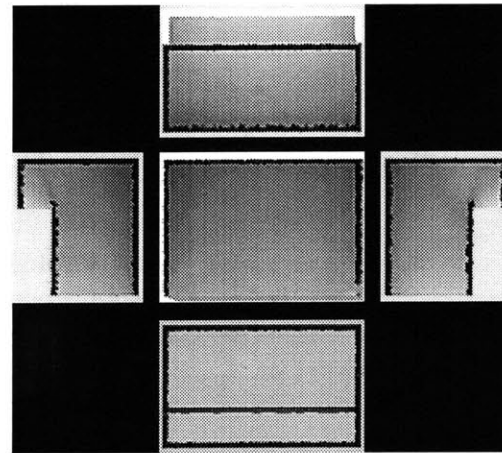
8:00 am



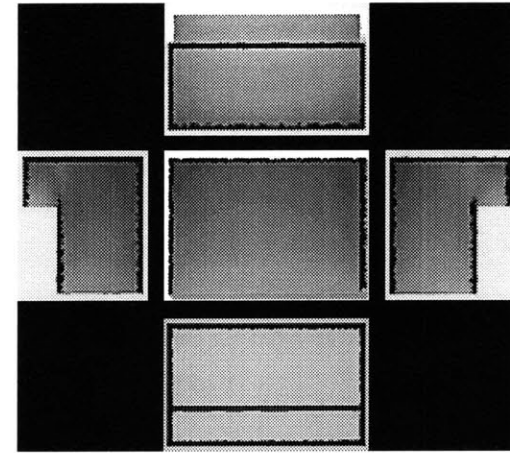
10:00 am



12:00 pm

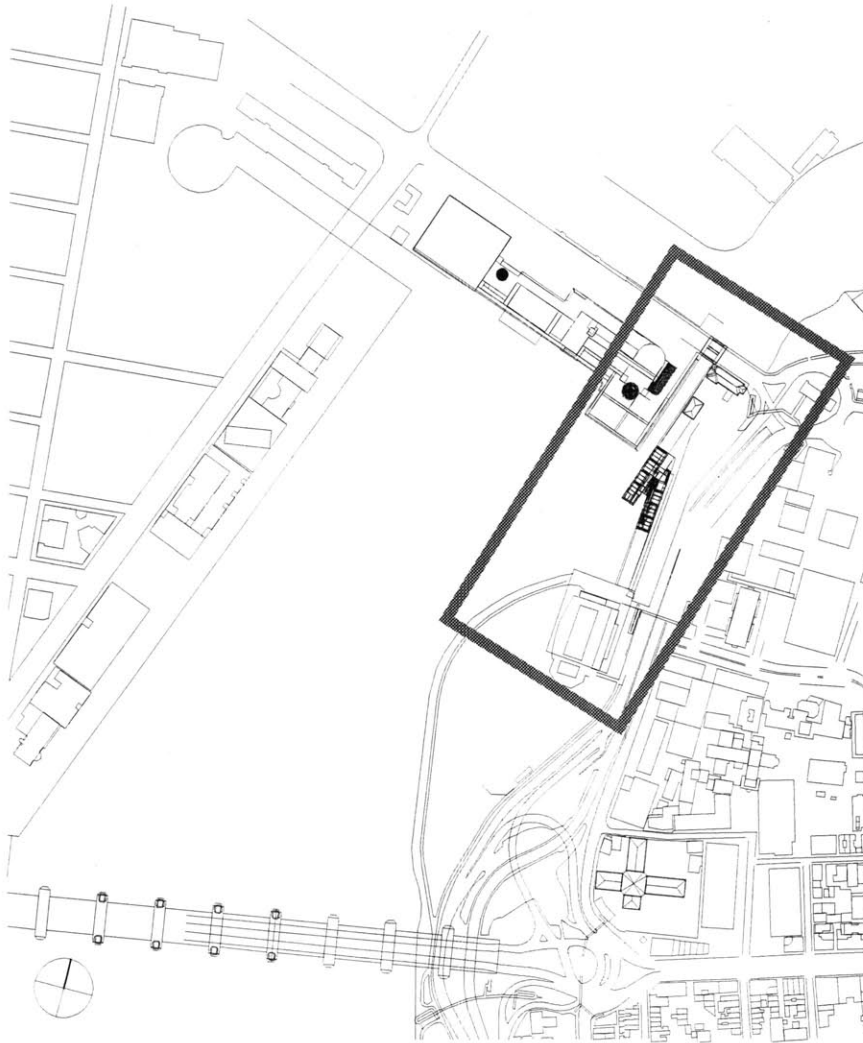


2:00 pm



4:00 pm

Multi-section light-box diagrams in time series from 6:00 am to 4:00 pm, June 22, Boston longitude and latitude. The box is oriented along the North/South axis (North faces to the right on page) and opens to the East. In each composition of five sections, the center image is the plan section, with the images top, bottom, left, and right representing the unfolded vertical sections.



Site plan: Charles River Dam and Museum of Science

## **Project**

The chosen problem for exploring these questions is the design of a library of approximately 50,000 square feet on the Charles River in Boston. The library type provides a rich set of precedents, in which light is used as a primary material for building spatial experience. The project evolved by focusing on the use of light in making spaces and territories appropriate to the program and site. The design was developed largely through the use of various computational tools for visualizing light and space, in order to begin to enunciate and further articulate the questions driving the thesis. The design method is one that sought to design the “effects” and “qualities” of light associated with some given use territory. Ultimately, our perception of light as we experience it is built through material and form. Understanding the qualities and effects desired for some use is inherently wrapped up in decisions of material and form. Thus, by understanding a set of interrelated spatial experiences as built through light, material, form and structure, the design process for the project developed outwards from an interior spatial knowledge.

## **Site**

The site for the project is on the Charles River Basin adjacent to the Museum of Science. It is bounded on one edge by Storrow Drive and on the other by the remaining original channel lock for controlling water levels and boat access. The channel is approximately 50 feet wide. The other edge of the channel is built by outdoor

space belonging to the Museum of Science.

There are three main design conditions that the site offers: light, edge, and public continuity.

First: the site poses three major natural light problems, 1) relative North/South axis of sight, 2) eastern light that comes in over the land and city, and 3) western light that comes in over the water.

Second: the nature of this site creates clear edge conditions that must be resolved in the design, the noise and motion of Storrow Drive, on the one hand, versus the linear land water relation of the channel, on the other.

Third: at the larger size the opportunity exists to resolve the continuity of pedestrian access through the site and around to the other side of the river.

These problems create a clear set of issues that situate the building on the site and preference the initial design actions within the building itself.

### **Program**

The adjacency of the site to the Museum of Science suggests that the program of the library be driven in part by the needs for science and technology related information and research facilities. The library will be equipped with reading rooms of differing capacity, stack space, individual and group work spaces, seminar facilities,

computer facilities, offices, and other support uses.

### **Scope**

The scope of the project was intentionally narrow so as to allow the questions of the thesis to be explored in an explicit and deep manner. The program of the library type was chosen because it provided a rich set of precedents that clearly show the centrality of light to designing space. The design of the library was approached by understanding the use of light, utilizing a certain array of computational design tools, to build space and relations appropriate to the program. Focusing the problem and process in this manner allowed a critical understanding of the problems of computation and visualization to be developed through the process of the design activity.

Given that the larger focus of the project was concerned with design process and the use of computational tools in that process, the design of the library may be understood as the medium within which the exploration derived and evolved. This being the case, the project may be considered as ongoing, since there is much in the design of the “library” that remains to be resolved. There is also much that may be further clarified and explored in understanding the process and use of the chosen design media.



### Exploration and Design

The process for this project is one that developed within the site of the design exploration itself. It can be outlined as follows:

#### Prototype and Analysis (light and site)

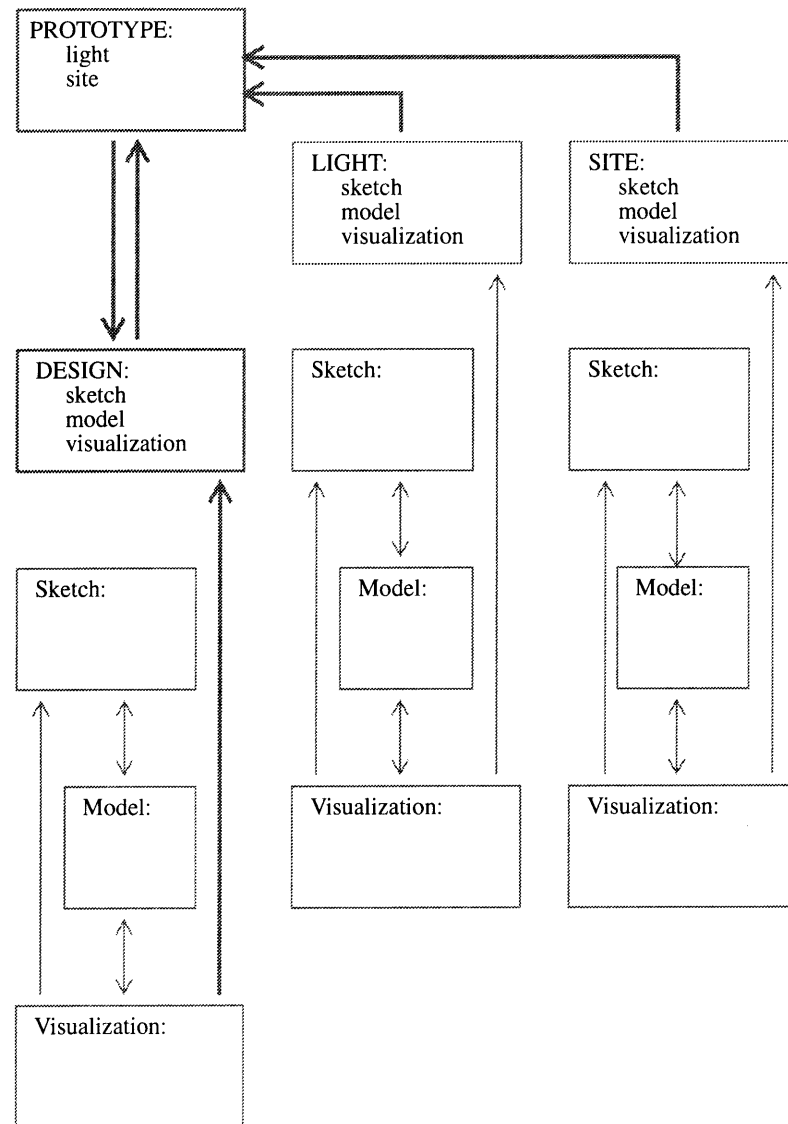
- light prototypes
- sketching
- modeling
- visualization
- organizational studies
- sketching
- modeling
- visualization

#### Design and Visualization (building project)

- sketching
- modeling
- visualization

Sketching, modeling and visualization were the three key representational modes within the process. At some stages, the sketch and the model were used interchangeably, at other stages, the sketch was used as a way to mediate between models, visualizations and iterations in the design process.

The design process was initiated by making a set of observations of the fundamental behaviors and problems of the site. These observations served to locate the building on the site. They also began to define the critical requirements for how the building should act architecturally on the site. These observations are as follows:



Process flow diagram, indicating relations between different representational strategies in the process, as well as the relations between the different stage in the process.

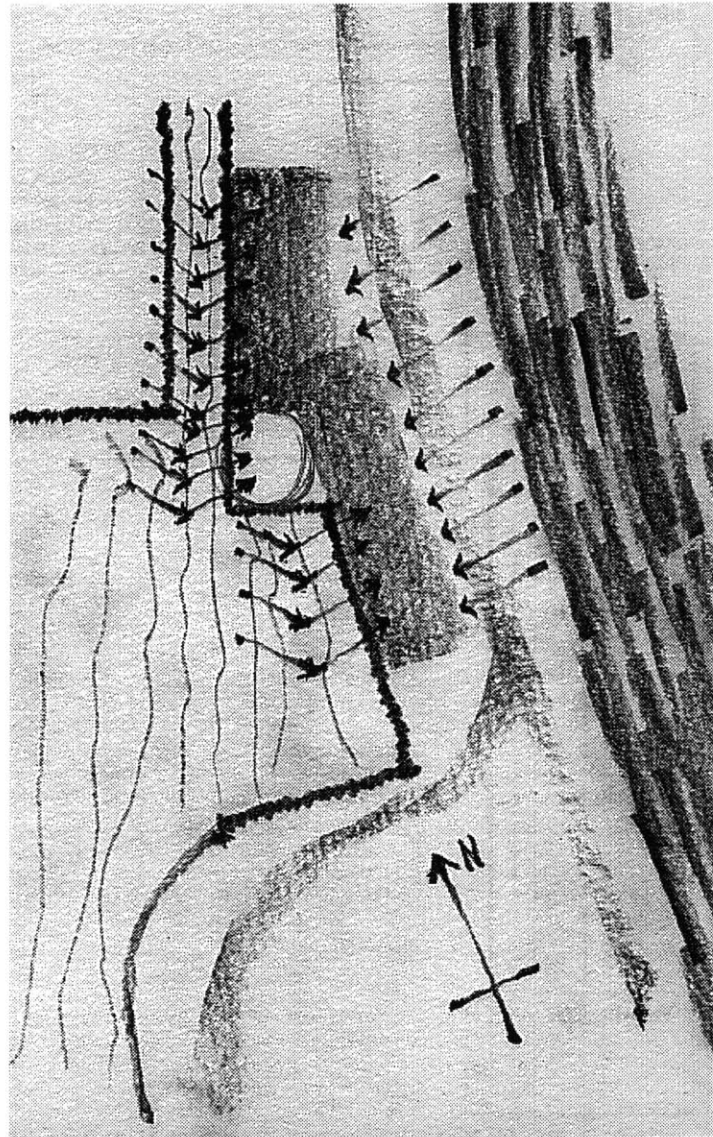


Diagram indicating site conditions and observations.

- 1) edge intensification of channel
- 2) corner as arrival on water
- 3) light generating qualities of water
- 4) relative North/South orientation of site
- 5) low angle East/West sun
- 6) pedestrian access on site

These observations relate to issues both about architecture as well as light. Based on this set of initial observations, three dimensional computer study models were generated. These models were used to quickly visualize whether and how an idea relating to one of the above issues worked as part of developing a design proposition for the site. Thus, they served to further clarify the observations made about the site. These initial models usually took no longer than one half hour to build plus another one half hour to render.

### **Prototype and Analysis**

Two types of study models were used at this early stage in the design process. The first had to do with responding to the lighting conditions of the site. The second had to do with initial attempts at site organization. In the first case, light was considered in terms of four types of conditions: displaced, overhead, reflected, and screened. These conditions attempted to categorize in a meaningful way the types of light that one might build with, given the observations and conditions of the site. These categories developed as a result of the continued devel-



opment of models studying how light might be used to build in the site. In the second case, the site organization was studied by using colored transparent boxes to develop a diagram of the building on the site. The use of transparency and color allowed elements to be placed within each other, thus offering some three dimensional spatial sense to the diagram, as well as proposing programmatic and spatial relations in the design. These models took into account results from the light study models. They also served to make projective decisions that lead to further studies of the lighting conditions.

The lighting conditions can be simply broken down in terms of the type of light that each provides: indirect or direct. The odd case here is screened light, which can build both indirect and direct qualities of light.

Indirect:

- displaced
- overhead
- reflected
- screened

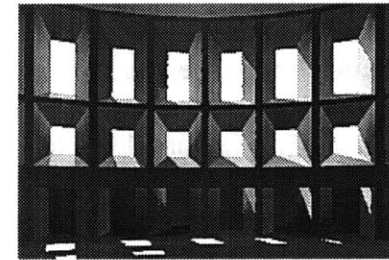
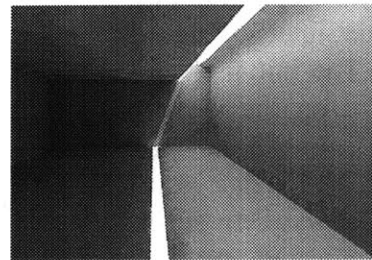
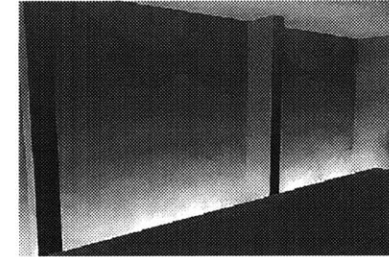
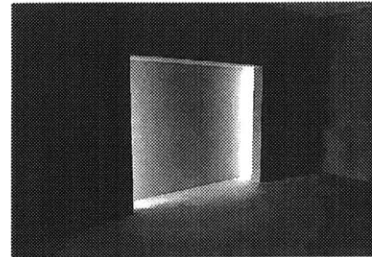
Direct:

- screened

These conditions can also be broken down in terms of the site and directional properties of the sun: East/West or North/South.

East/West:

- displaced
- overhead
- reflected



Clockwise from top left: displaced, reflected, screened and overhead light models.

screened

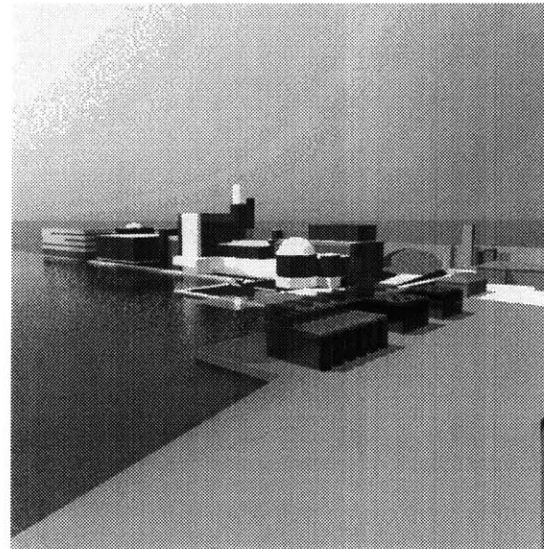
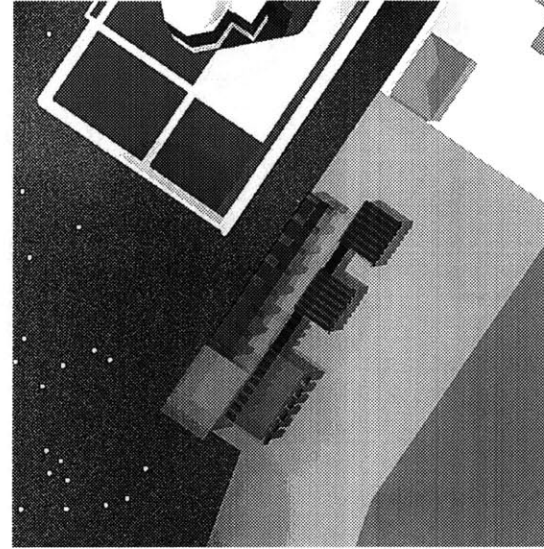
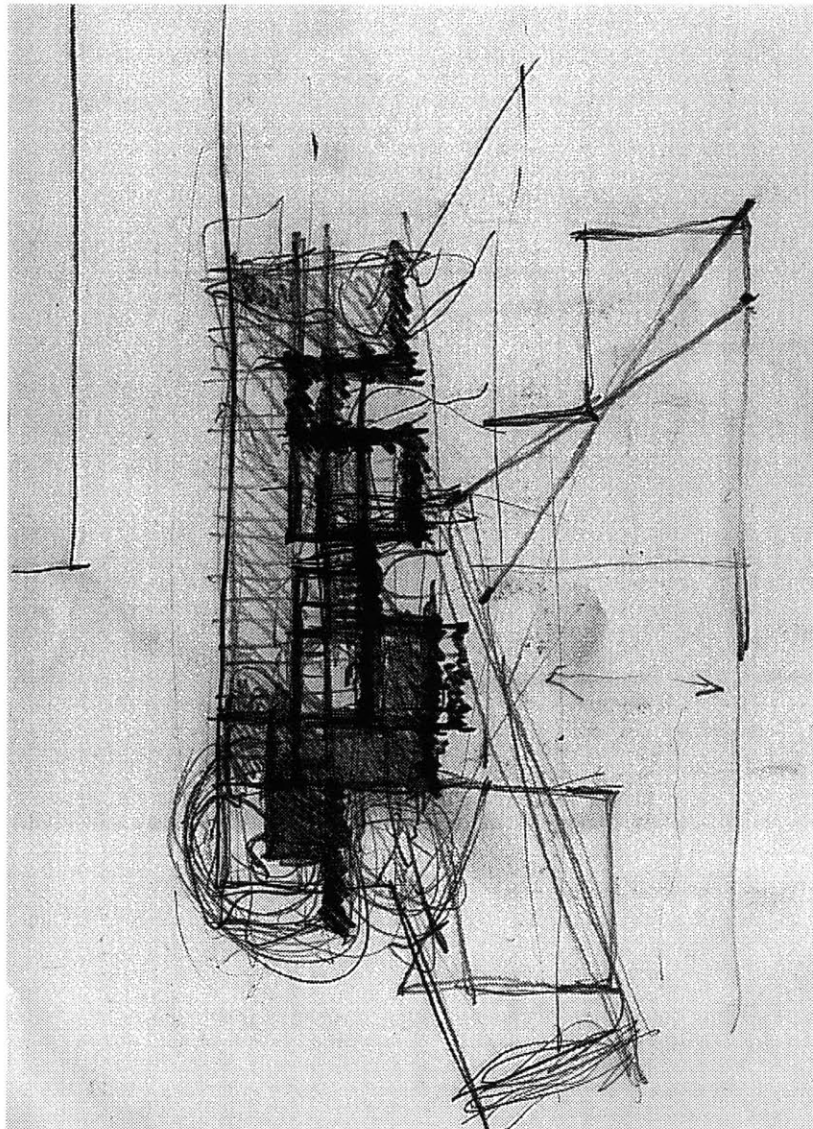
North/South:  
overhead  
screened

An example of the process at this stage is as follows. Several studies considering indirect lighting propositions for the west facing edge of the site were considered. This edge provided several opportunities: controlling western light over the water, intensifying the channel edge, generating the corner. The initial studies considered only how to control light on the western edge. This in turn lead to considering how the light could be used to generate and intensify the edge of the channel. In the transparency model that was then generated, these two issues were clearly indicated and dealt with, but the problem of the corner was opened up. The corner needed to be articulated as turning from West to South. This lead to a series of studies considering how the corner might be built and turned using screen elements.

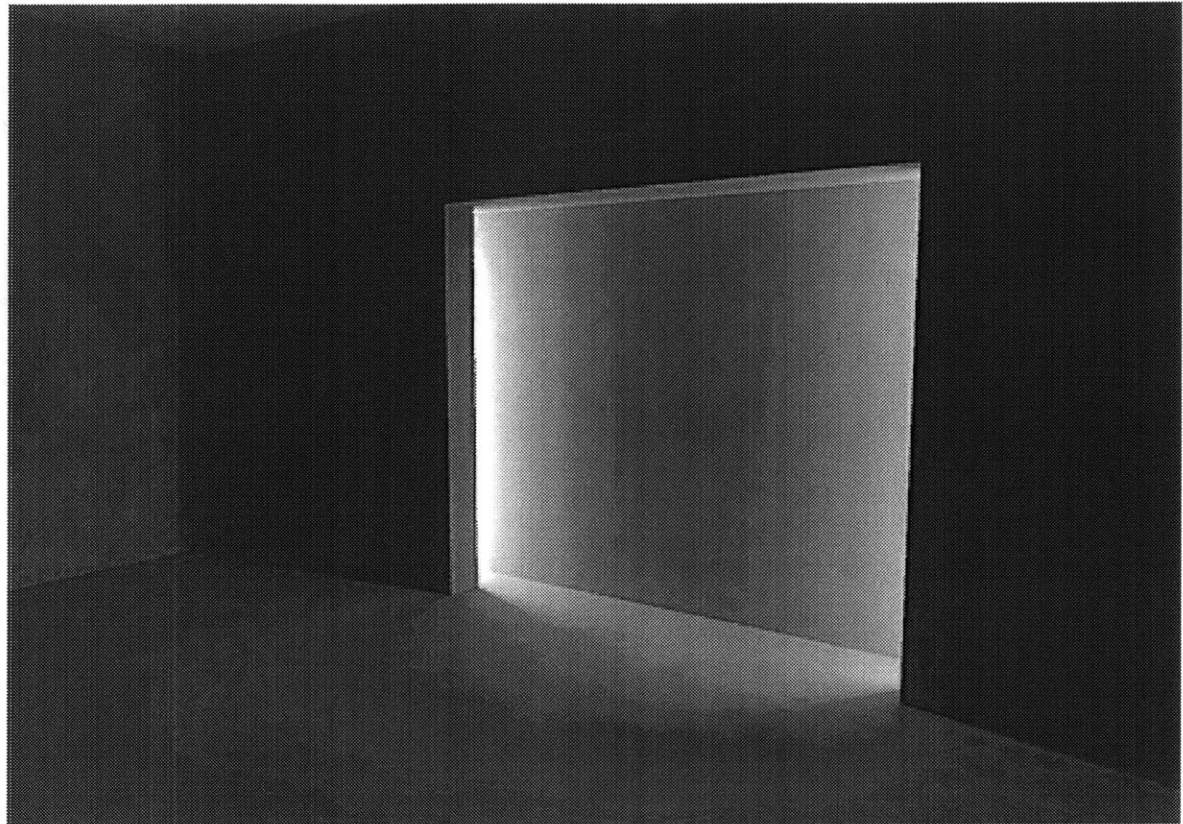
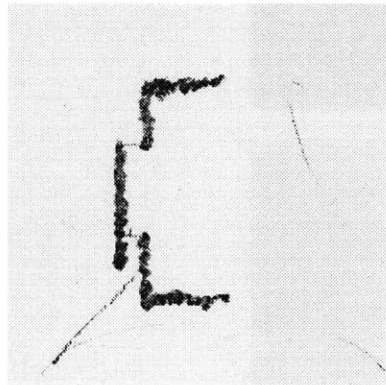
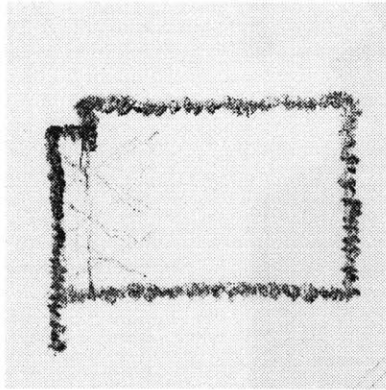
### **Modeling and Visualization**

As the problem became one of transitioning from numerous individualized studies and prototypes to the problem of providing a building solution, the sketch started to play a fundamental role. The sketch was the main tool in mediating between the initial prototypes and studies, and the larger building design. The sketch provided a quick and easy way to make projections for how the early prototypes could be deployed on the site

to start to organize and make a building. The sketch also provided a means to quickly transition from one iteration of the building design to the next. This was particularly true while the building organization was still being filled in. But, as the building design became more developed, it was the visualizations that mediated from model iteration to model iteration in the design process. Small images could be generated quite quickly using the same camera viewpoint from iteration to iteration. These small images allowed for a crude but not unreasonable sense of what the space might be like. They also provided very direct feedback as to whether the quality or effect of light was working in one place or another as desired.

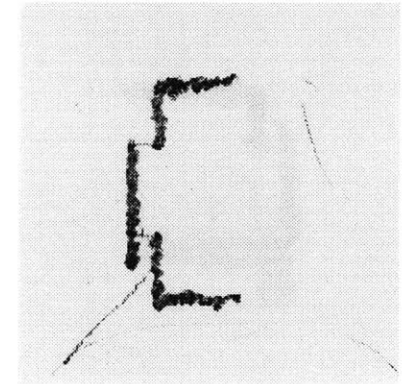
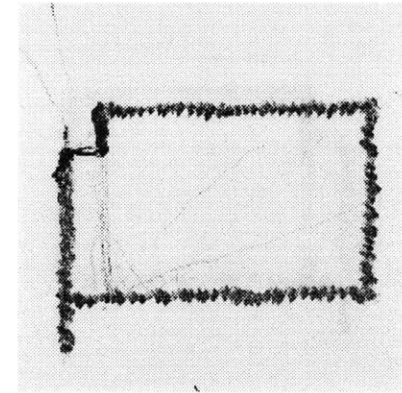
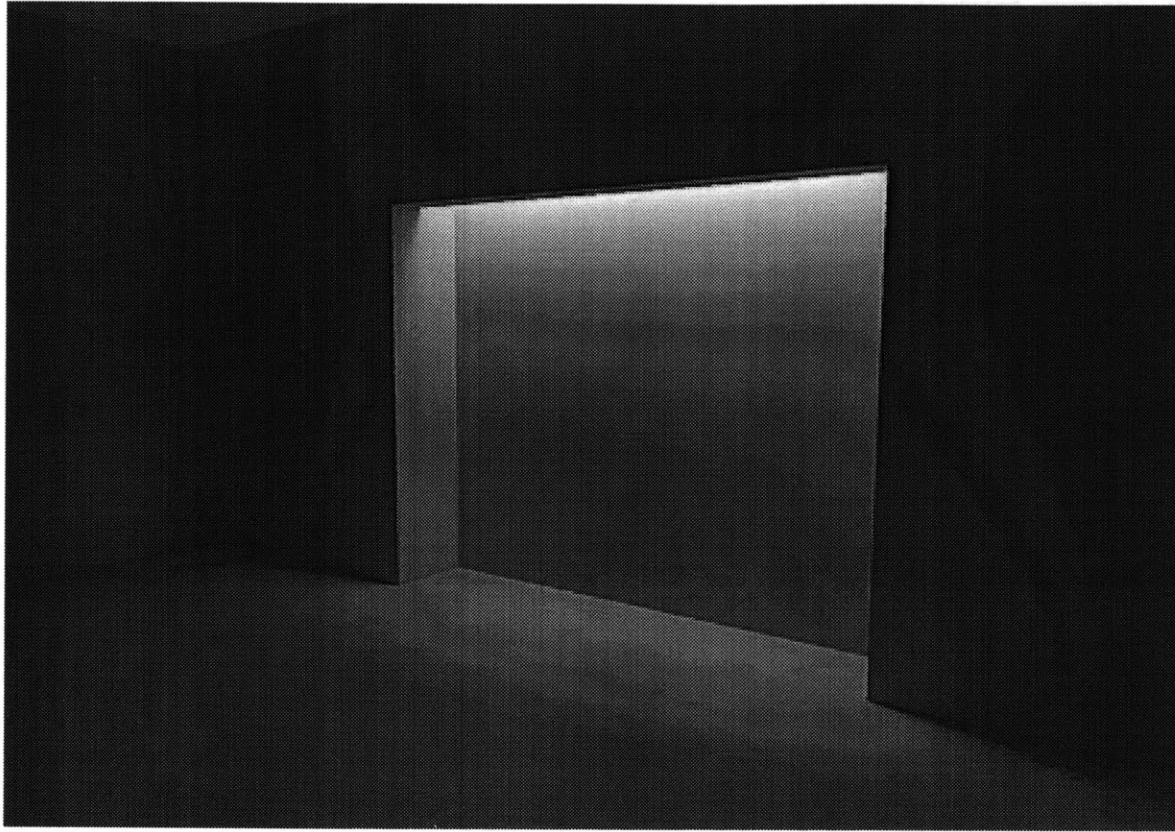


**Above:** plan diagram, channel edge intensification. **Right:** transparency diagrams, plan and perspective.



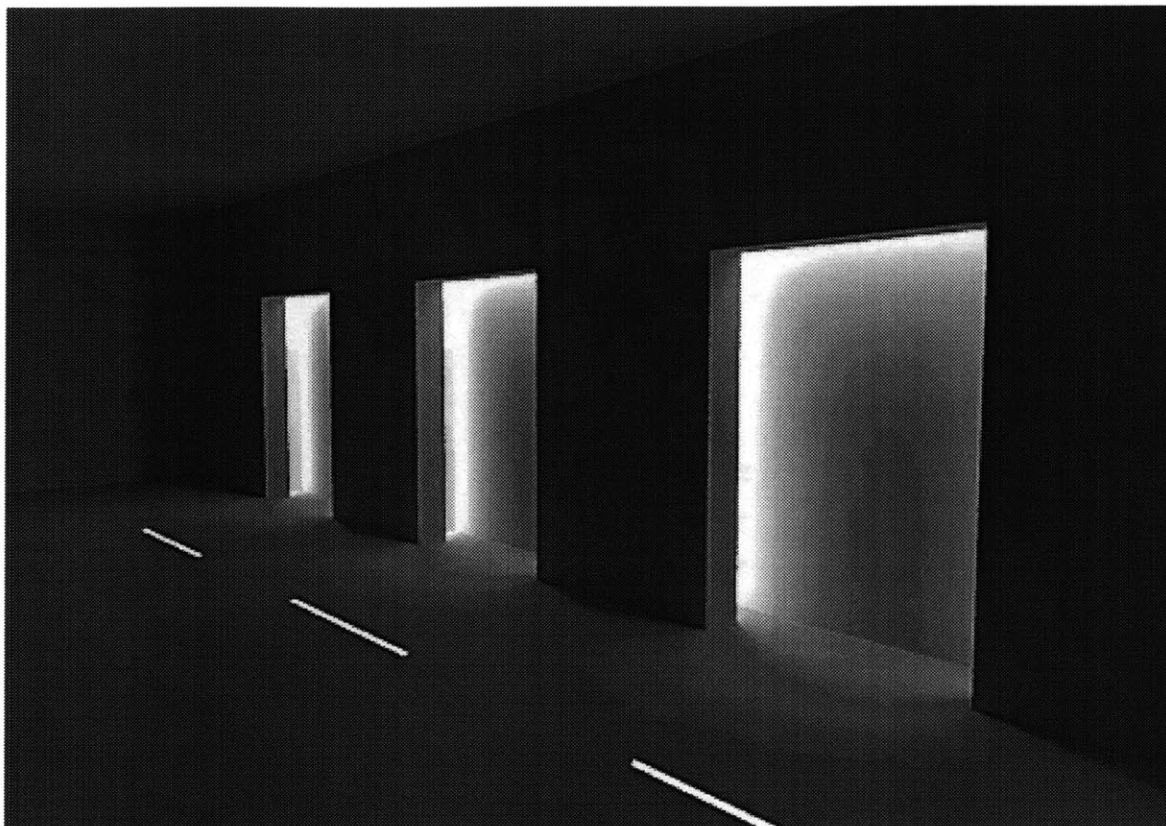
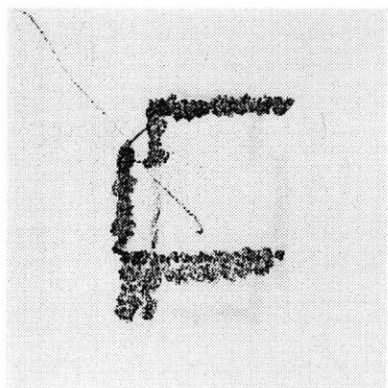
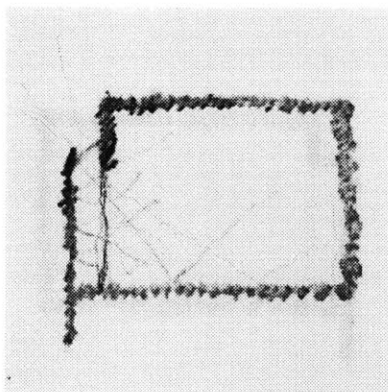
Displaced Surface Model: pass one.

**Left:** sectional and plan diagrams. **Above:** visualization of light through displaced surface. Light from sides.

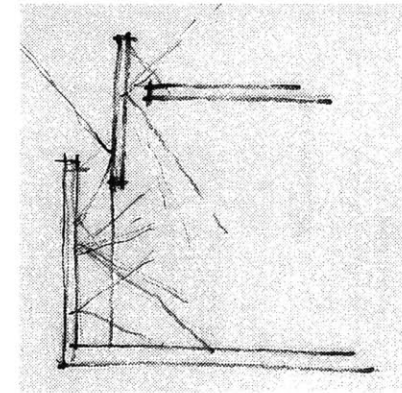
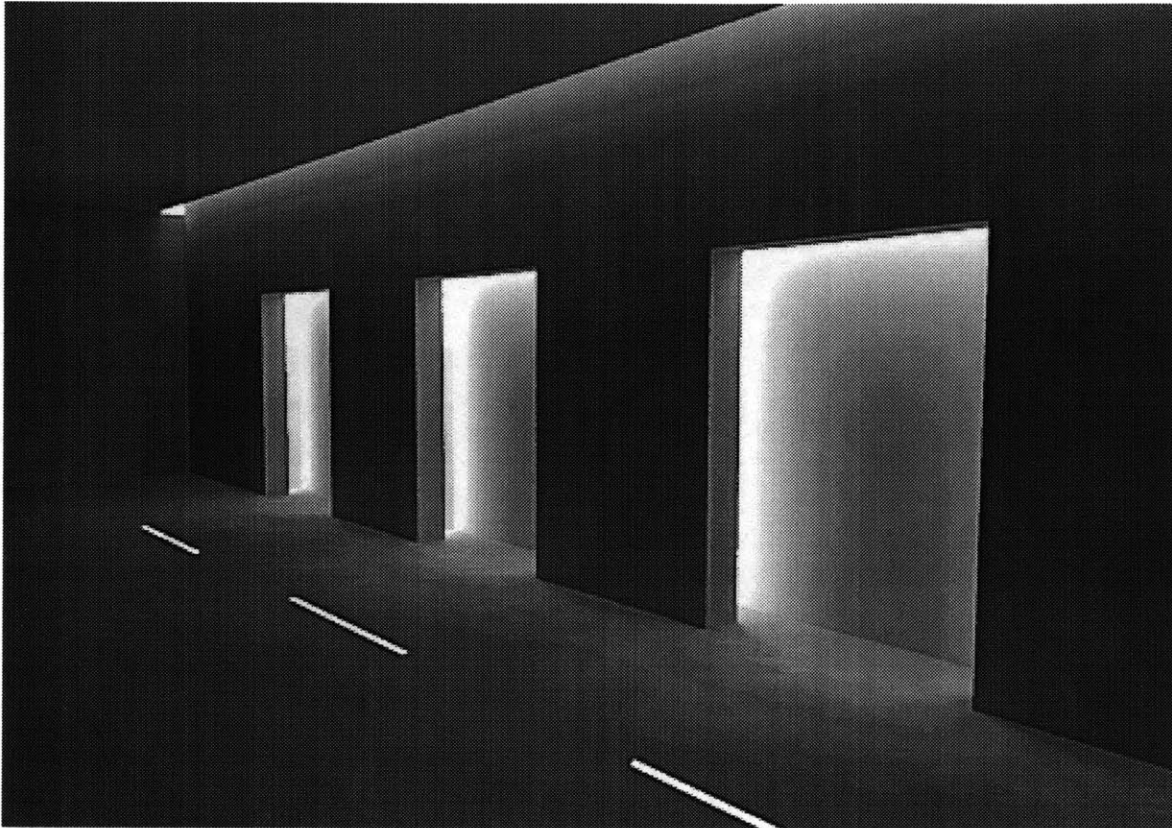


Displaced Surface Model: pass two.

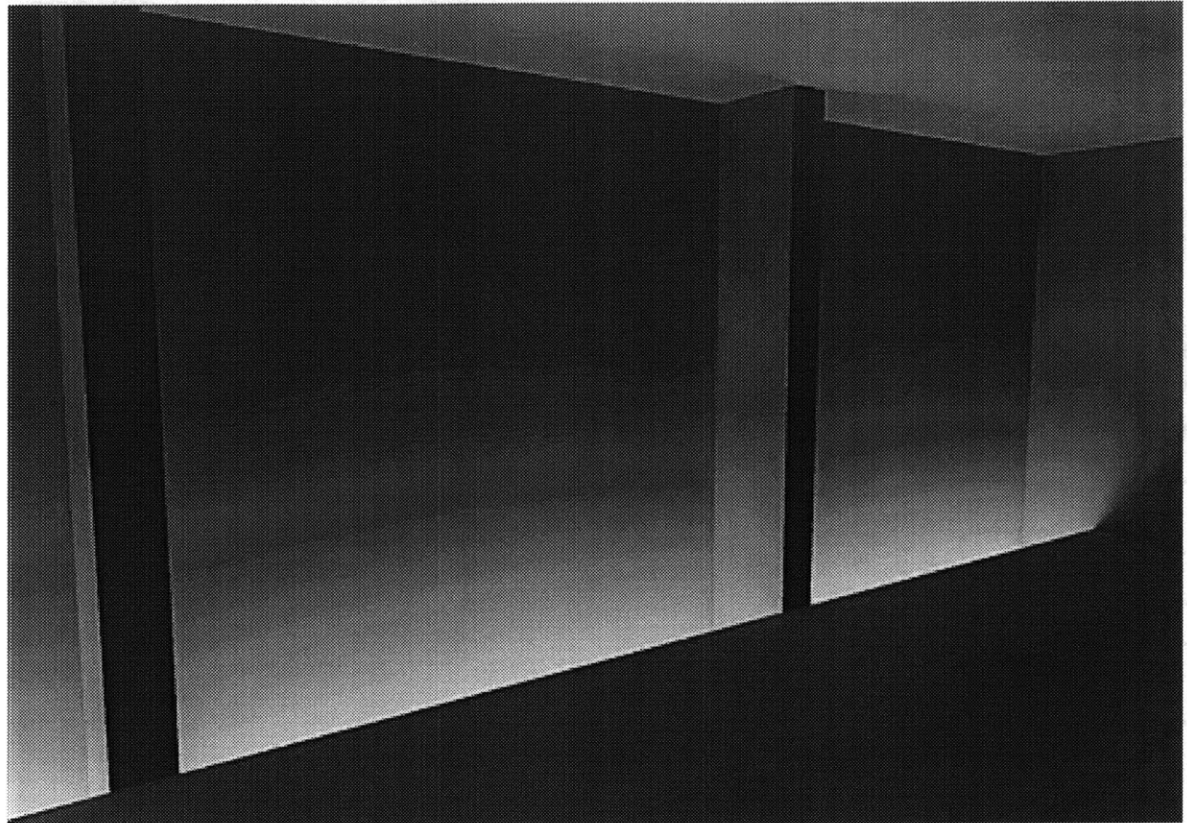
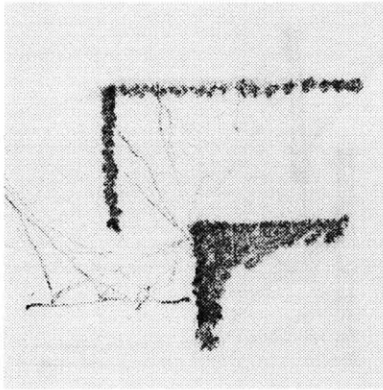
**Above:** visualization of light through displaced surface. Light from above. **Right:** sectional and plan diagrams.



Displaced Surface Model: pass three. Combination and serial addition of passes one and two.  
**Left:** sectional diagrams. **Above:** visualization of light through displaced surface.

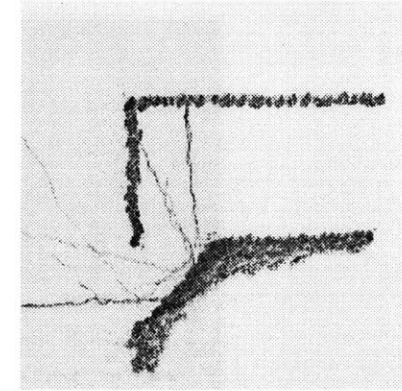
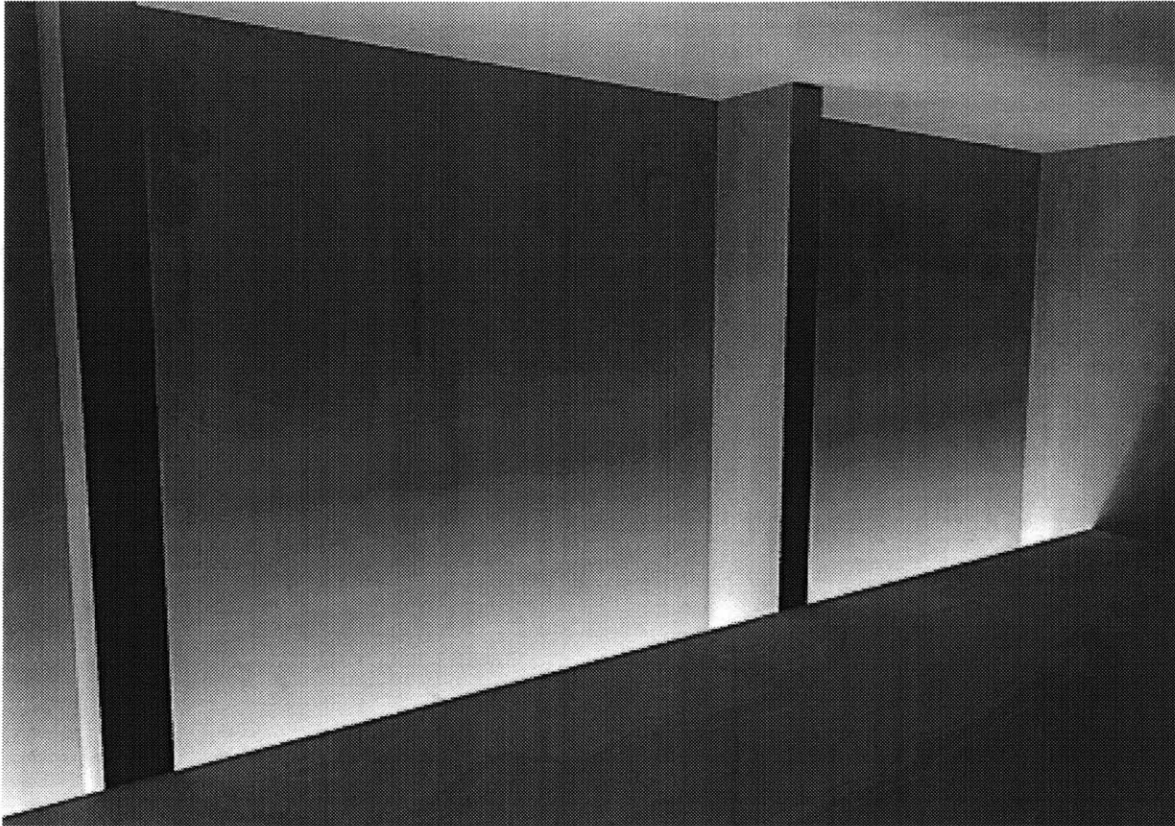


Displaced Surface Model: pass four. Pass three with roof opening.  
**Above:** visualization of light through displaced surface. **Right:** sectional diagram.



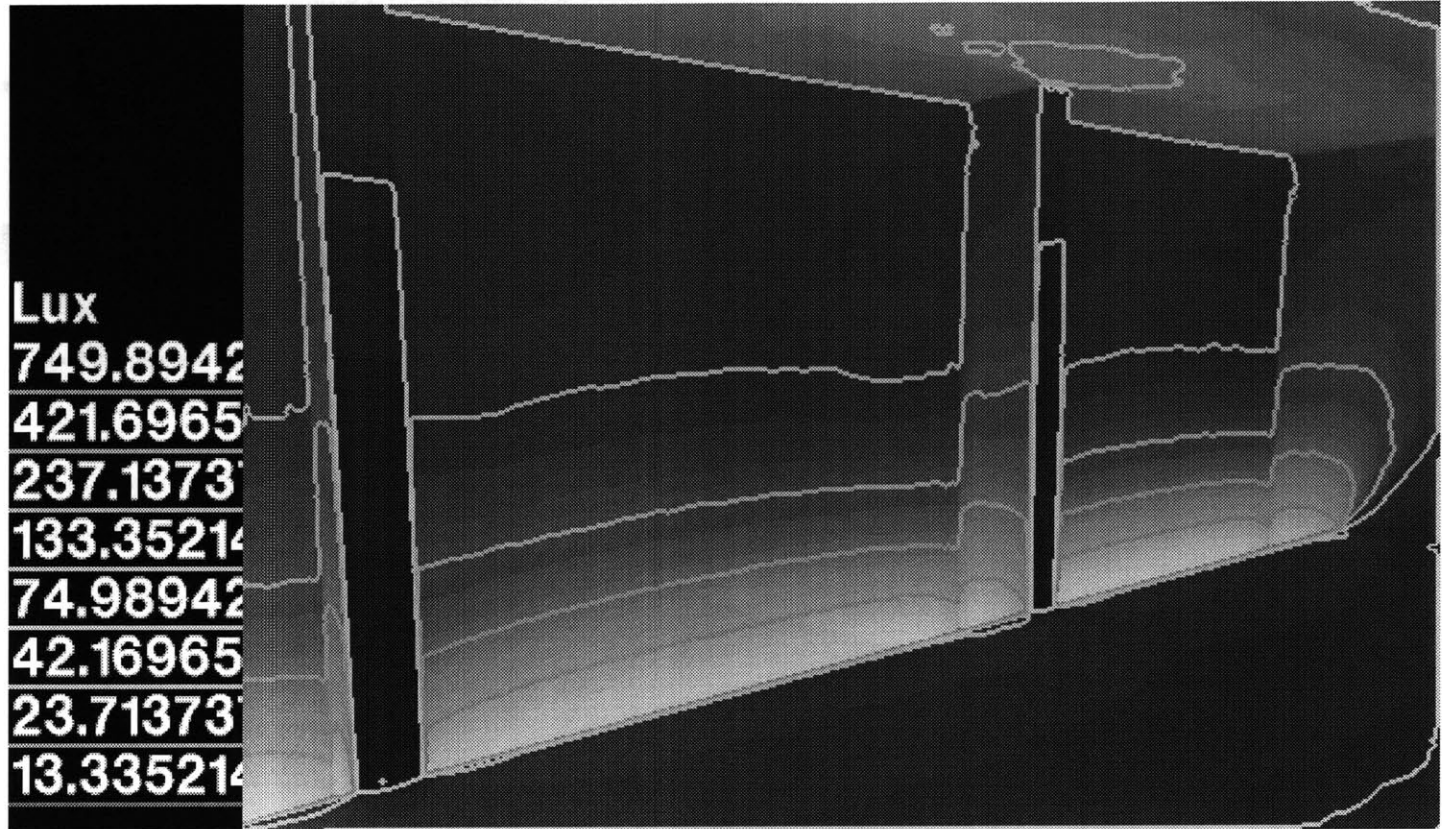
Reflected Light: pass one. Lighting reflecting off of water surface.  
**Left:** sectional diagram. **Above:** visualization of light reflected up into space off of water surface.



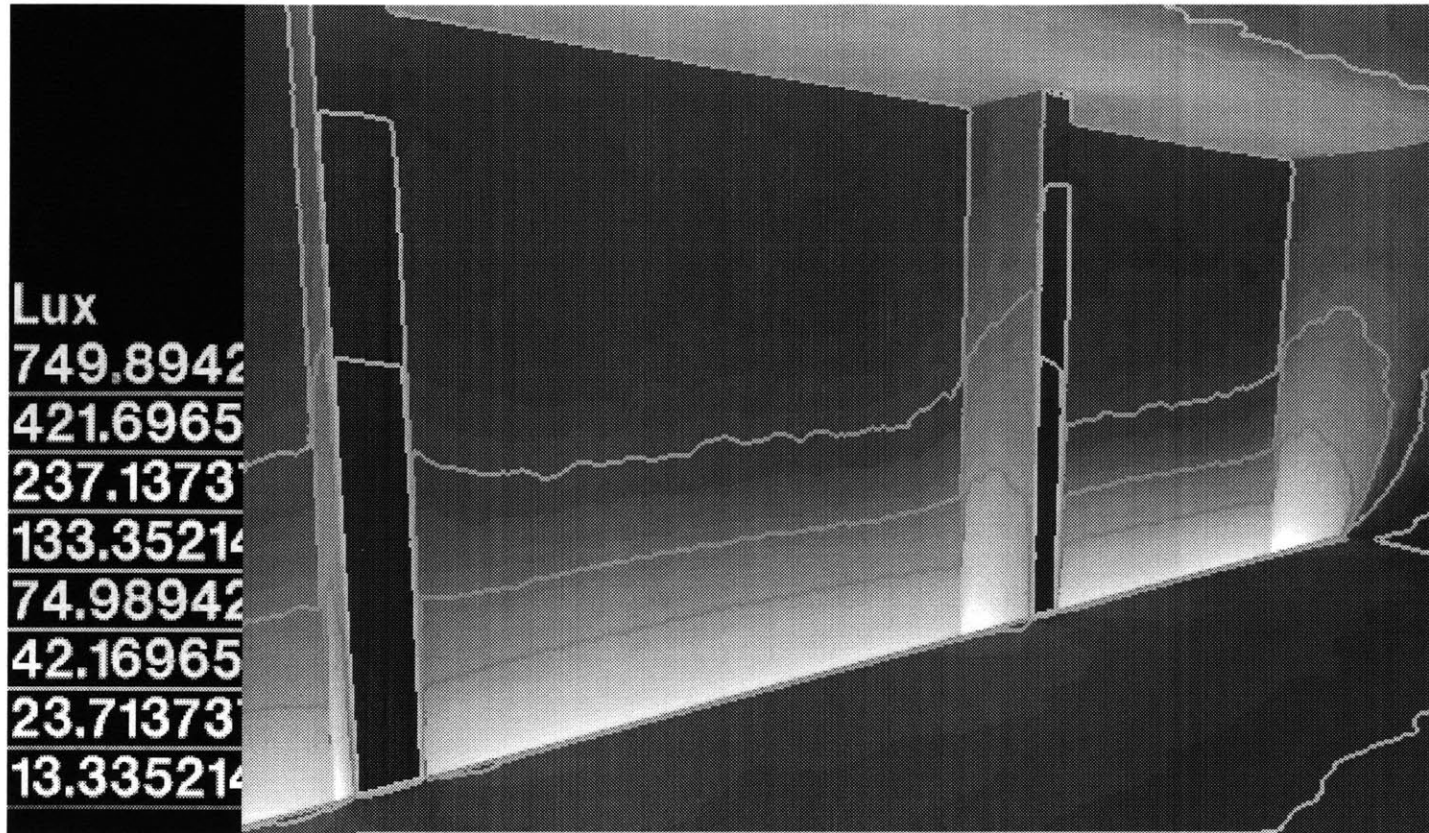


Reflected Light: pass two. Light reflecting off of water and inclined white reflector.

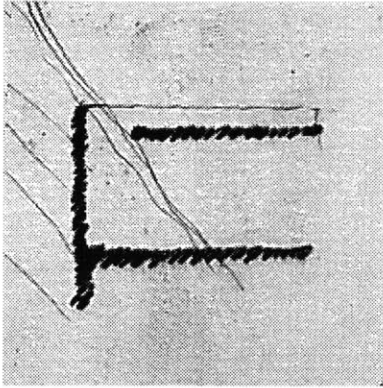
**Above:** visualization of light reflection up into space off of water and white reflector. **Right:** sectional diagram.



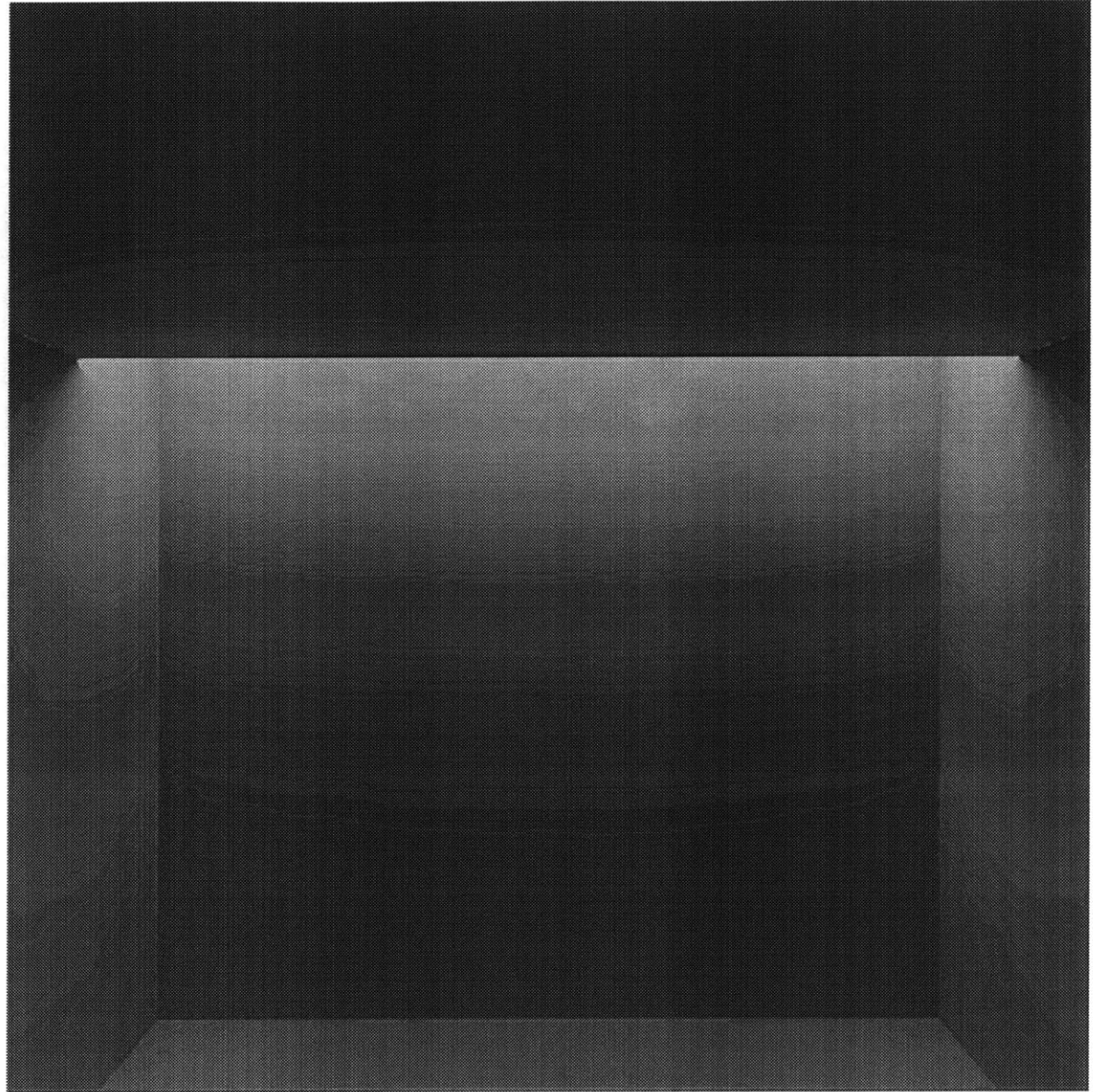
Reflected Light: pass one. Illuminance map on logarithmic scale, contour lines indicate changes in levels.

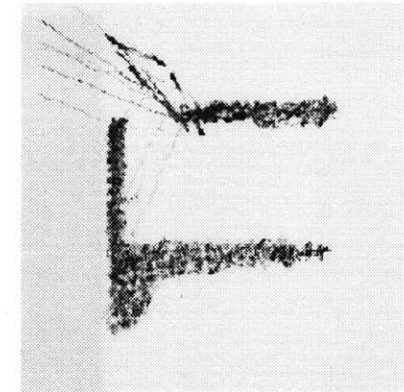
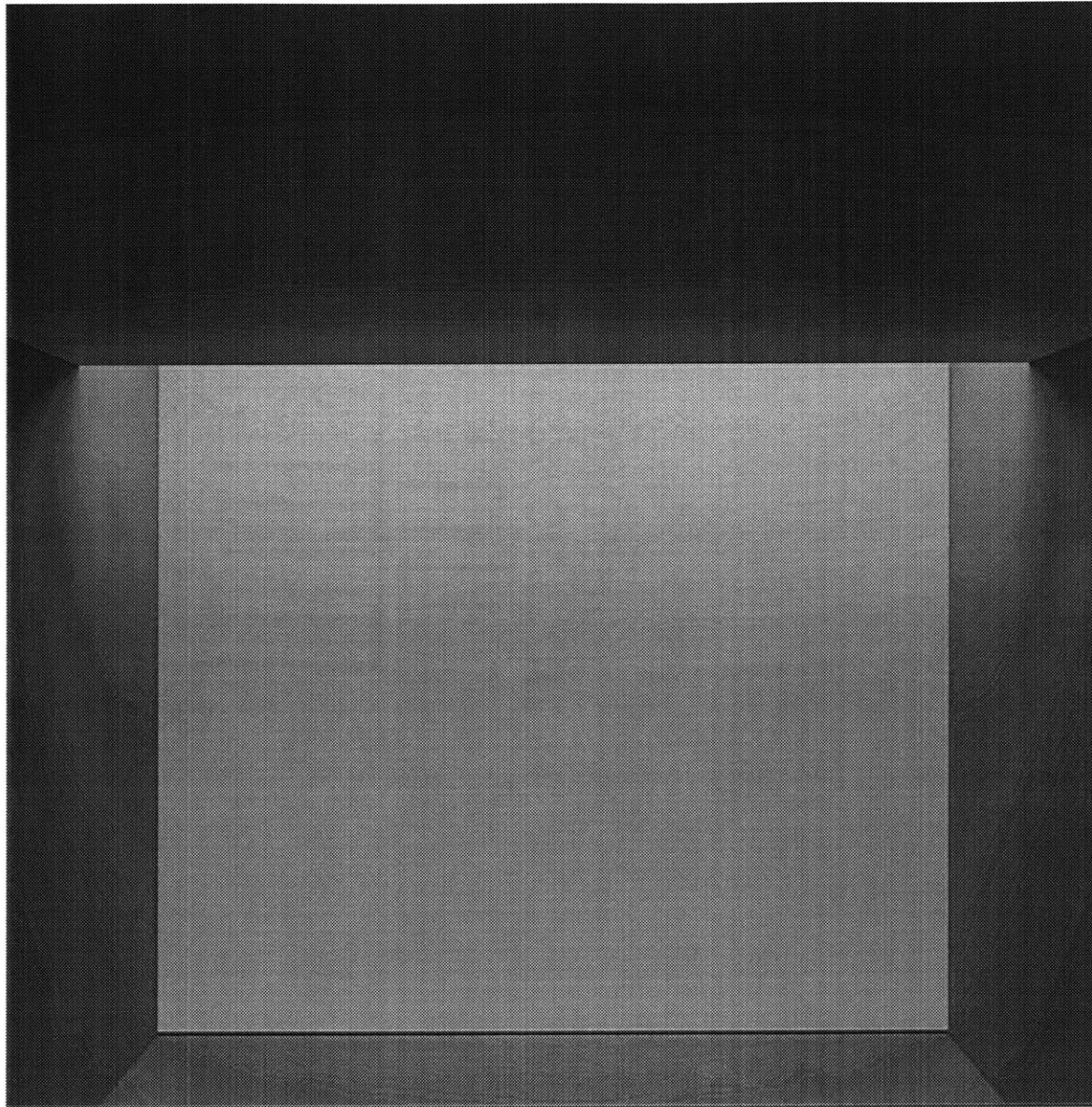


Reflected Light: pass two. Illuminance map on logarithmic scale, contour lines indicate changes in levels.

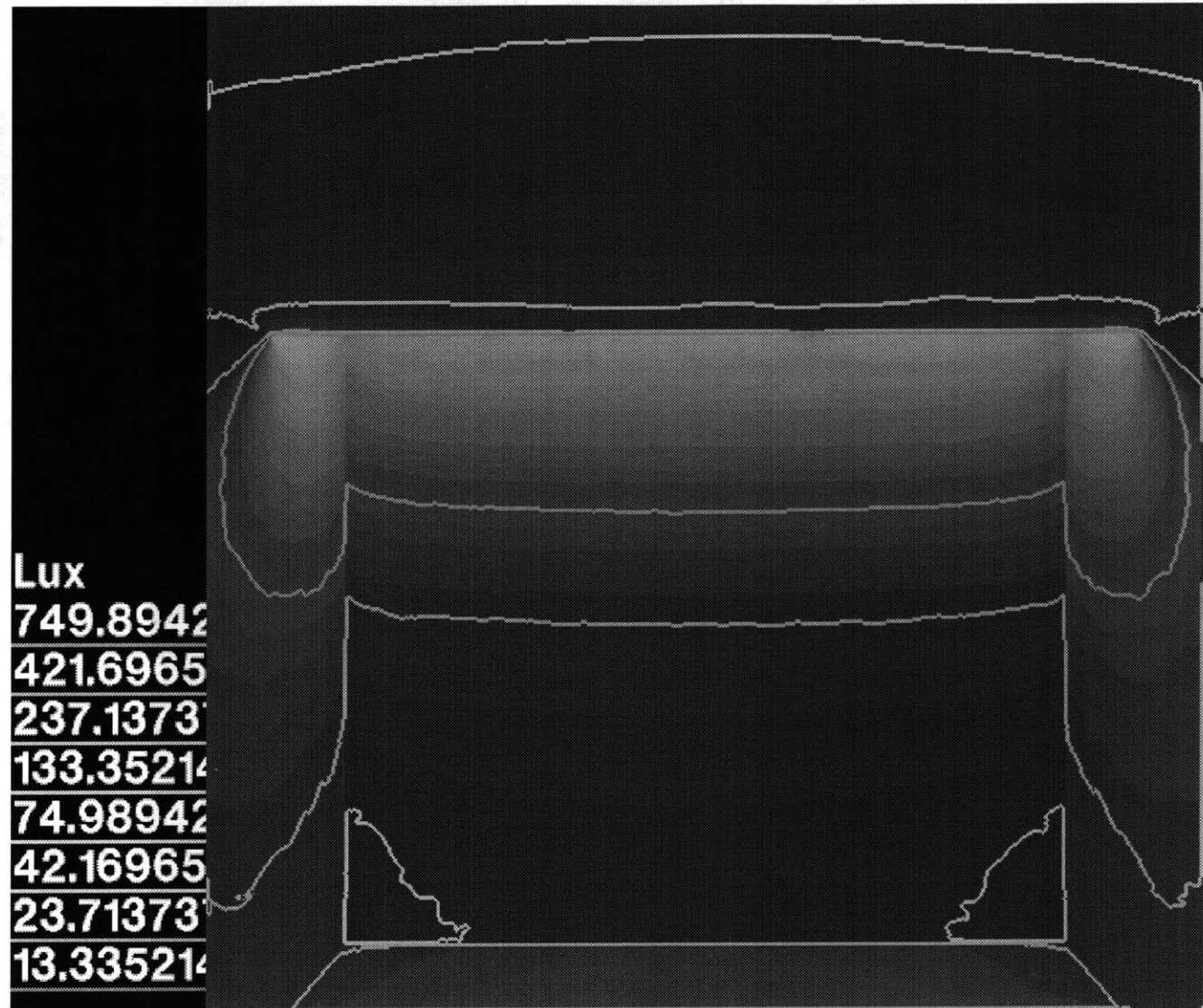


Reflected Light: pass three. Overhead opening with no reflector. **Above:** sectional diagram. **Right:** visualization.

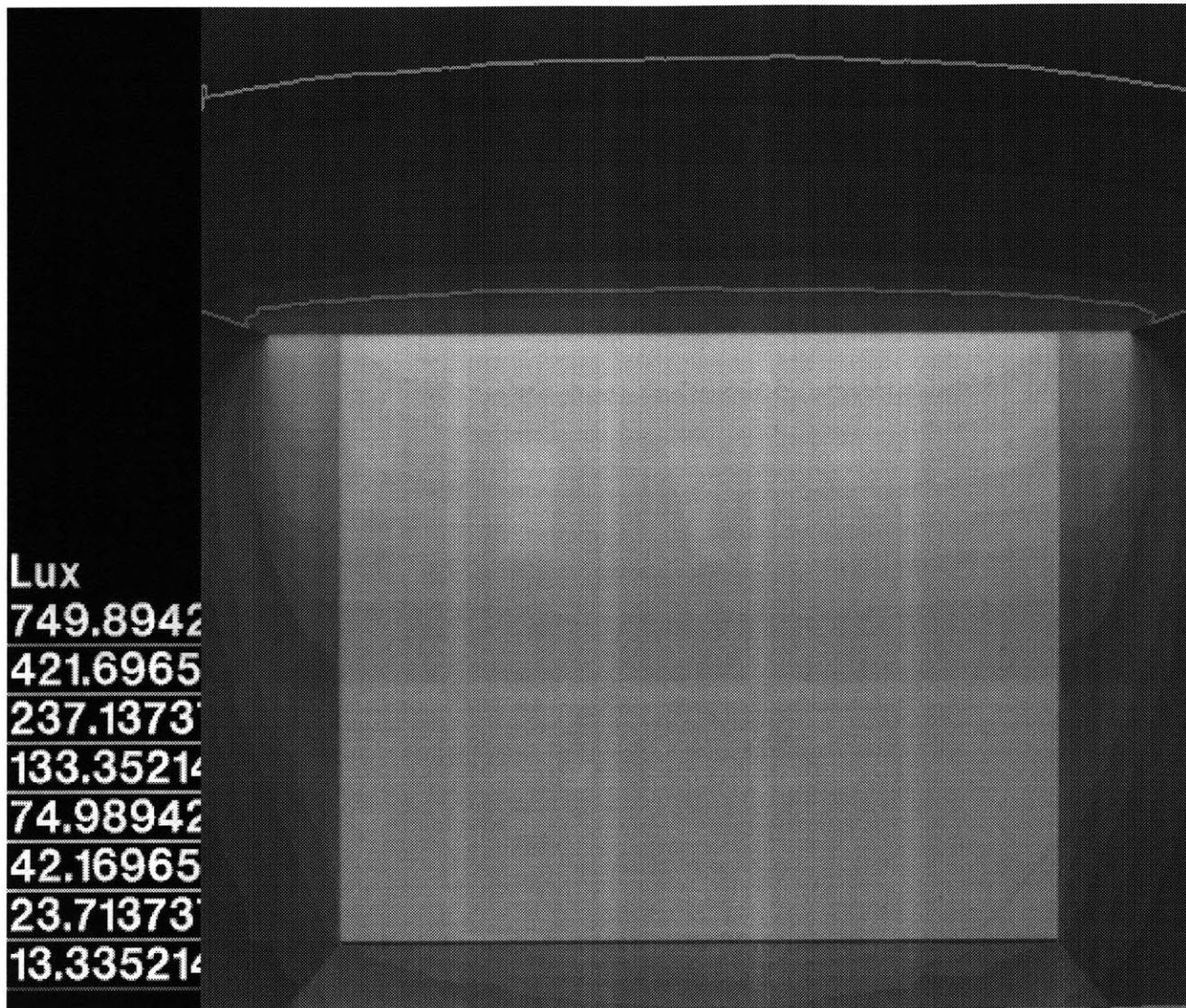




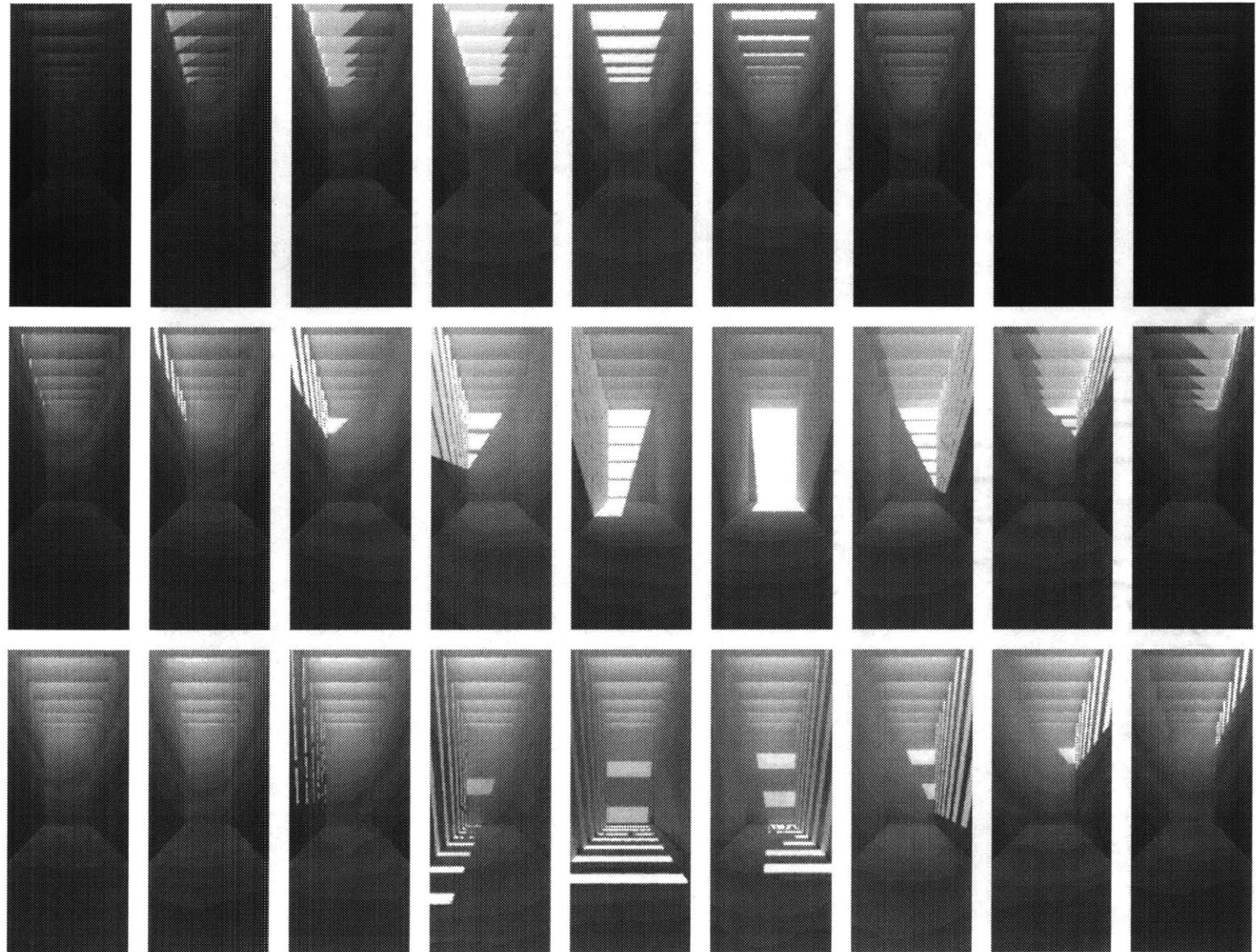
Reflected Light: pass four. Overhead opening with reflector. **Above:** sectional diagram. **Right:** visualization.



Reflected Light: pass three. Overhead opening with no reflector. Illuminance diagram on logarithmic scale, contour lines indicate changes in levels.

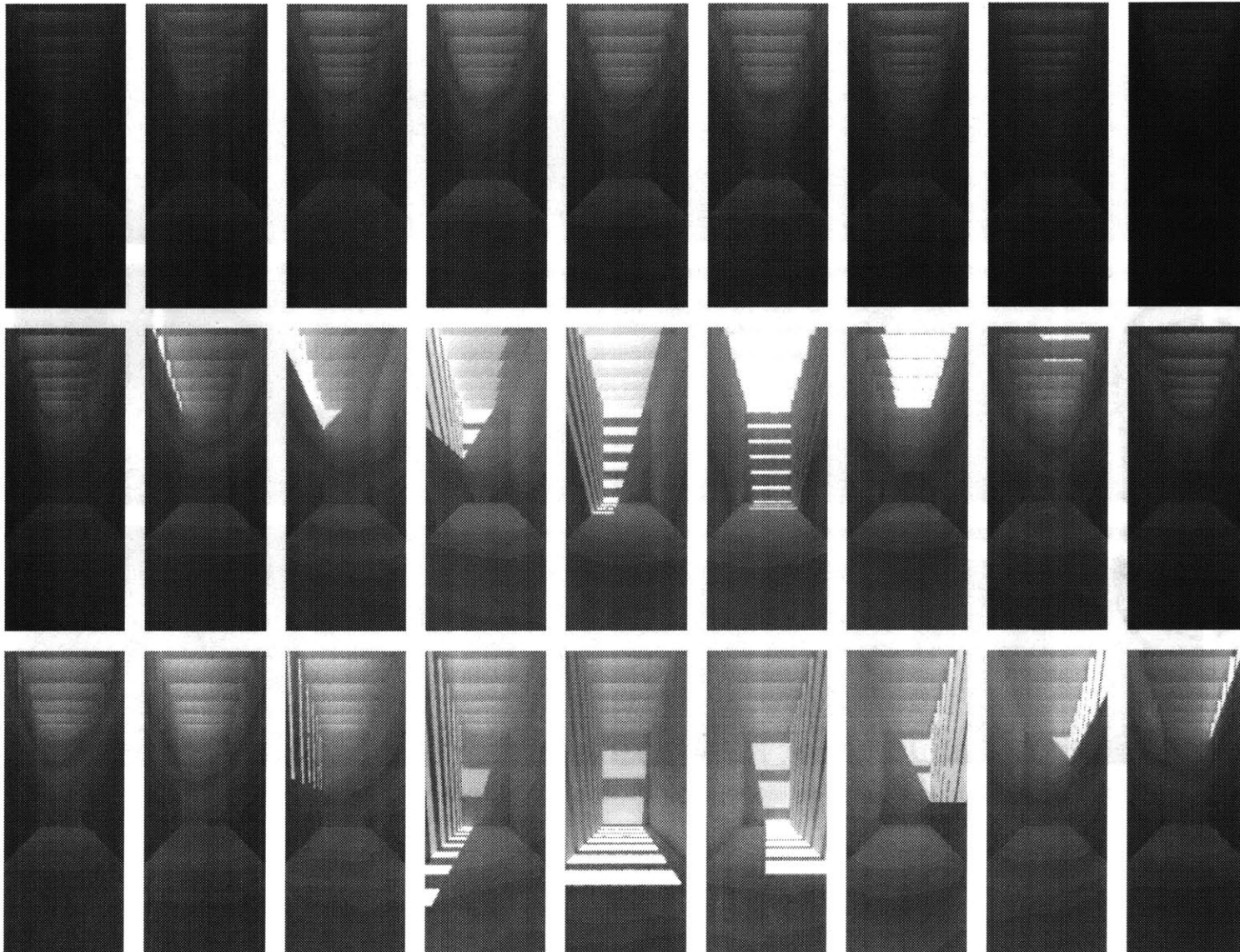


Reflected Light: pass four. Overhead opening with reflector. Illuminance diagram logarithmic scale, contour lines indicate changes in levels.



Overhead South facing louvre system at 45 degrees. 8:00 am to 4:00 pm in one hour steps. **Top:** December 22. **Middle:** March 22. **Bottom:** June 22.

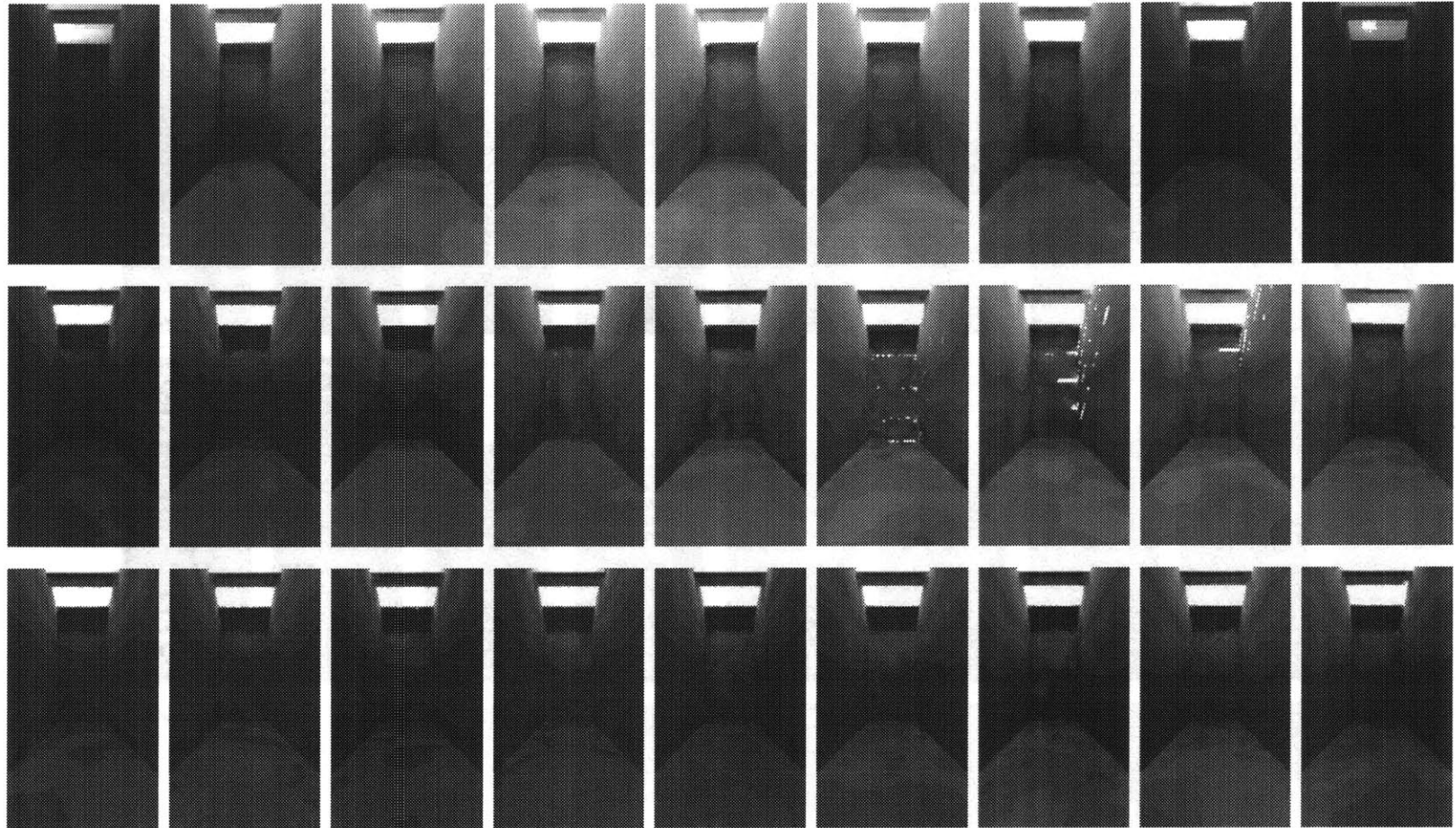




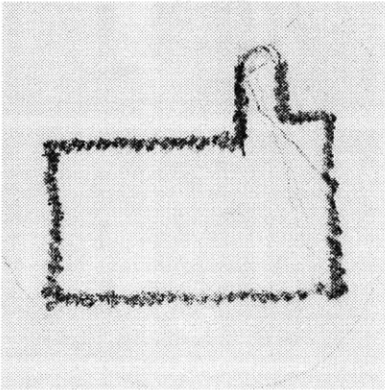
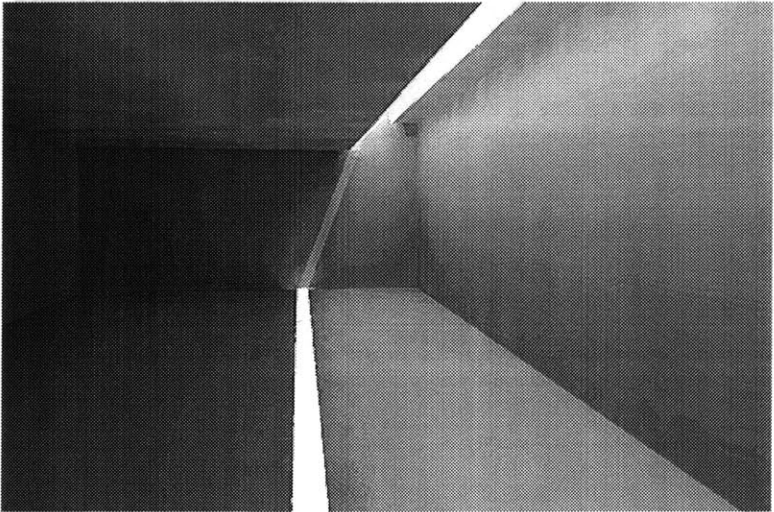
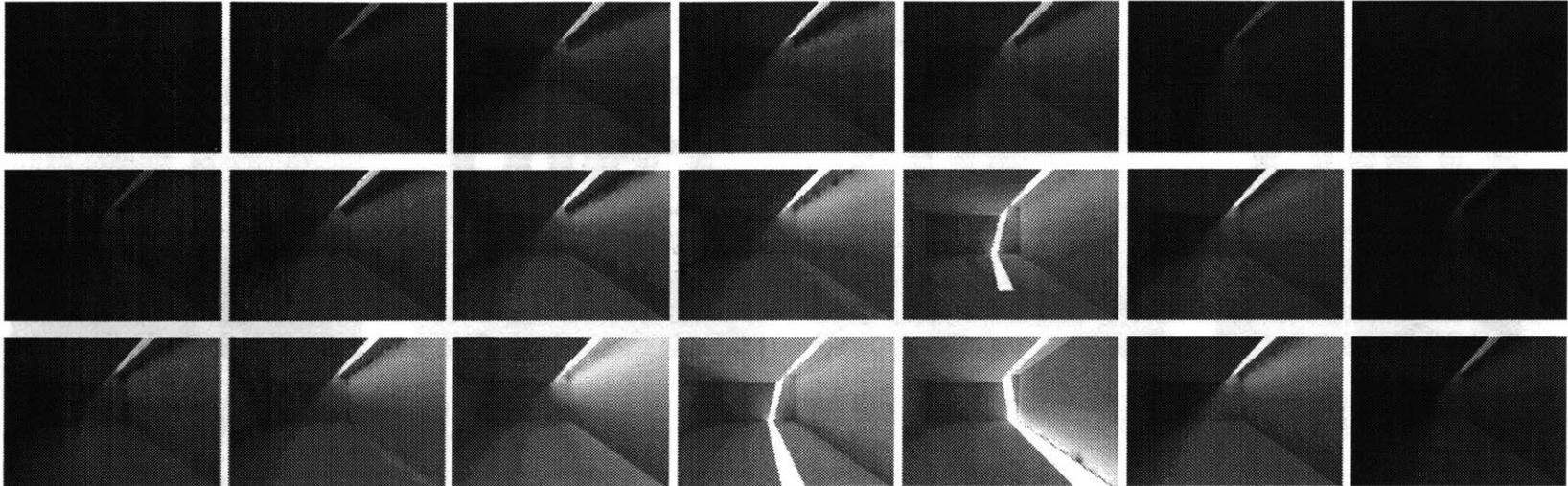
Overhead South facing louvre system at 60 degrees. 8:00 am to 4:00 pm in one hour steps. **Top:** December 22. **Middle:** March 22. **Bottom:** June 22.

**Process: light-model (overhead light)**

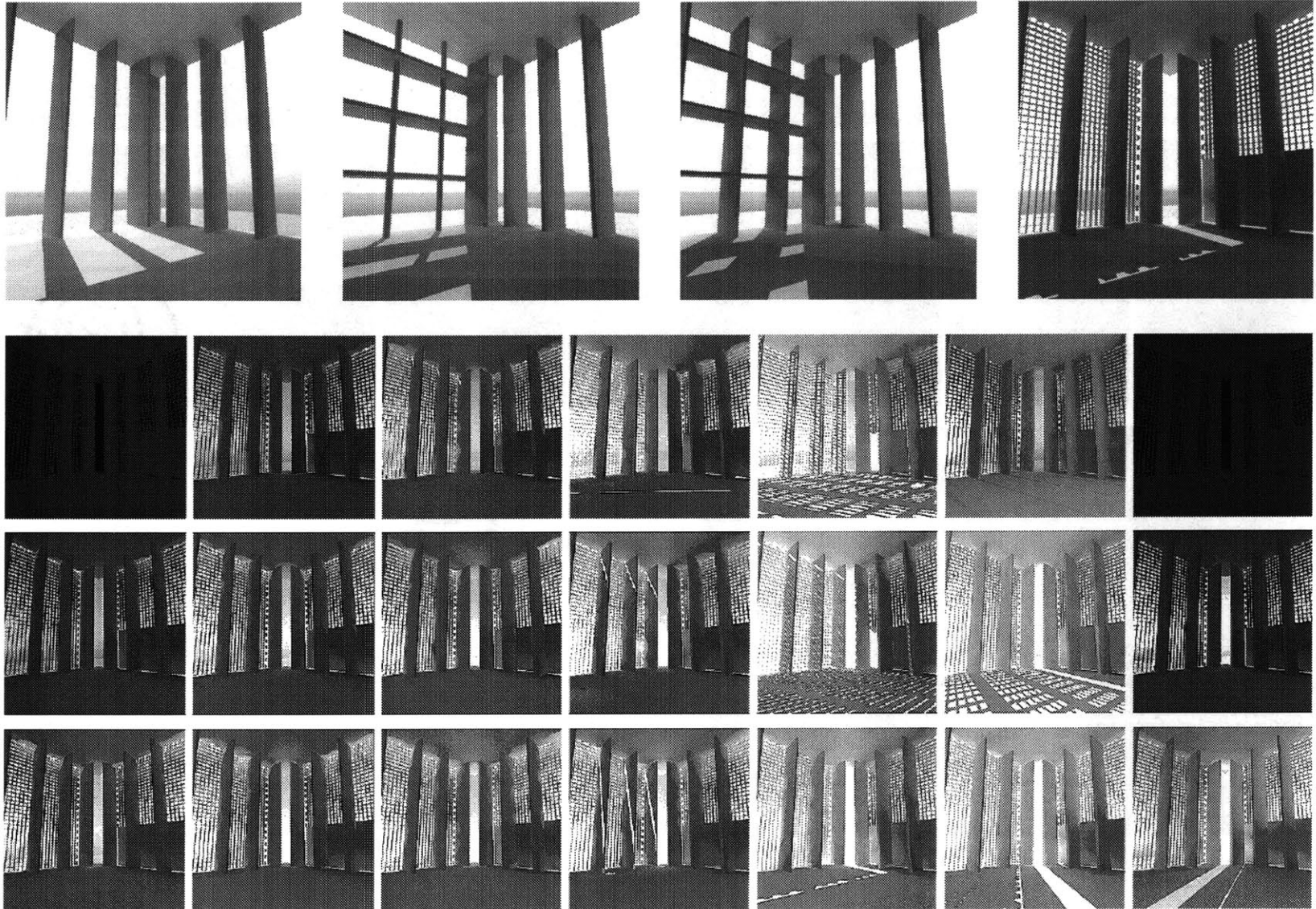
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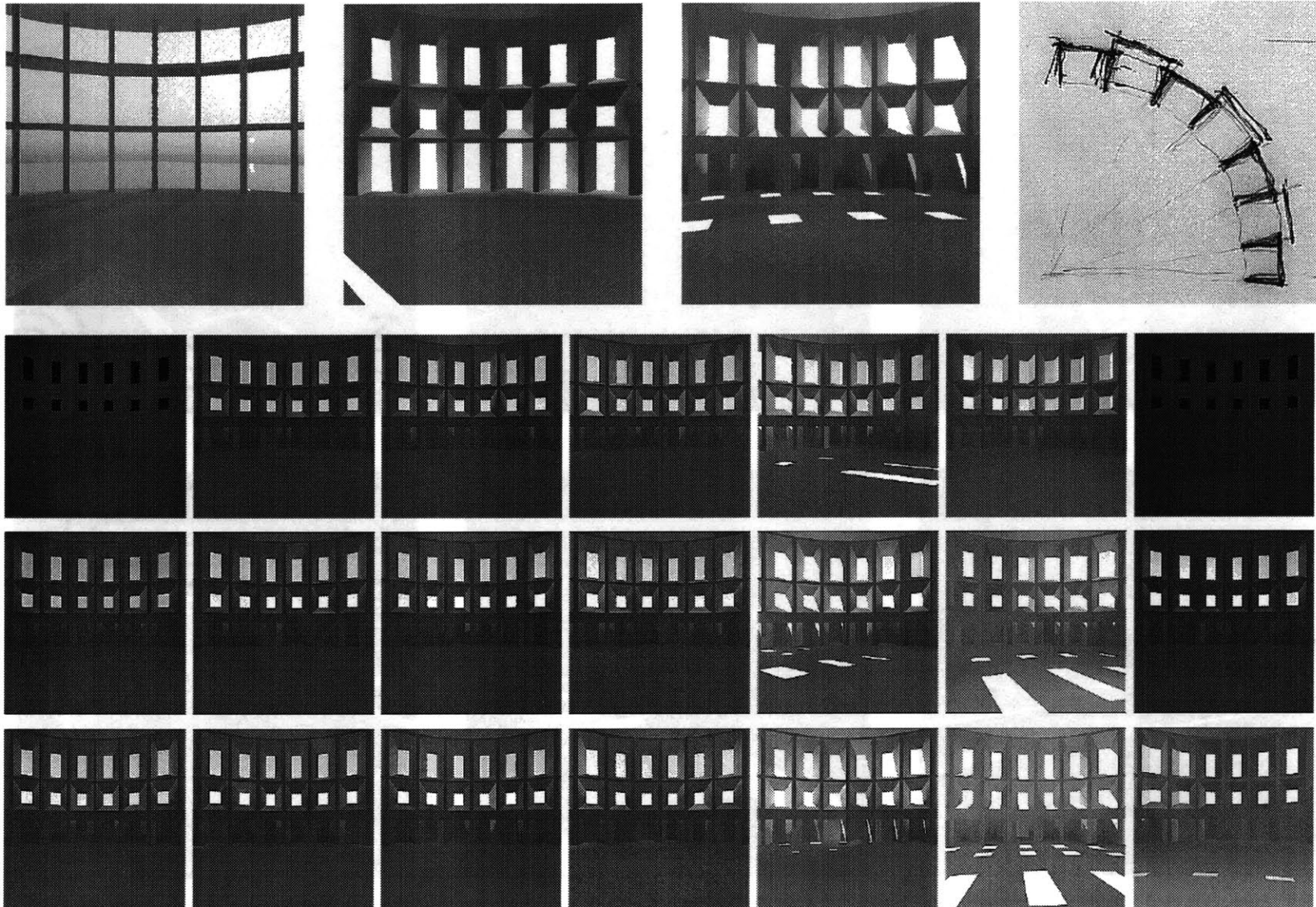
Overhead South facing light scoop system. 8:00 am to 4:00 pm in one hour steps. **Top:** December 22. **Middle:** March 22. **Bottom:** June 22.



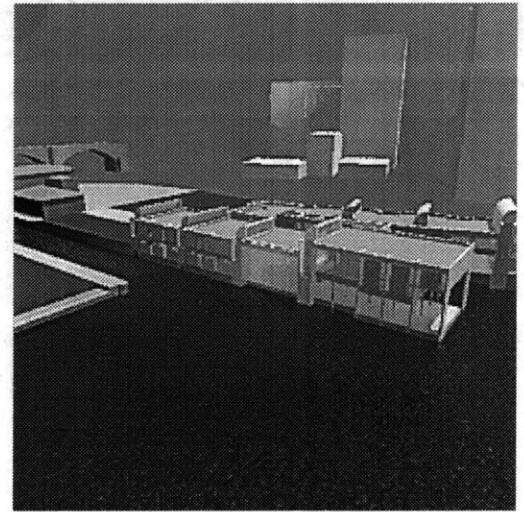
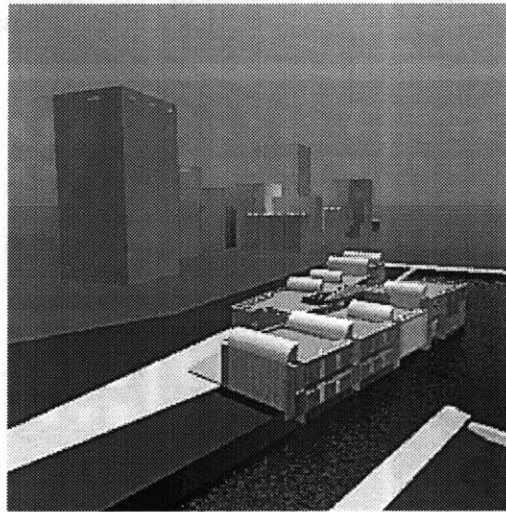
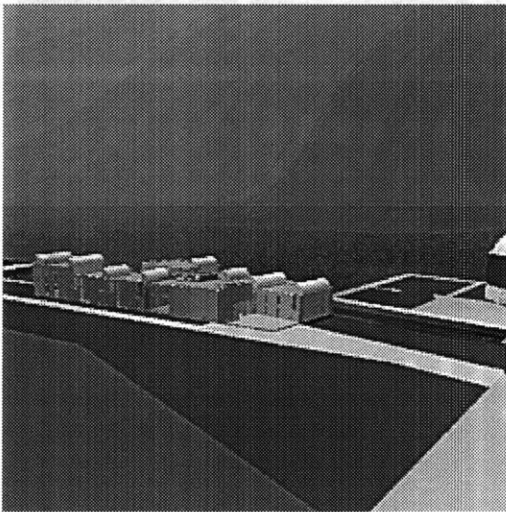
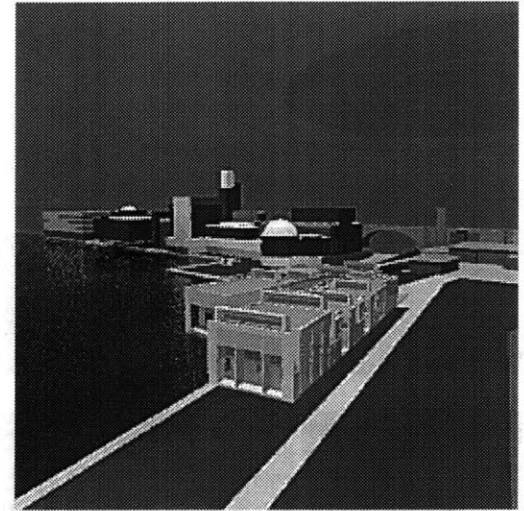
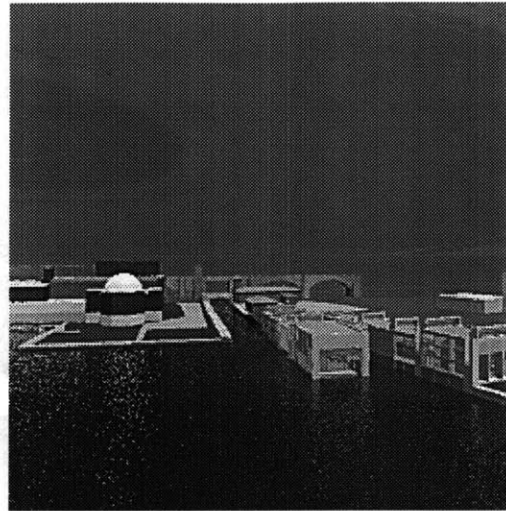
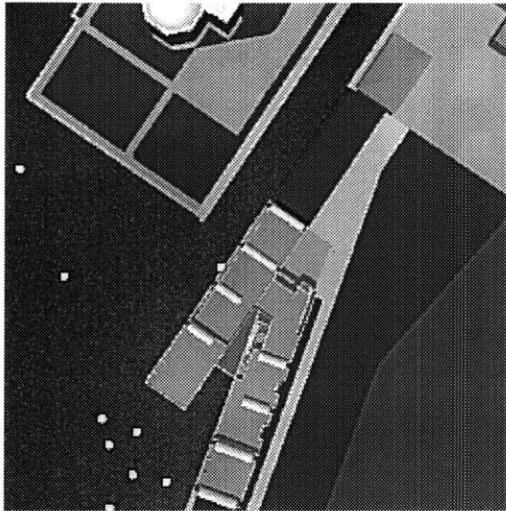
Above: overhead North/South channel. Top: 6:00 am to 6:00 pm, December 22, Mach 22, June 22. Right: sectional diagram.

**Process: light-model (screens)**

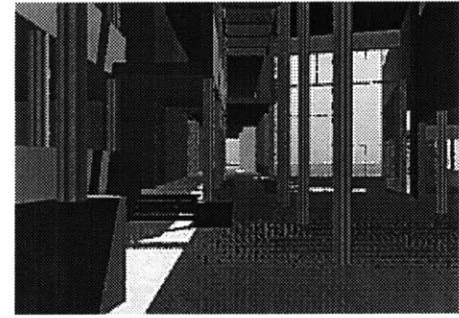
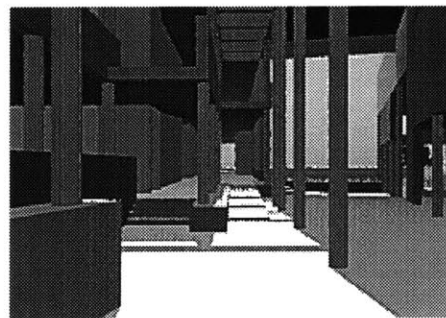
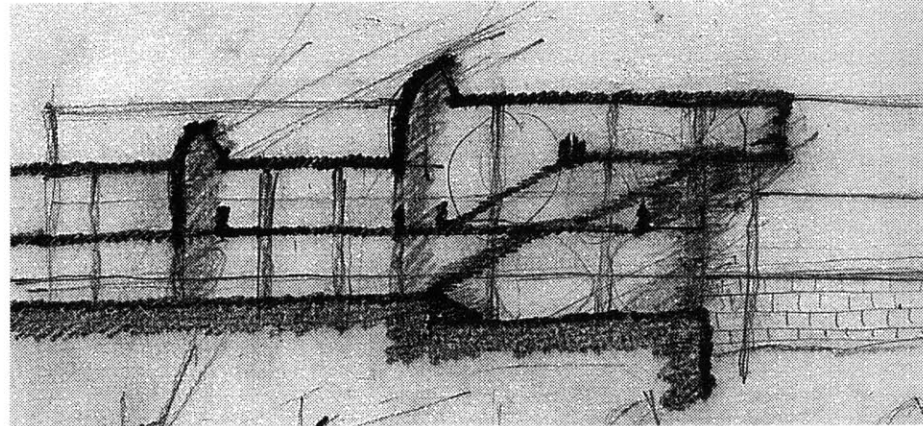
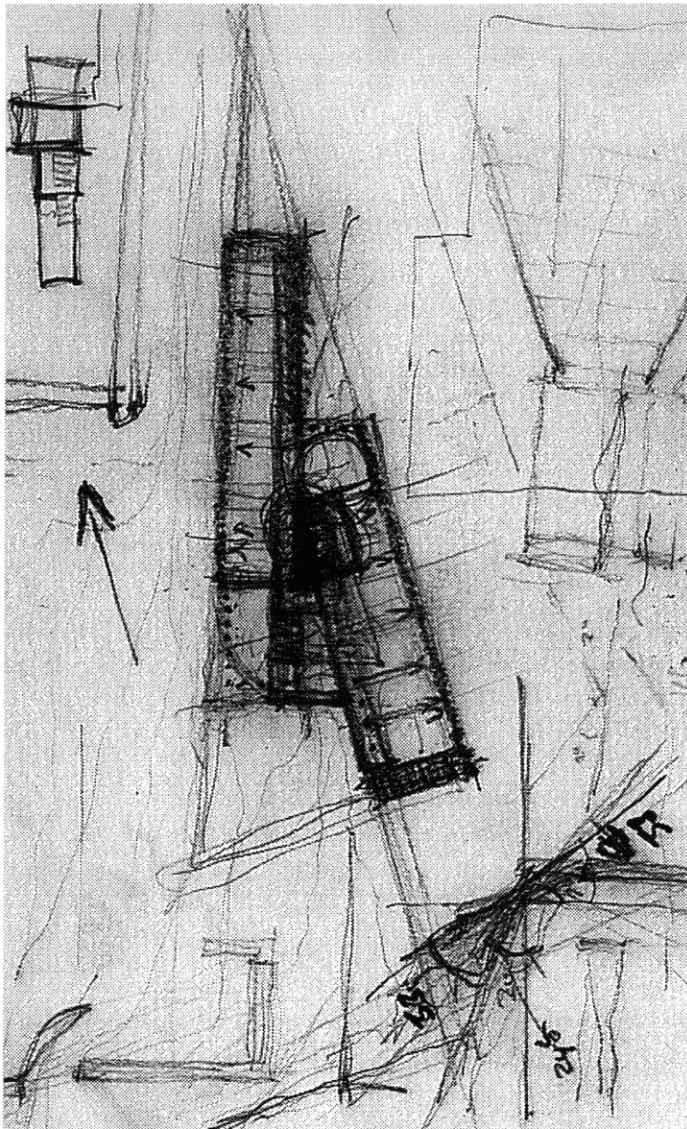
**Top:** structural screens options used to turn corner facing South to West, open to dense. **Bottom:** 6:00 am to 6:00 pm, December 22, March 22, June 22.



**Top:** quarter circle structural screen used to turn corner facing South to West, open to closed. **Bottom:** 6:00 am to 6:00 pm, December 22, March 22, June 22.



Views from study model, North is up on page. Model attempts to show differentiation of built edges with respect to light and sound. Water edge is more open or built by light controlling devices while land edge is built harder to keep out sound of Storrow Drive and city.



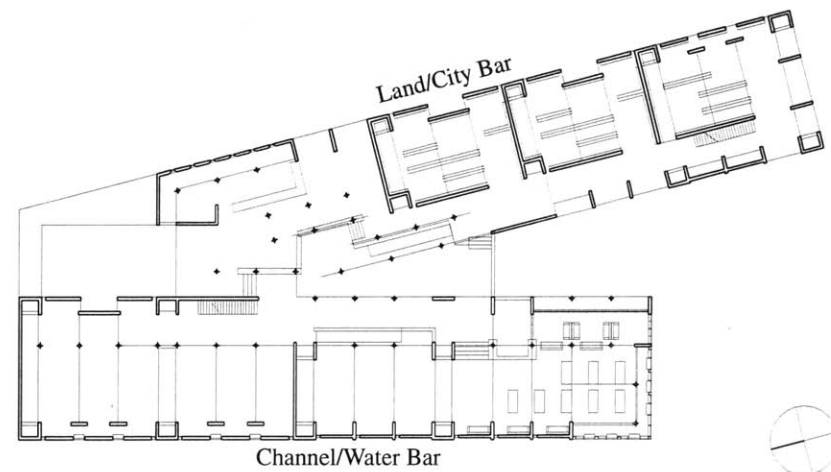
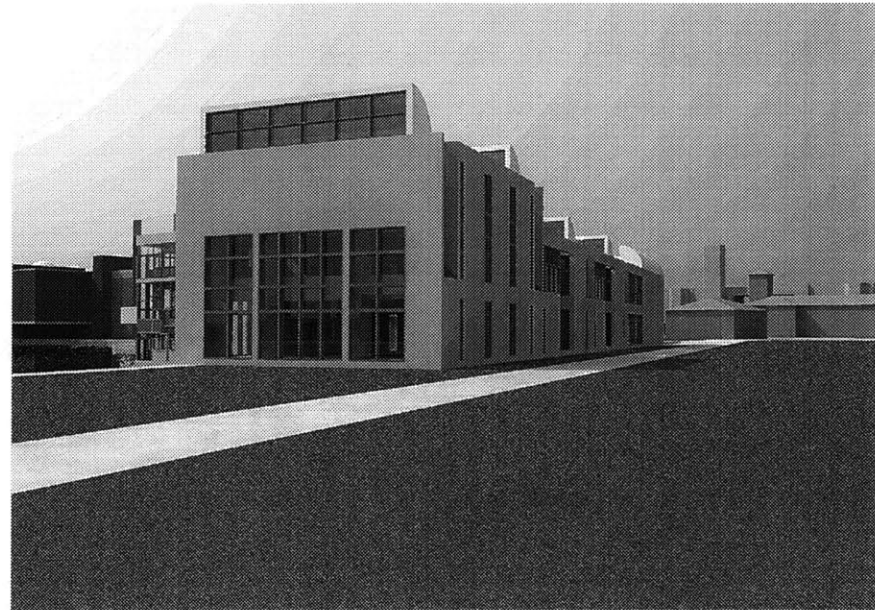
Above: plan diagram (north on arrow). Top right: sectional diagram at corner. Right: lobby space (slack between bars) at different times of day.



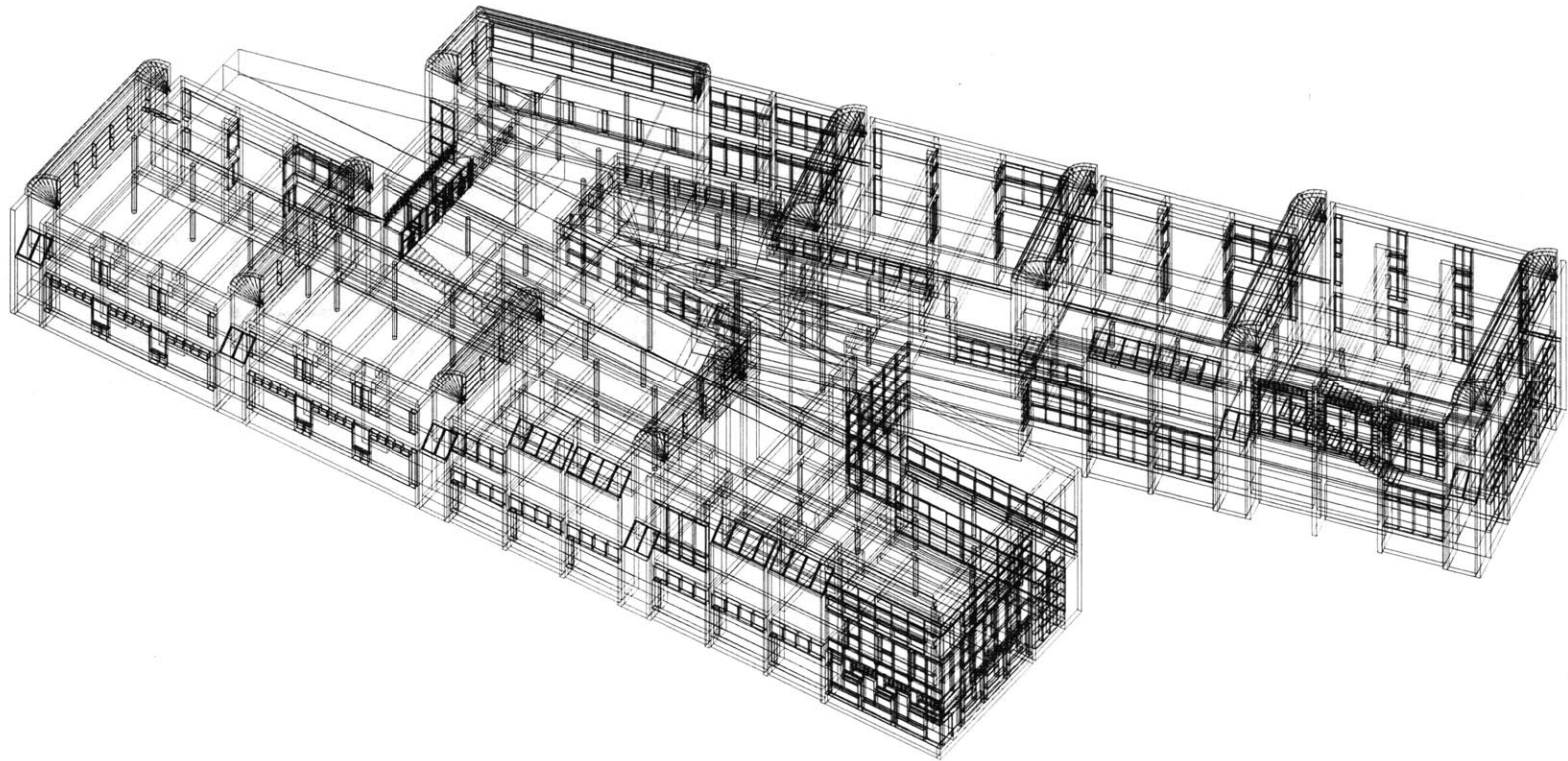


The library is built with two bars, one responding to the channel/water edge and the other to the land/city character of the urban edge. The bars are deployed in order to generate the experience of moving into the building and down to the water at the corner. The slack space between the two bars creates a courtyard territory with open vertical section to the roof. The land/city bar holds the stacks and administrative functions, while the bar on the channel/water edge holds a variety of reading spaces and more active uses. The territories generated in the land/city bar are meant to be contained and interior, while the territories generated on the channel/water bar are meant to have a more screen like quality with a variety of sizes for occupation. The section changes a total of four feet between entrance and the water corner, moving down two feet into the courtyard and another two feet down to the corner. This sectional change helps to intensify the experience of getting to the water and the light. The access zones for each wing have different characteristics as well. The eastern access zone has a more linear and vertical quality while the western access zone appears more horizontal and compressed in character. This differentiation in the characters of the land/city bar and the channel/water bar is driven largely by the quality of the light in the different territories.

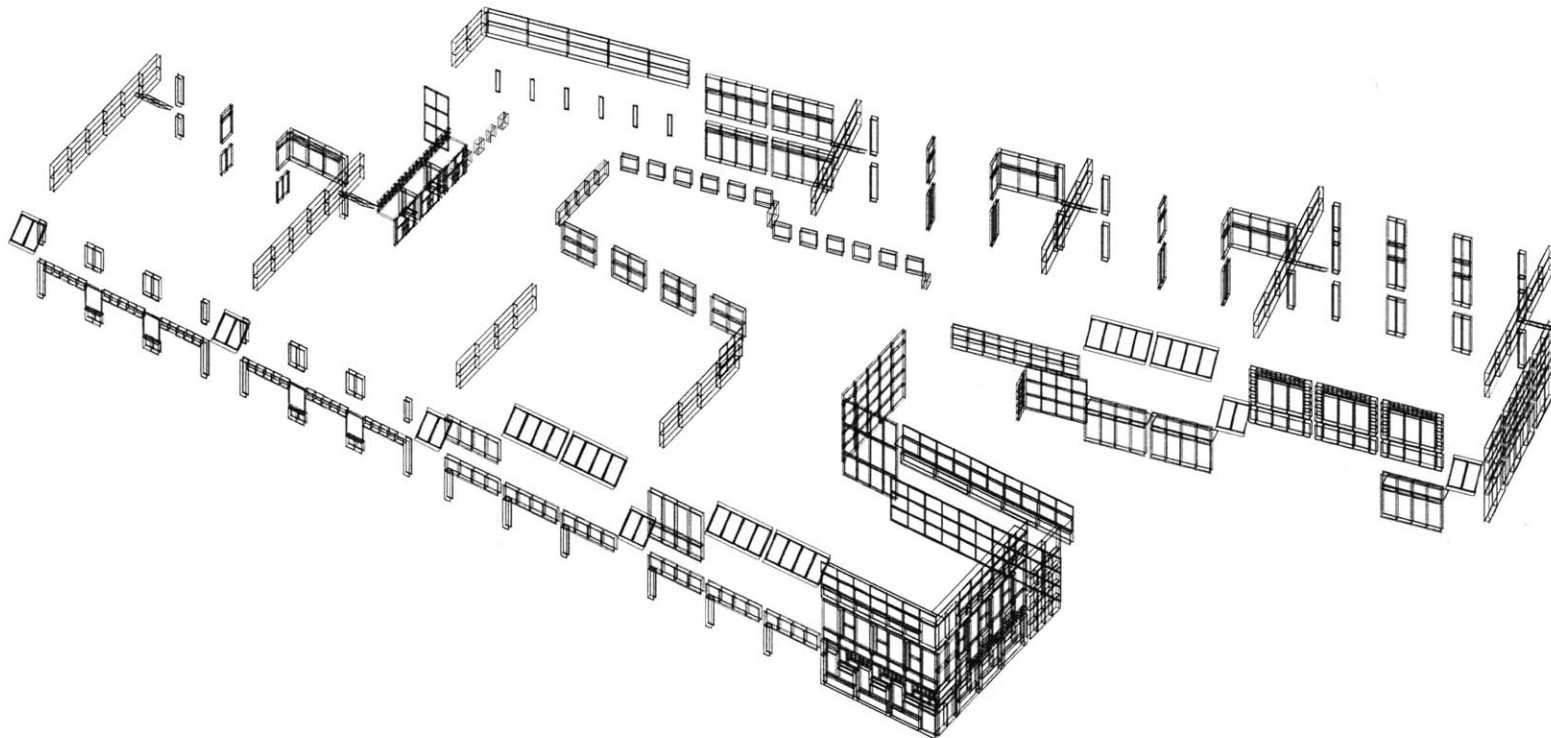
The following sets of images attempt to represent discrete and coherent events within the building. Each set is preceded by a group of smaller images indicating some sequence or set of relations to follow with the full page images. A small plan diagram is also included to help indicate the territory being examined by the set.



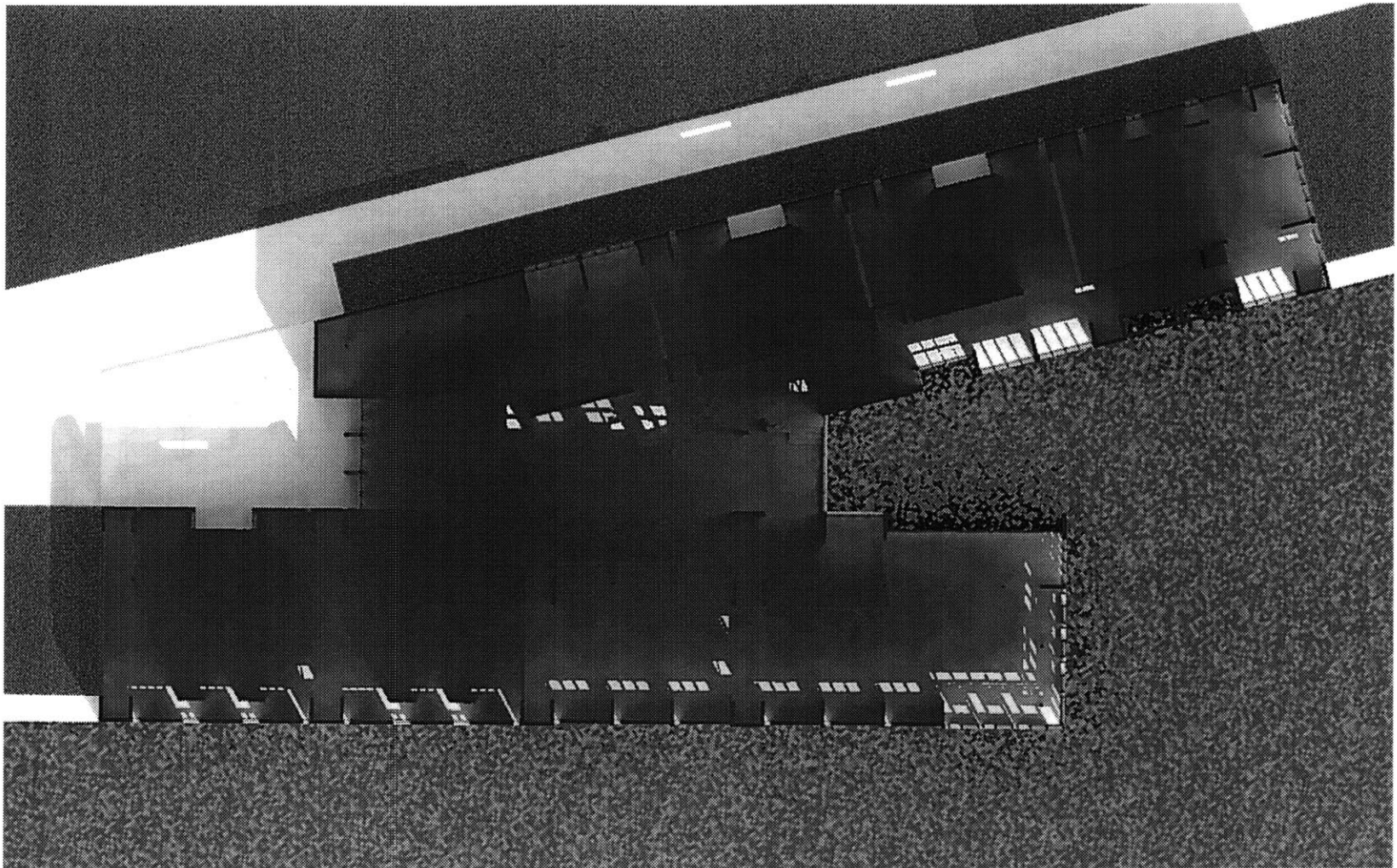
**Top:** view Northeast approaching library. **Bottom:** ground floor plan.



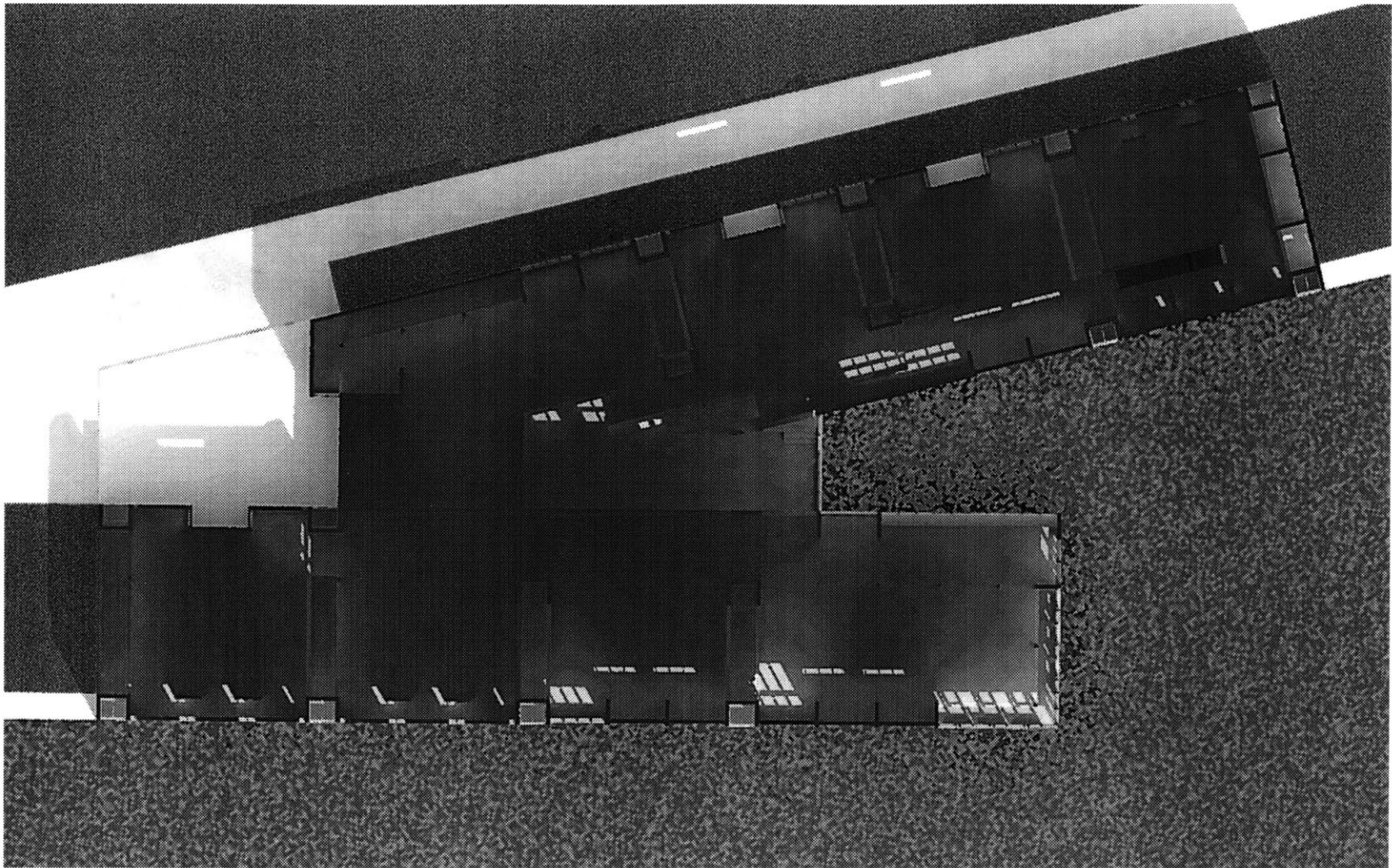
Axonometric of building.



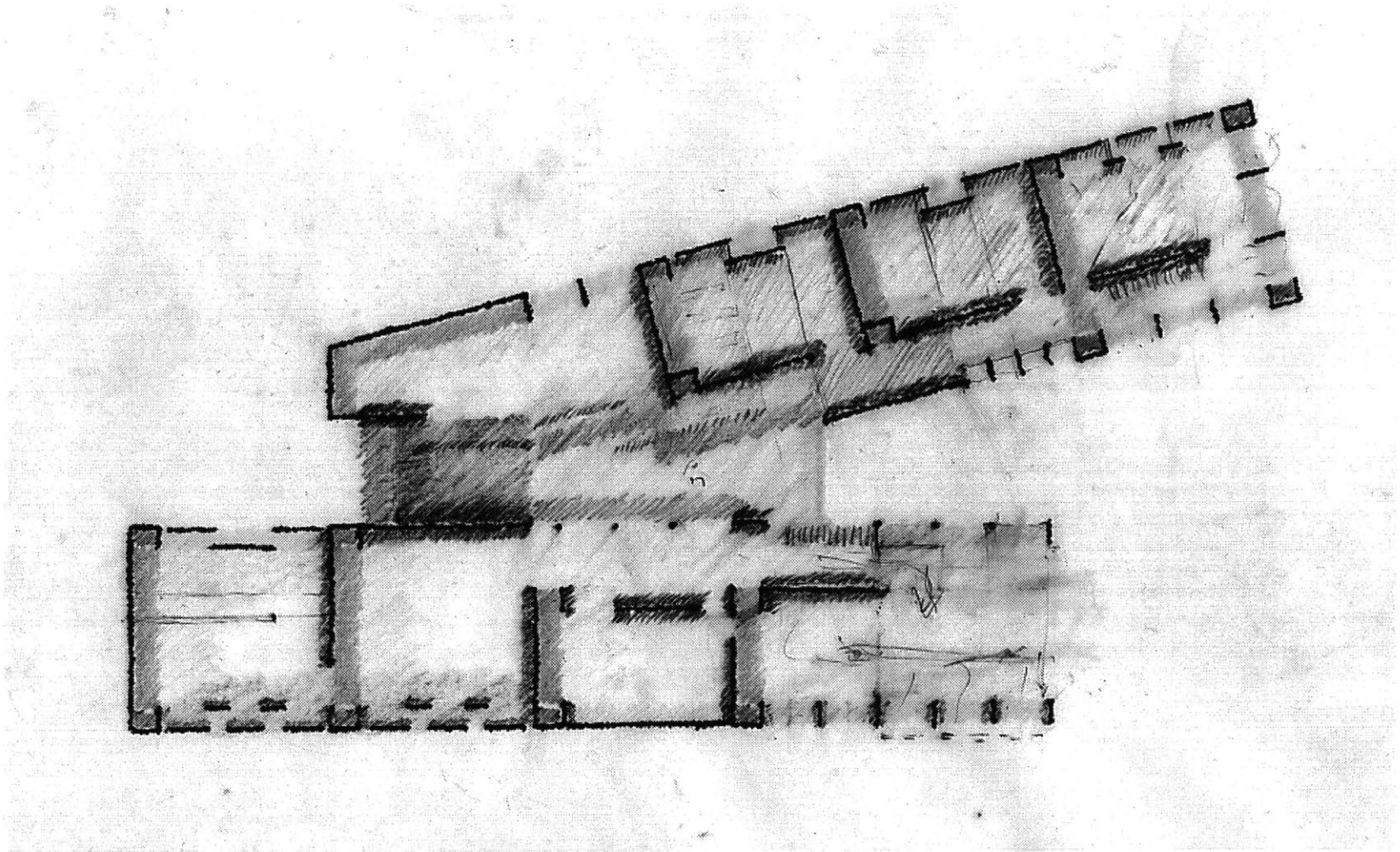
Axonometric of screens.



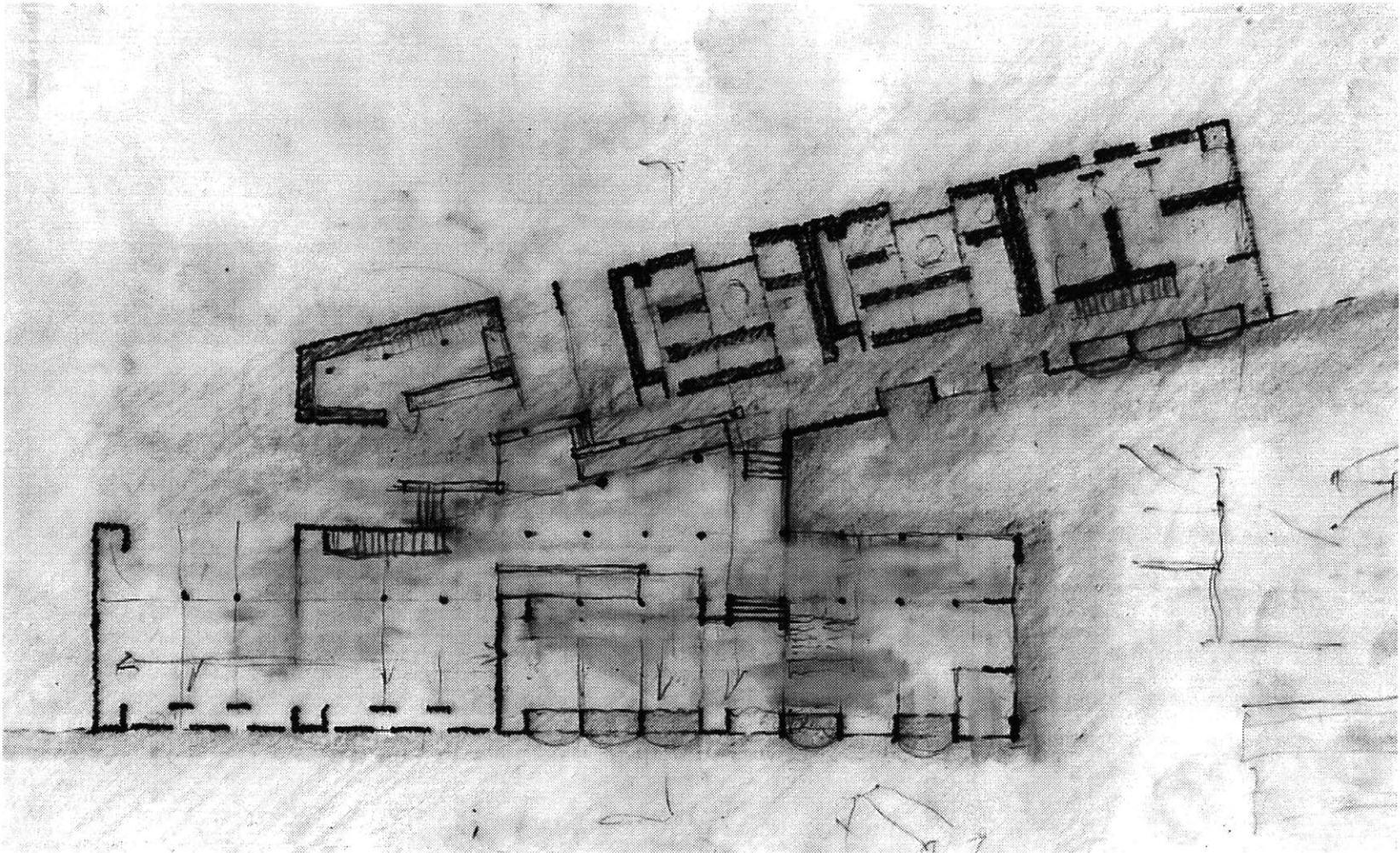
Ground floor section, 3:00 pm June 22.



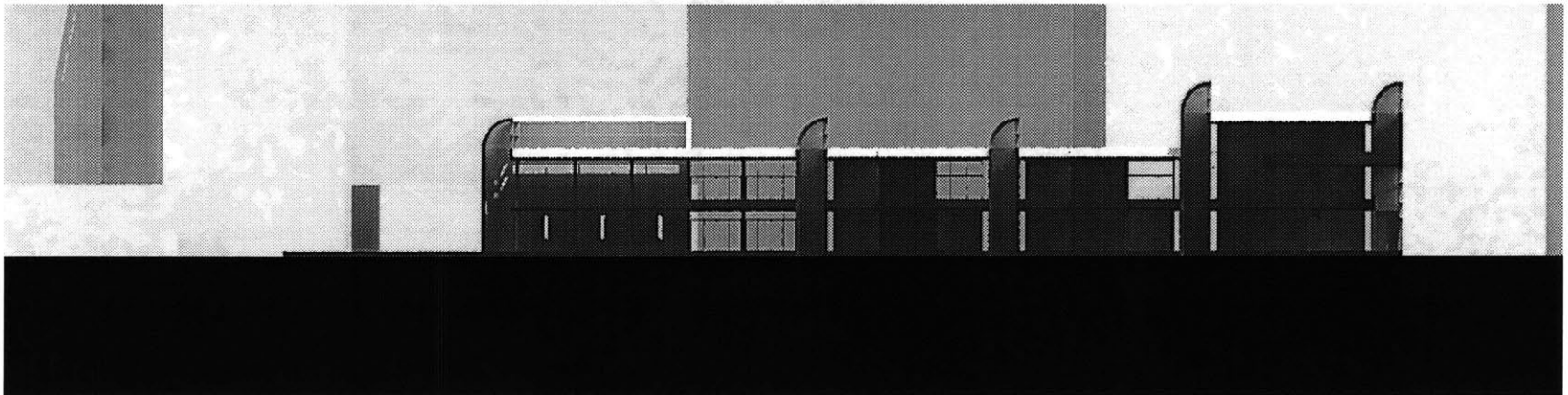
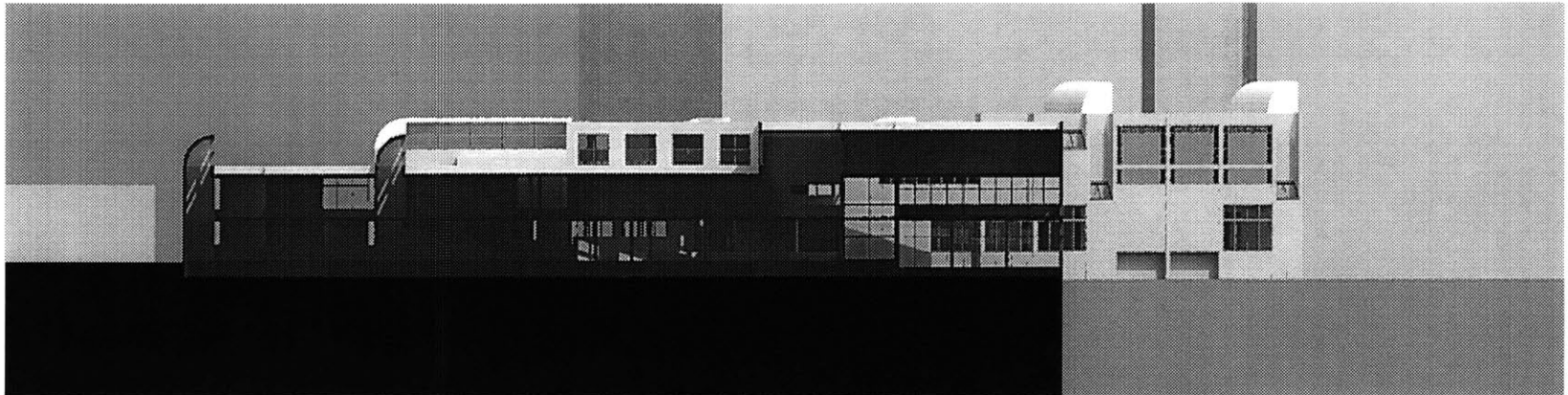
First floor section, 3:00 pm June 22.



Plan section diagram.

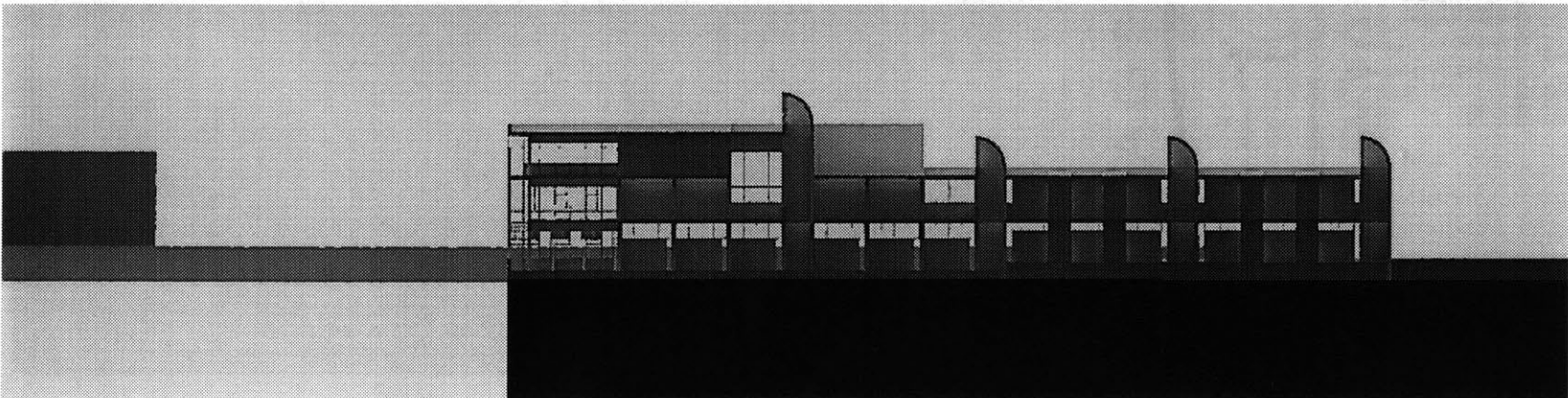
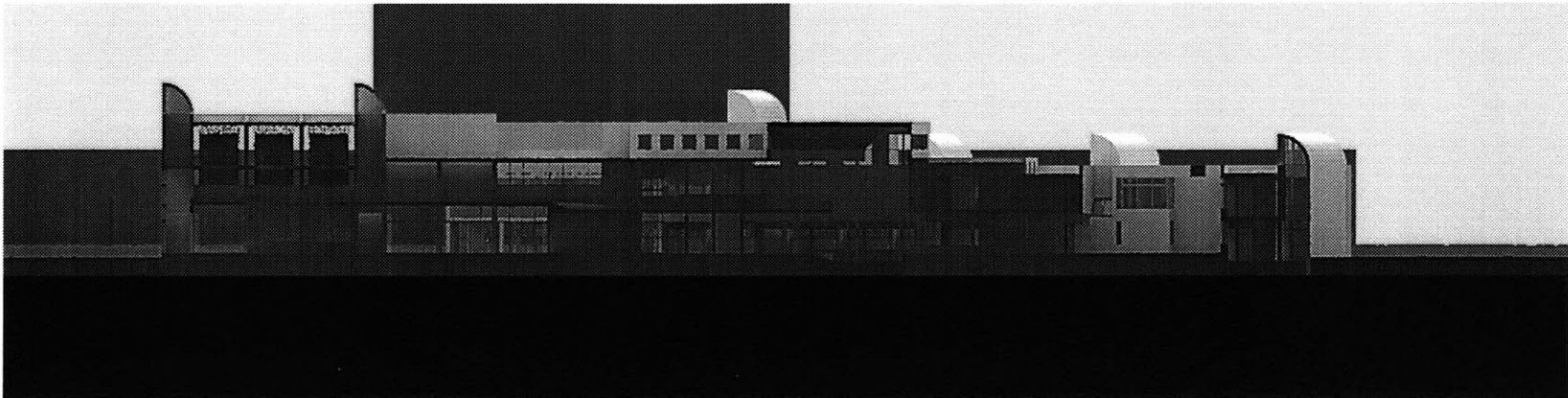


Plan section diagram.

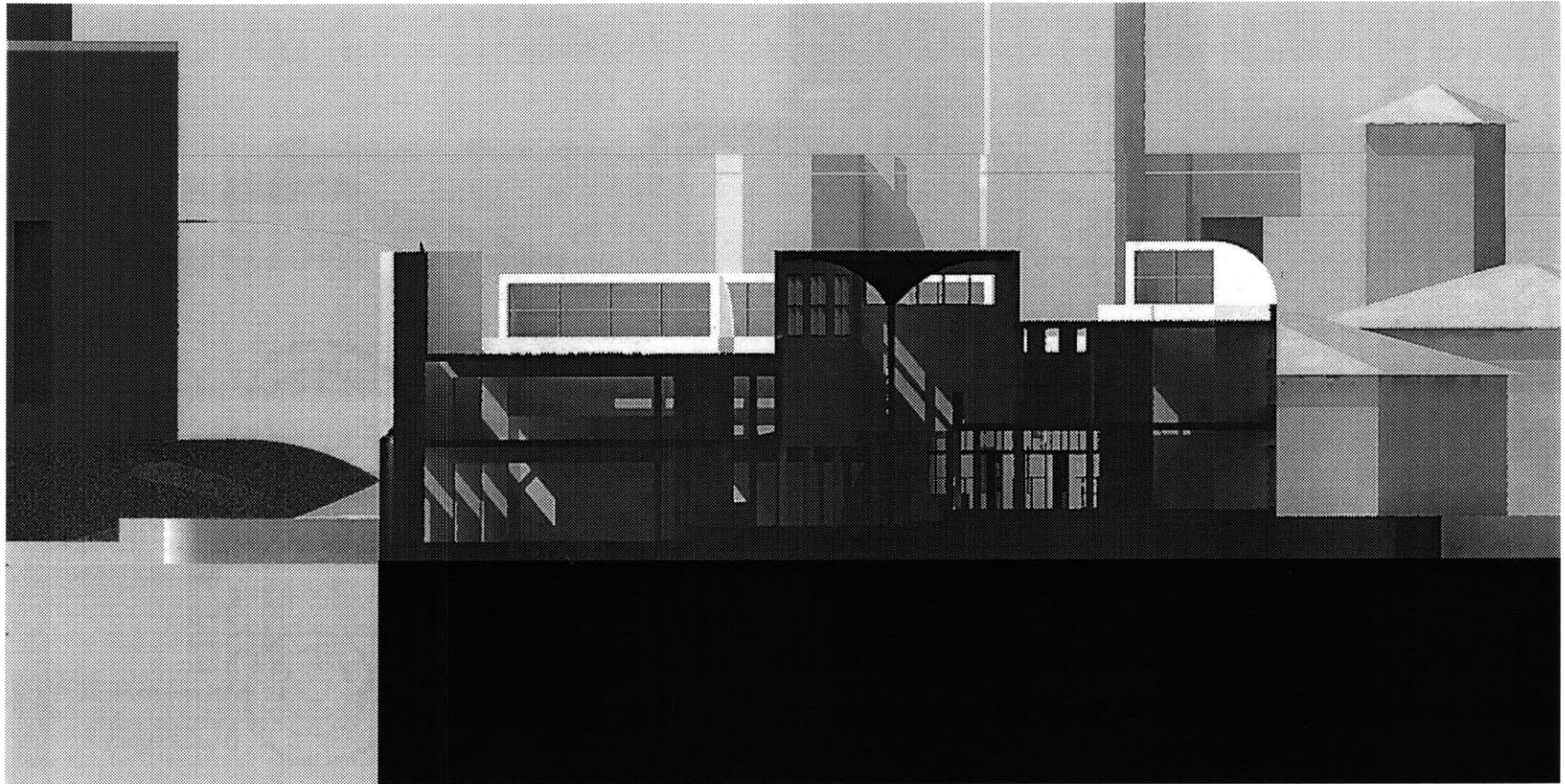
**Library: east sections**

**Top:** water edge, section facing East. **Bottom:** city edge, section facing East.

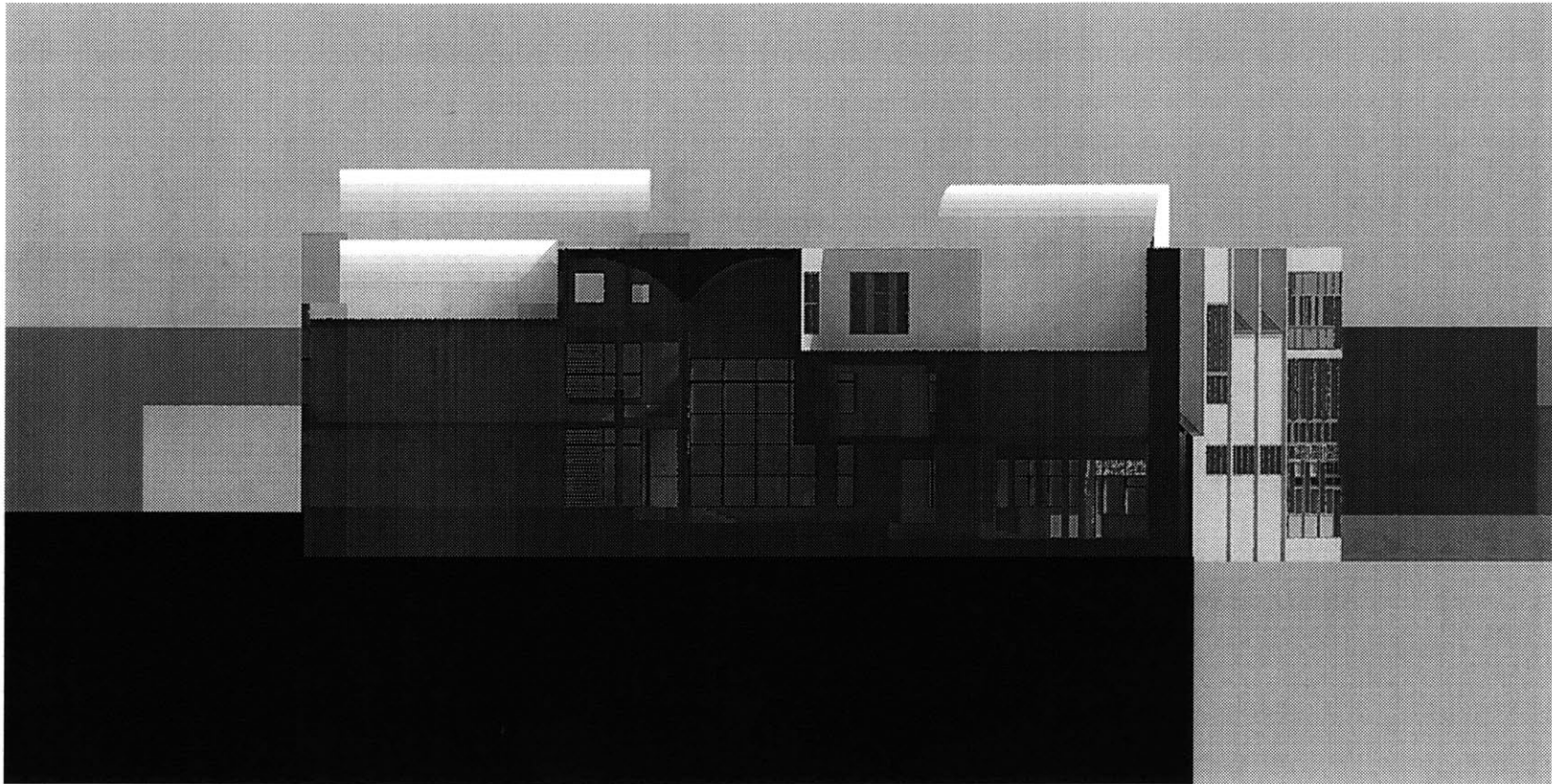




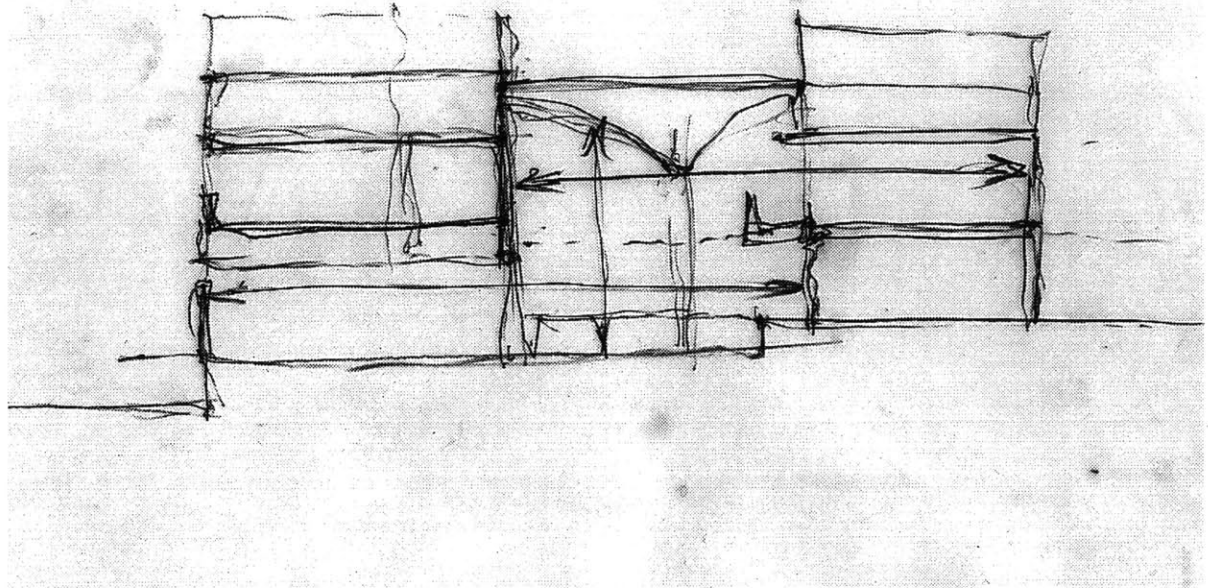
**Top:** city edge, section facing West. **Bottom:** water edge, section facing West.



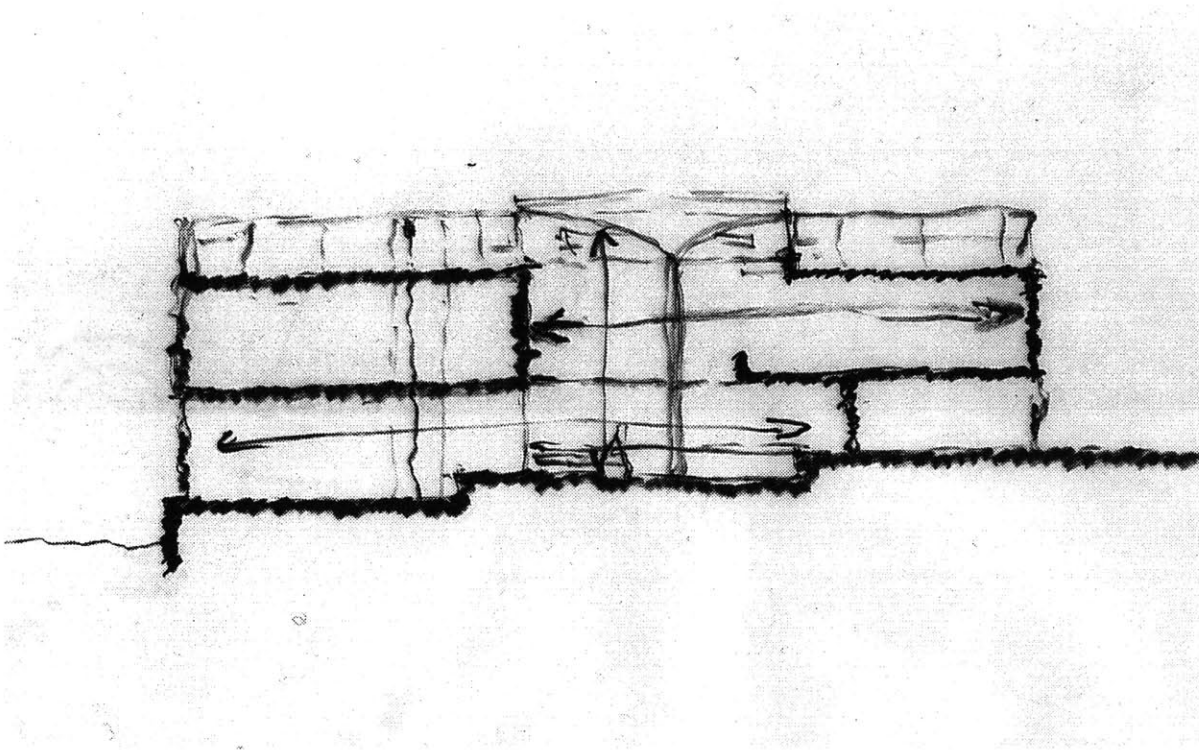
North facing section through courtyard.



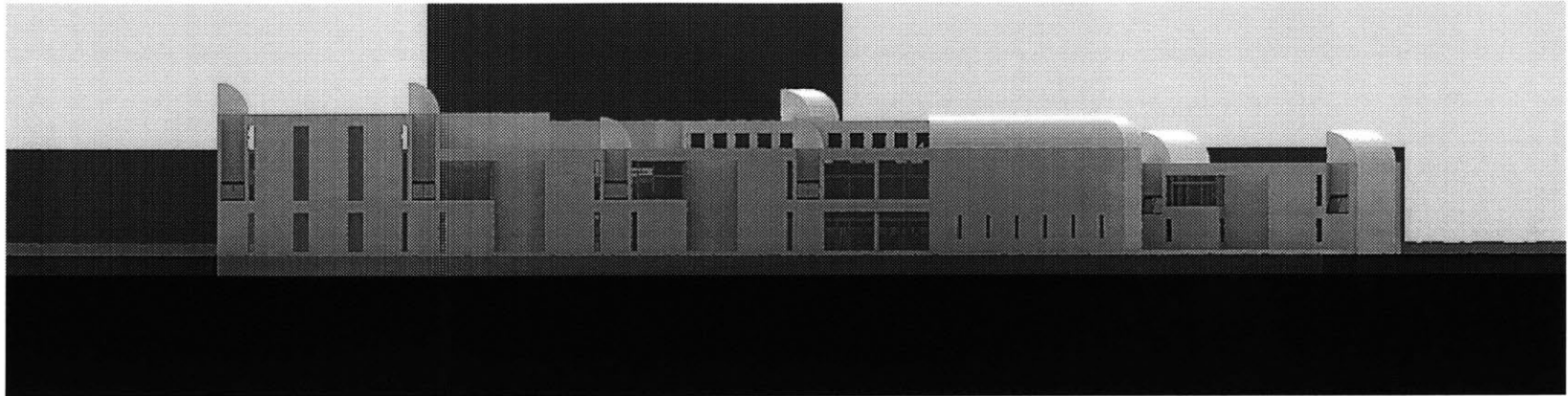
South facing section through courtyard.



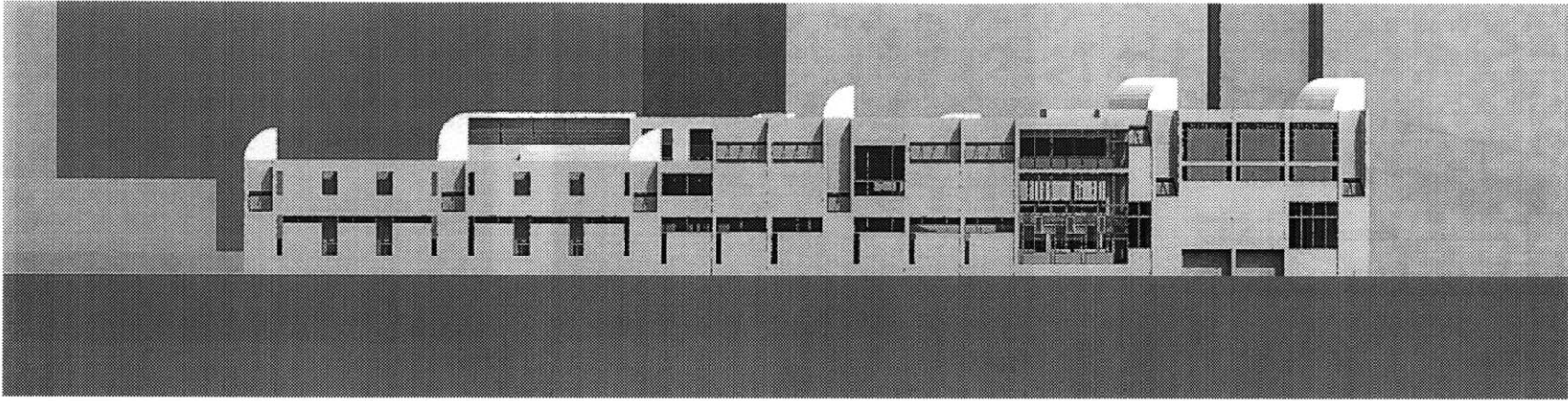
Section diagram facing North through courtyard from water on left to land on right.



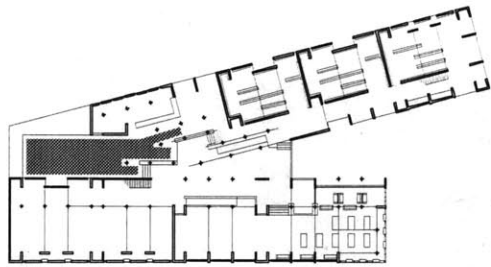
Section diagram facing North through courtyard from water on left to land on right.



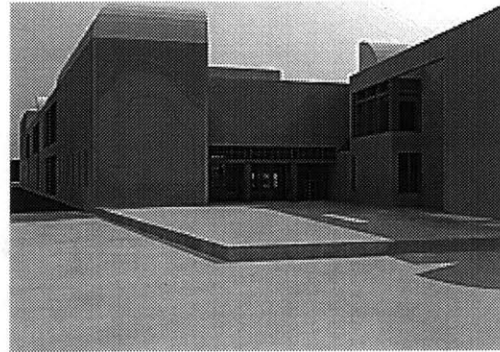
City edge, East elevation.



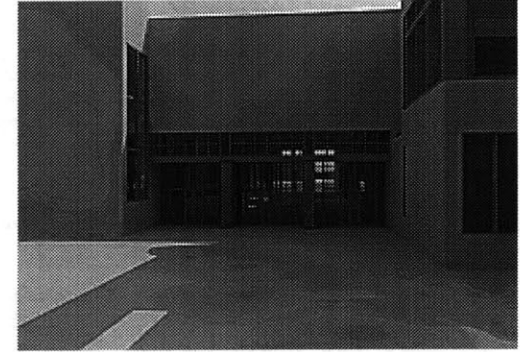
Water edge, West elevation.



Entry Zone.

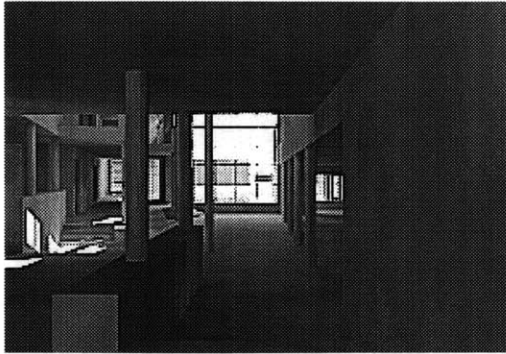


Approach.

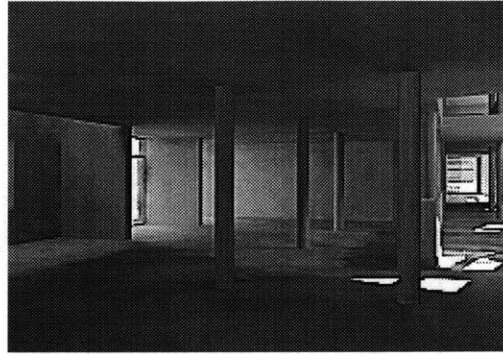


Plaza.

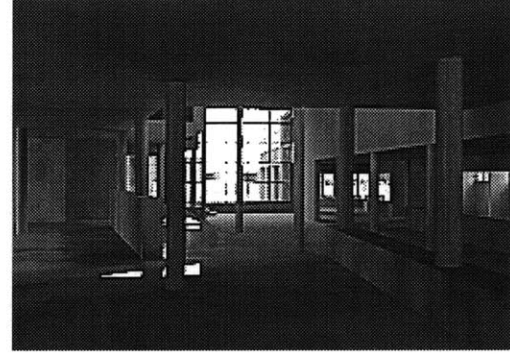




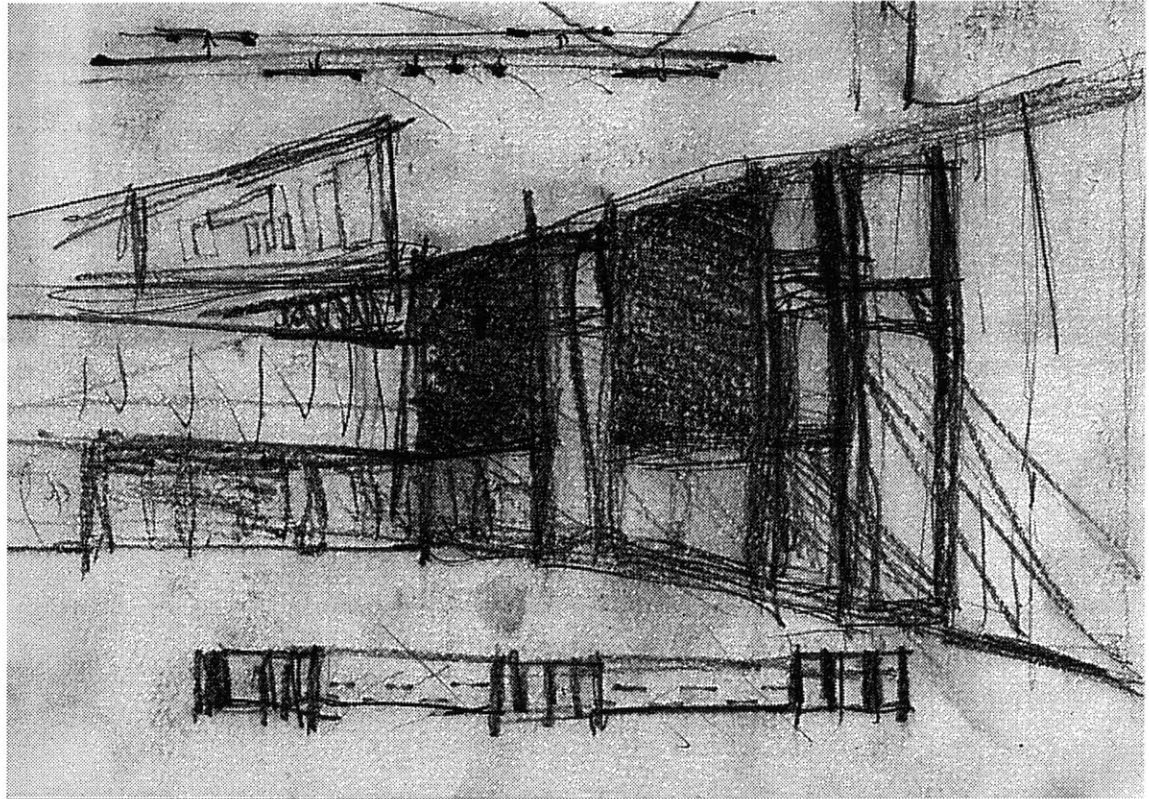
View South to courtyard.



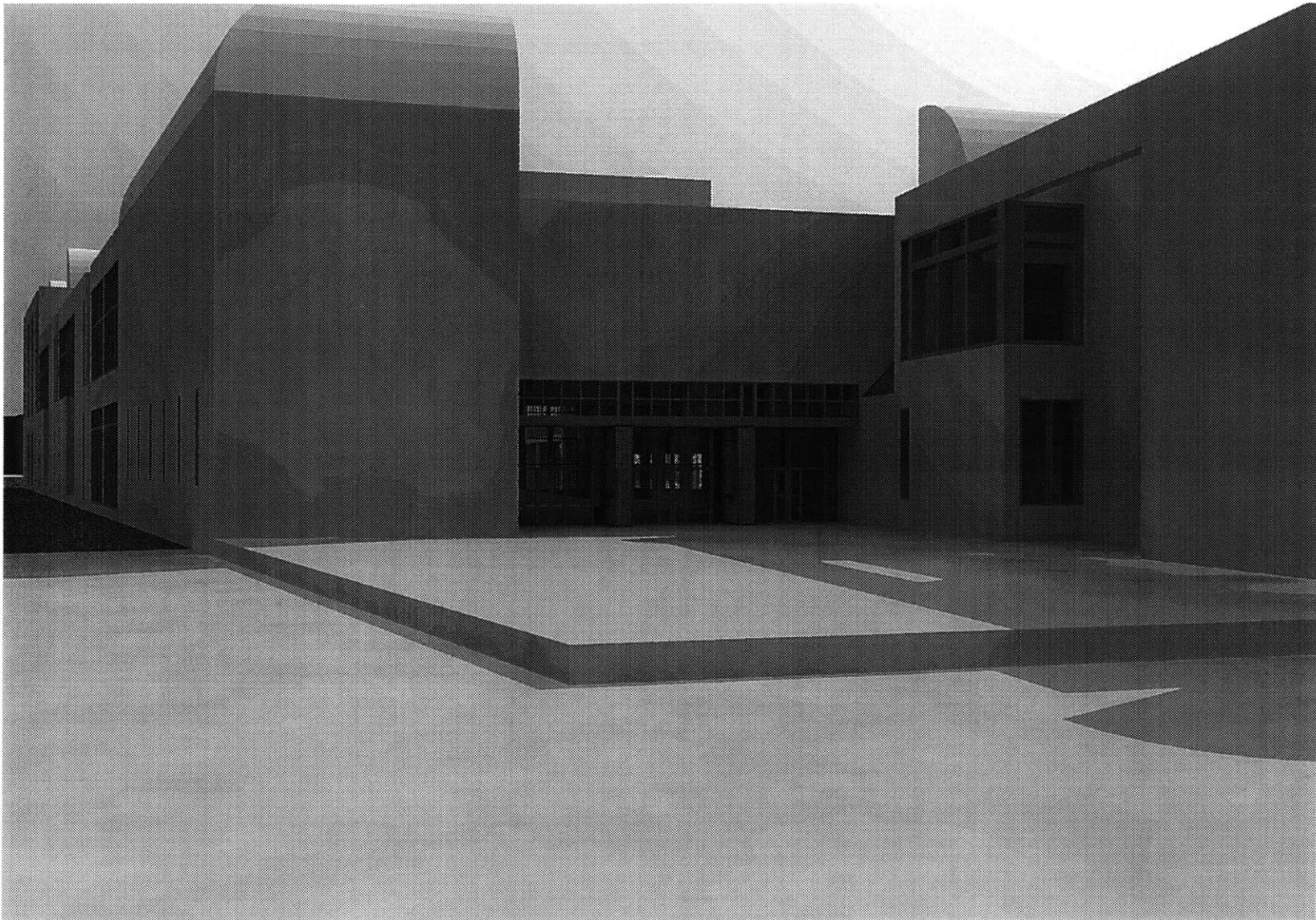
View Southeast.



View Southwest.



Early concept sketch of entrance.



View approaching library entrance from Northeast.



View of entry plaza demonstrating entry experience under solid compressive element towards light and water.



View South upon entering, compression from above moves the individual out into the section and towards the light.



View Southeast to lobby area with visual connection to city side edge and setting up the East access zone.



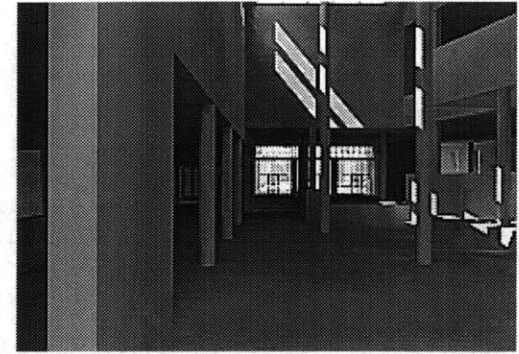
View Southwest from lobby area to water corner and West edge.



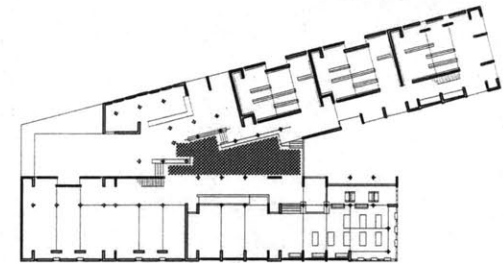
View South along East access zone.



View South in courtyard.



View North back to entrance.



Courtyard Territory.





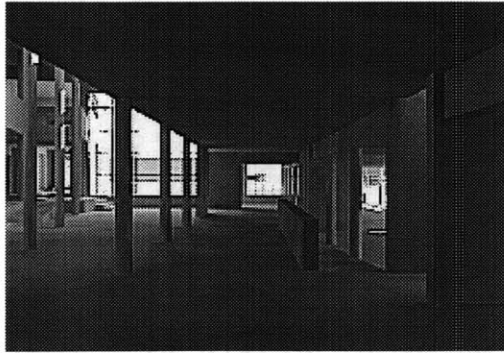
View South along East access zone. Note vertical quality of zone in this view.



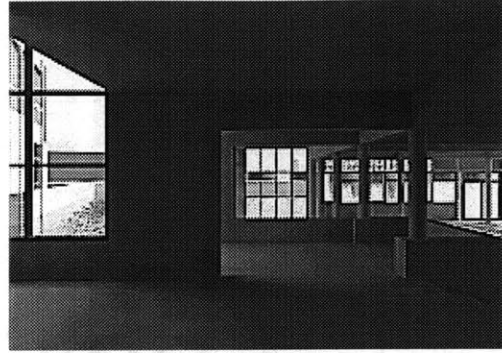
View South in courtyard. Vertical section is reinforced by columns. Note vertical quality of East access zone on left vs. horizontal quality of West access zone on right.



View North looking back to entry and overhead compressive element.



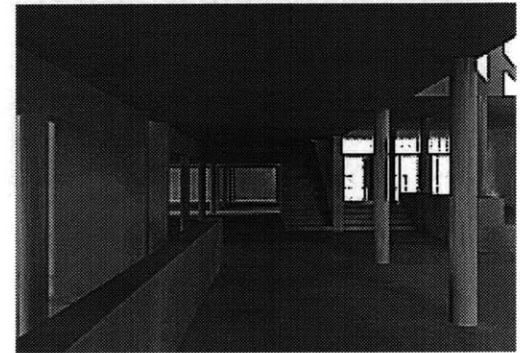
View South to water and corner.



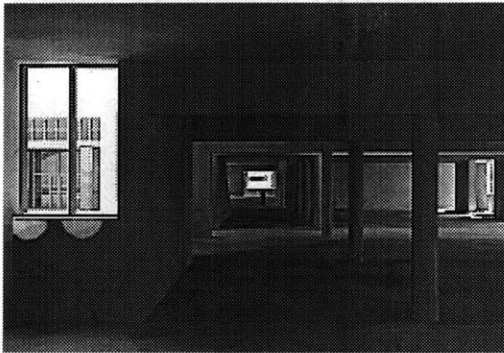
View South before turning down to corner.



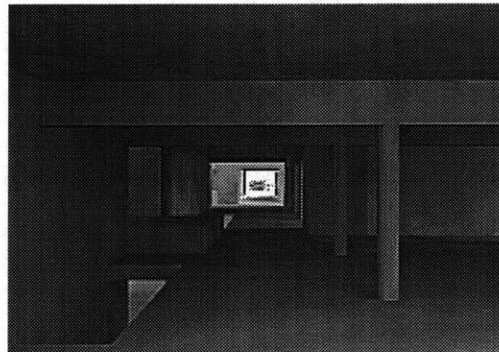
View North from previous view.



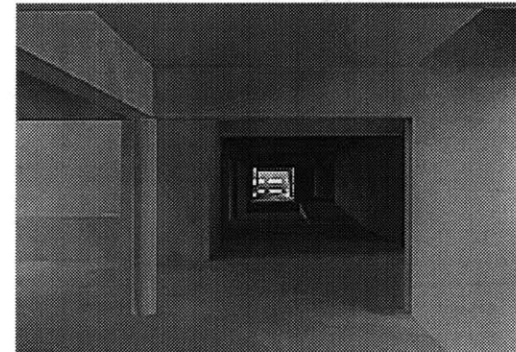
View North.



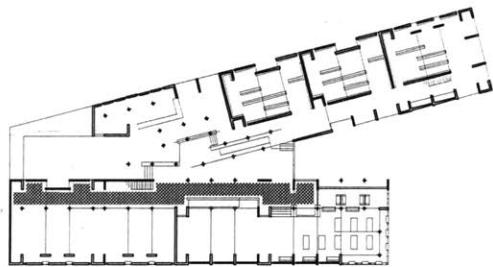
View South from North end of access zone.



View South on second floor.



View North on second floor.



West Access Zone.



View South to water and corner. Note horizontal and compressive quality of the zone from this view point.



View South before turning right and down into corner territory.



View North from previous view position with courtyard to right.

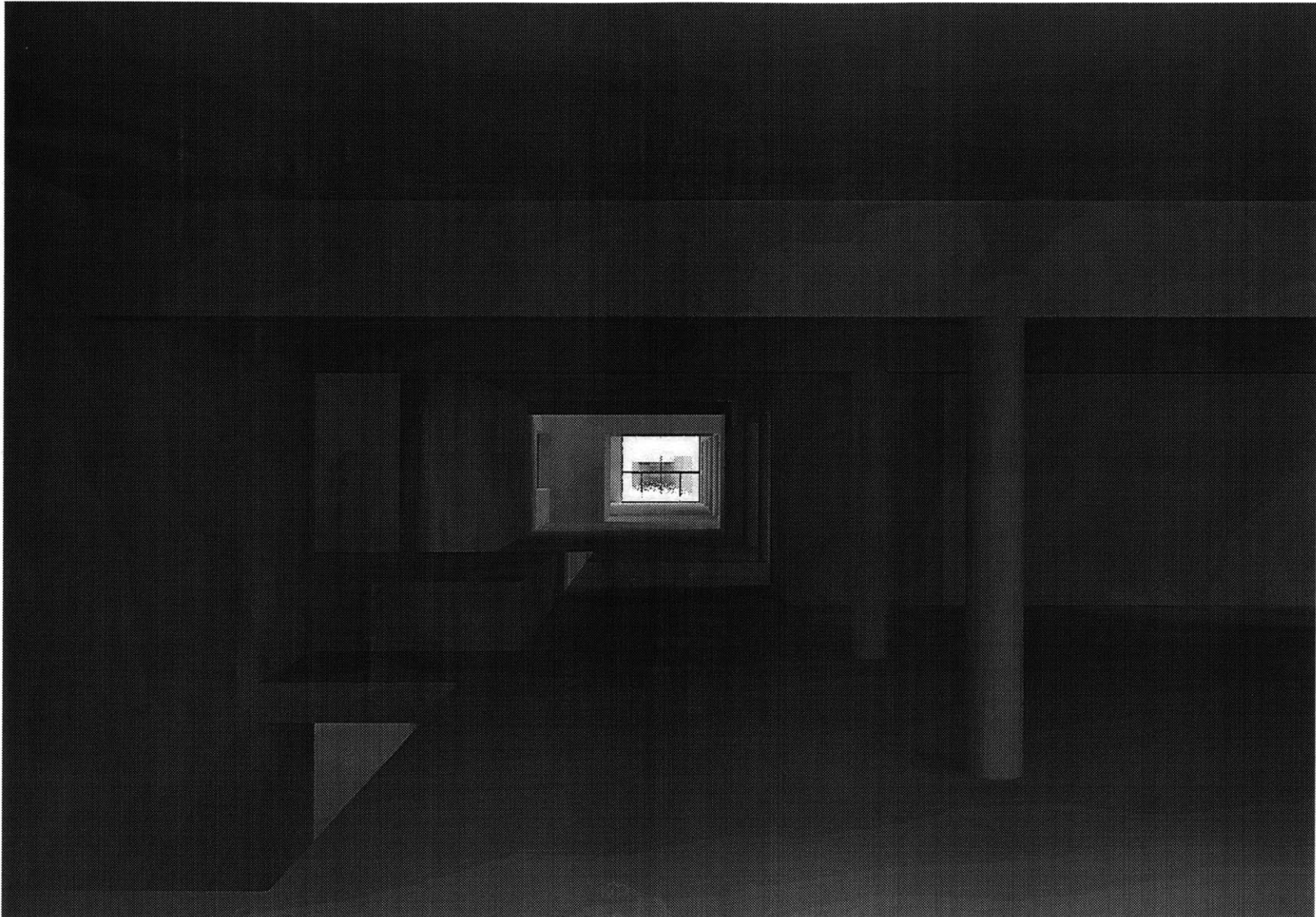




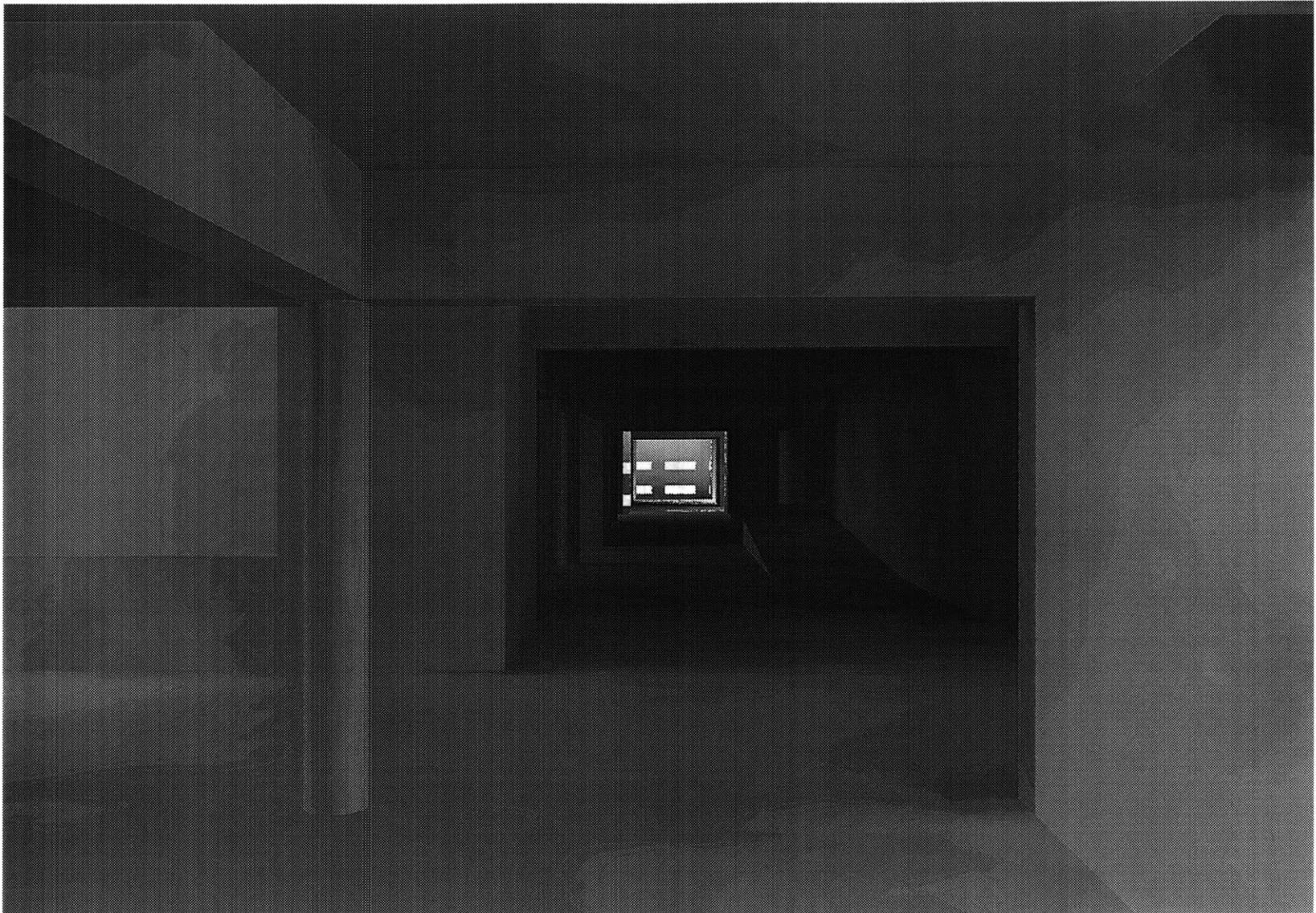
View North. Note horizontal quality on left vs. vertical quality on right.



View South from Northern point of access zone.



View South on second floor.

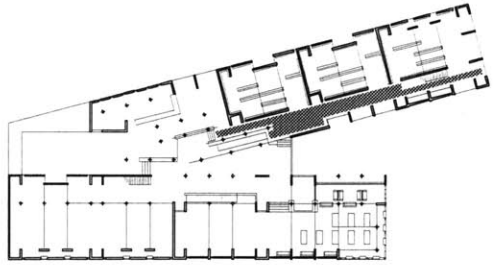


View North on second floor.

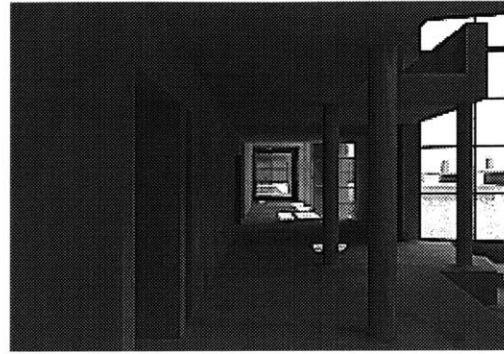


**Library: east access zone**

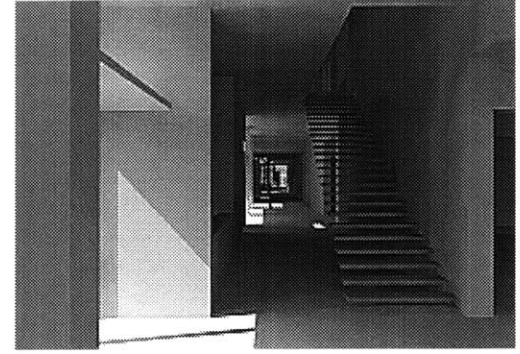
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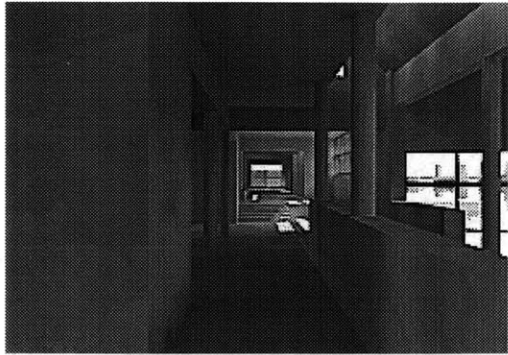
East Access Zone.



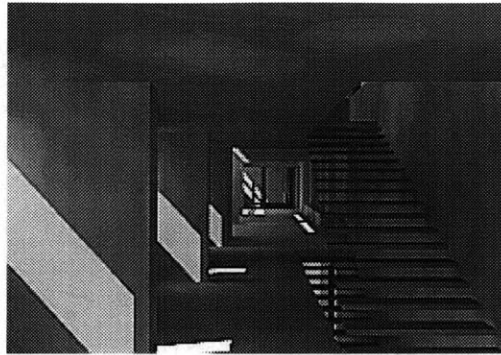
View South.



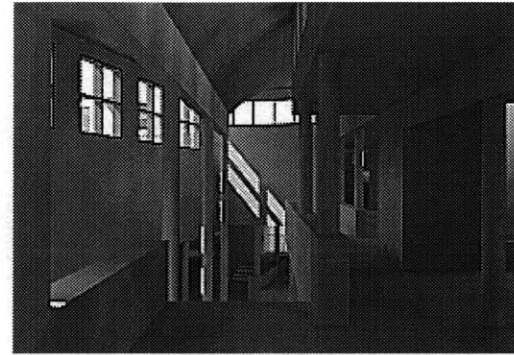
View North.



View South on second floor.



View North on second floor.



View North on second floor overlooking courtyard.



View South.





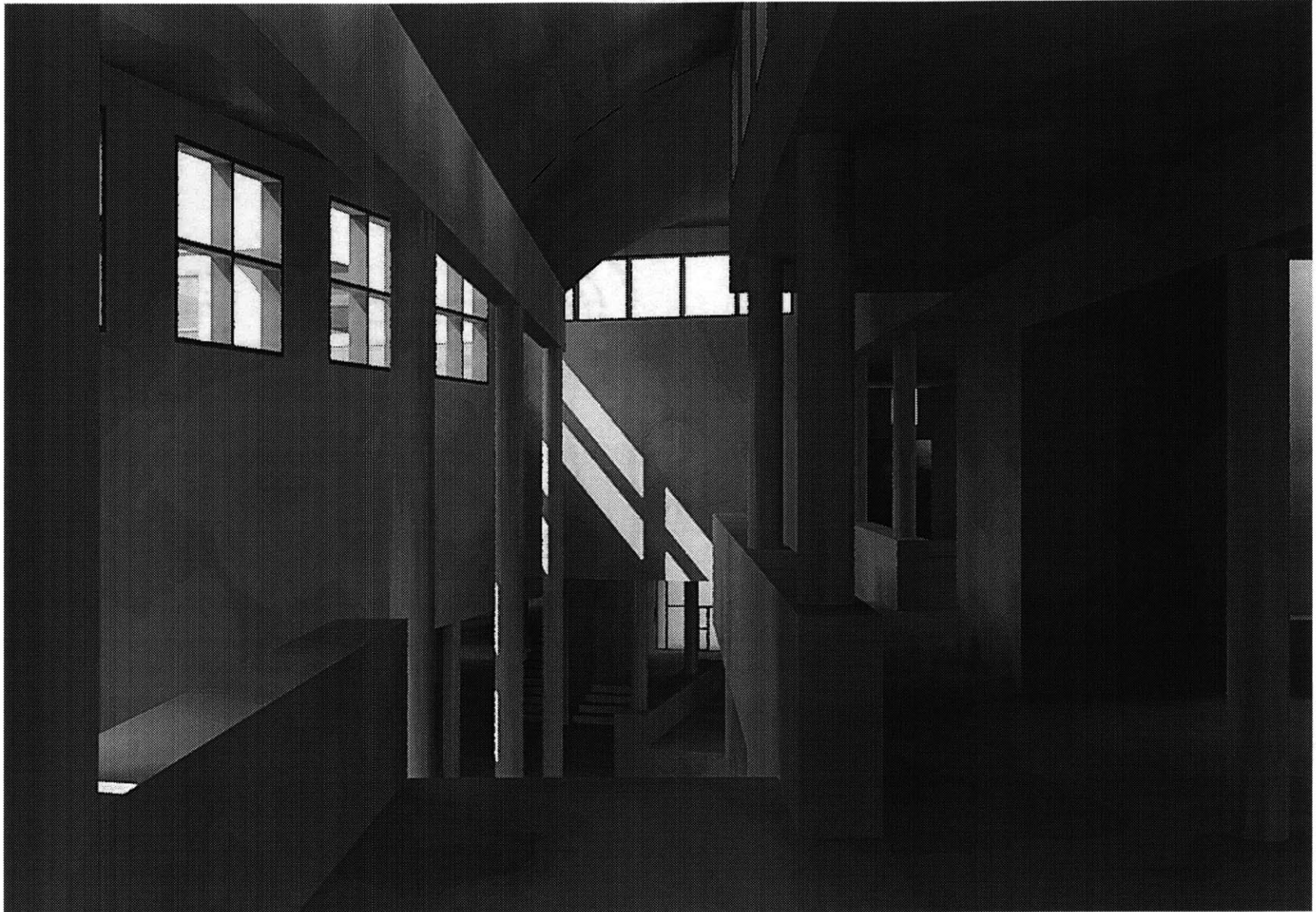
View North.



View South on second floor.

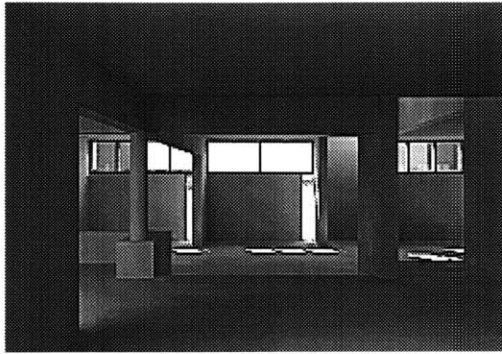


View North on second floor.



View North on second floor overlooking courtyard.

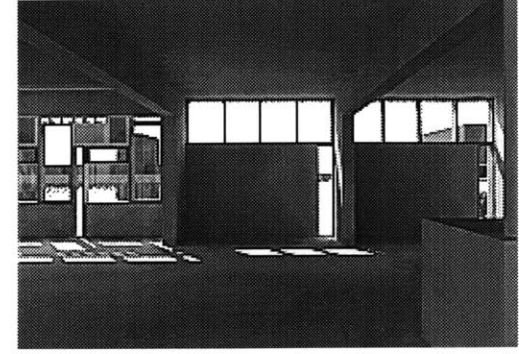


**Library: corner and water zone**

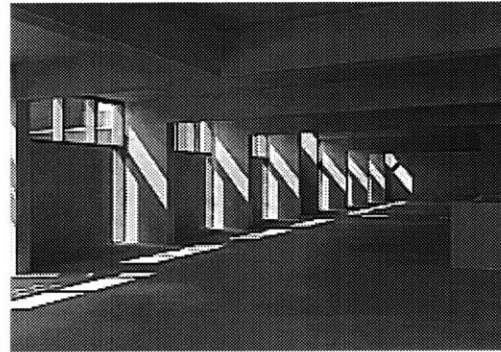
View West to water zone.



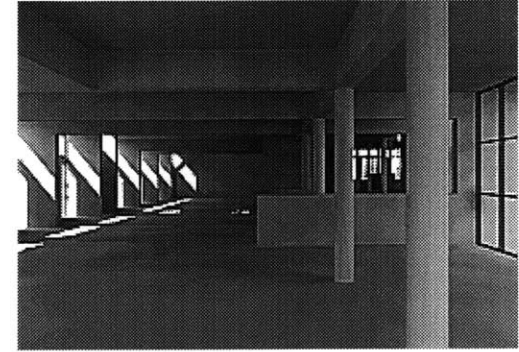
View Southwest to corner and water.



View West in corner.



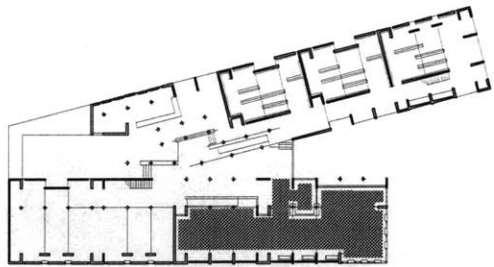
View Northwest in corner.



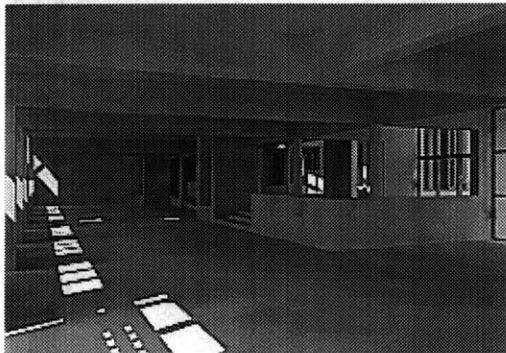
View North in corner.



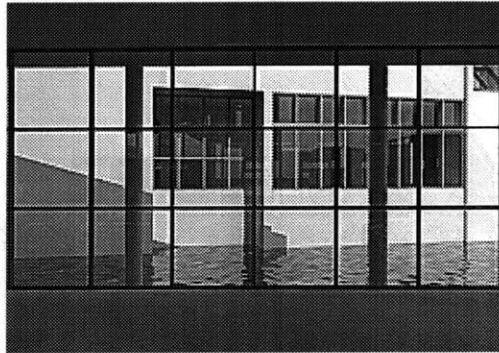
View South to corner.



Corner and Water Zones.



View North at Western edge.



View East across inlet water room.



View South in corner zone screen territory.



View South to corner.



View West entering corner from west access zone.

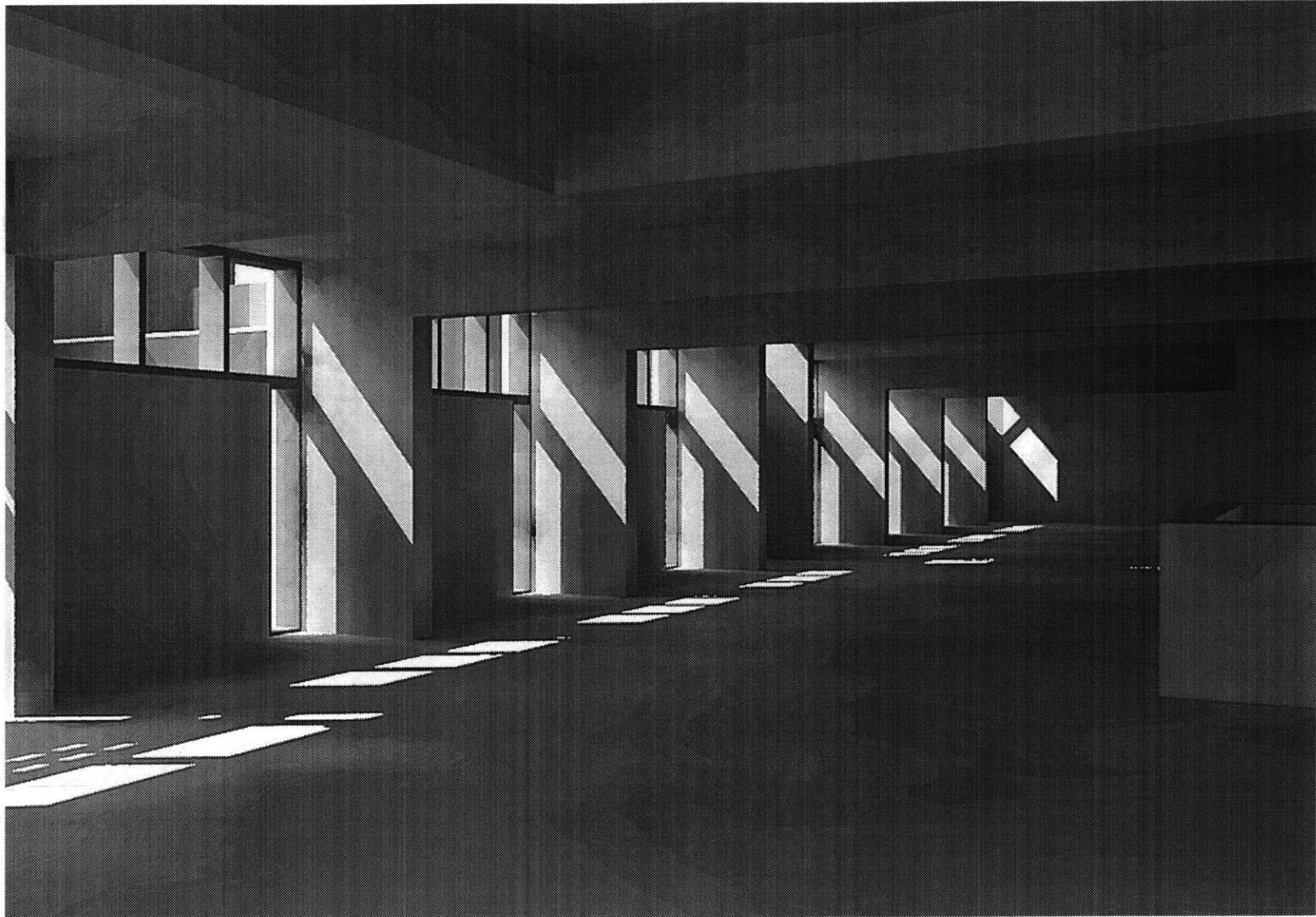




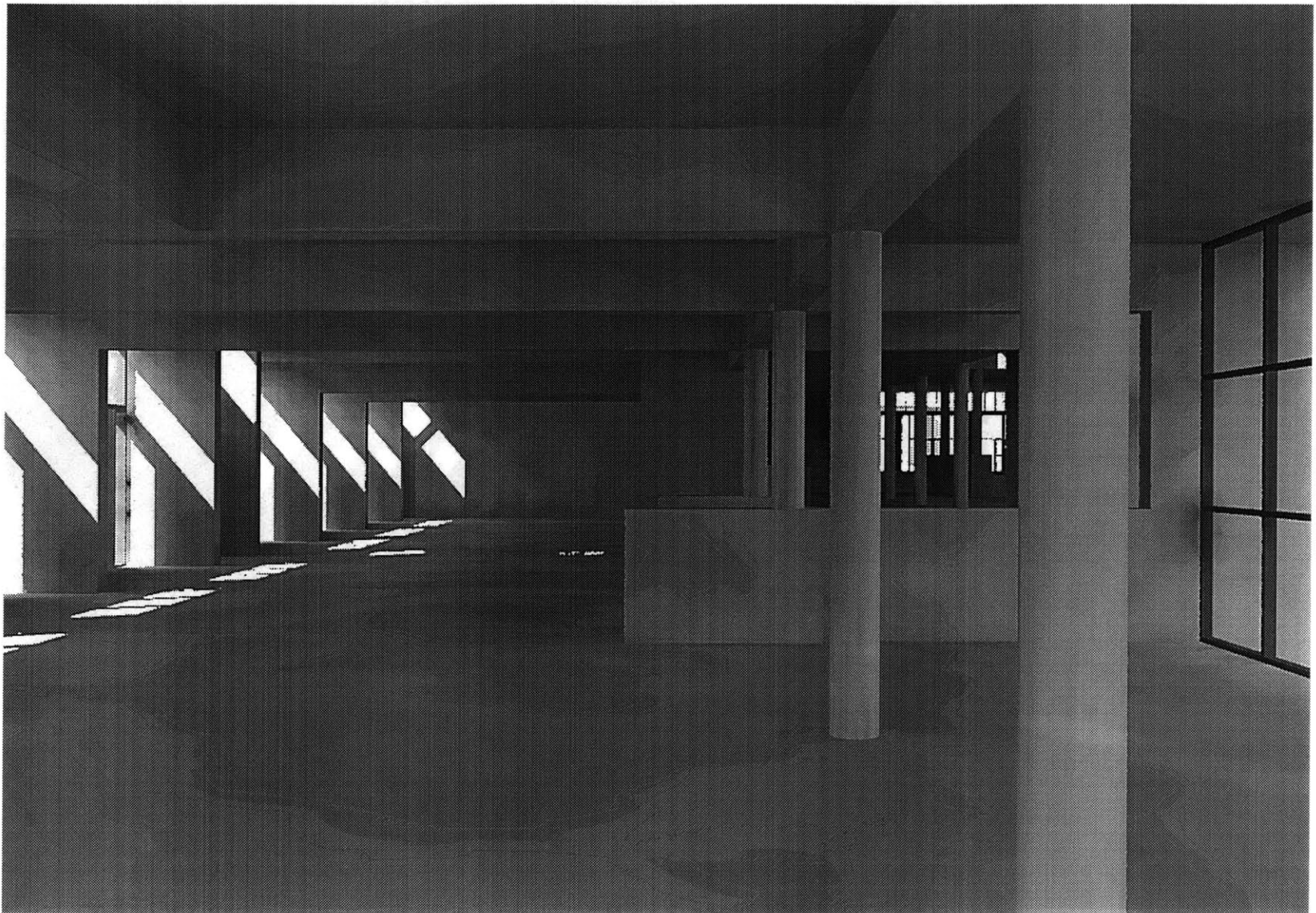
View Southwest into corner territory.



View West standing in corner.



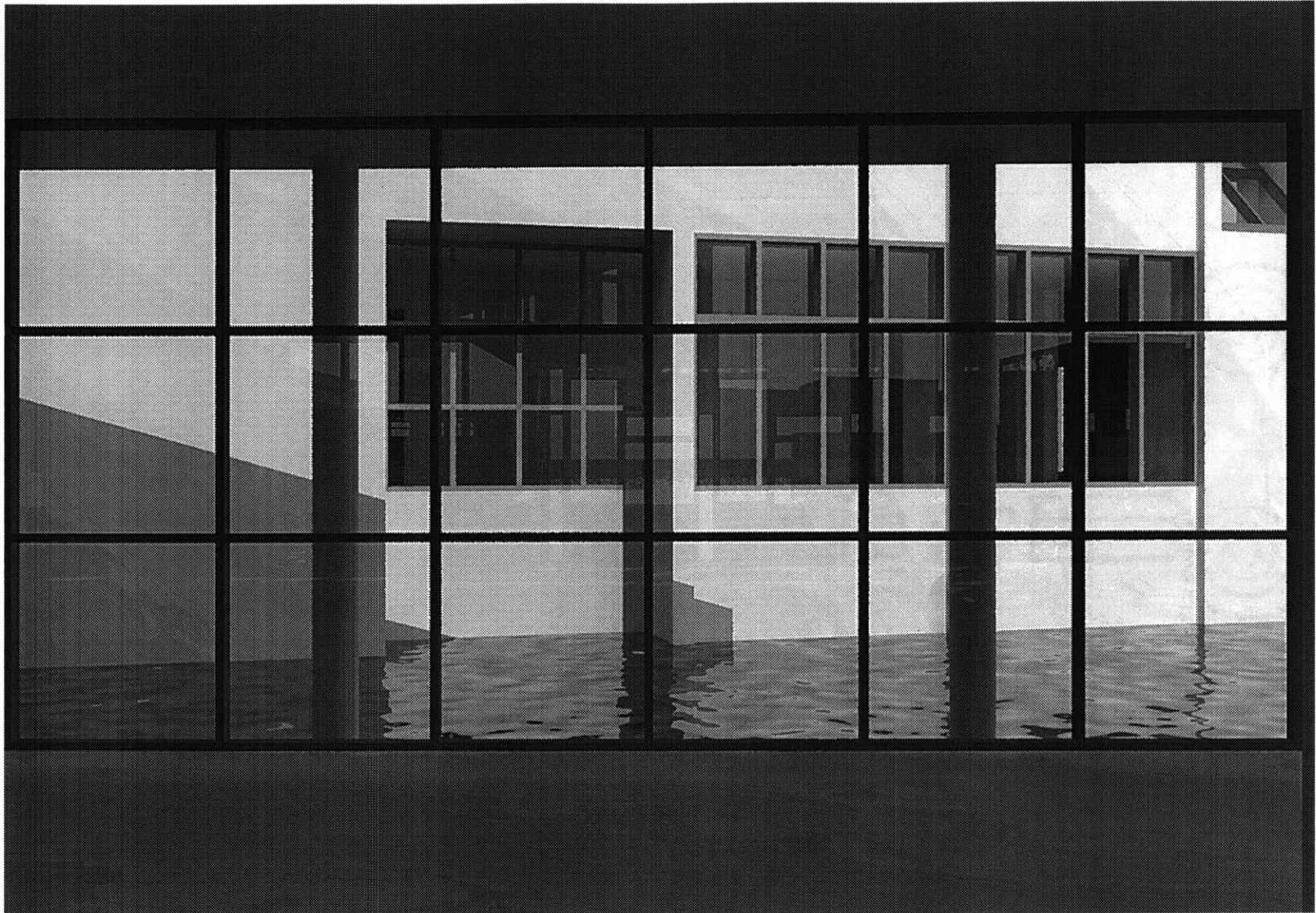
View Northwest along western edge.



View North.



View North at western edge.



View East across inlet water room.



View South in corner zone screen territory.

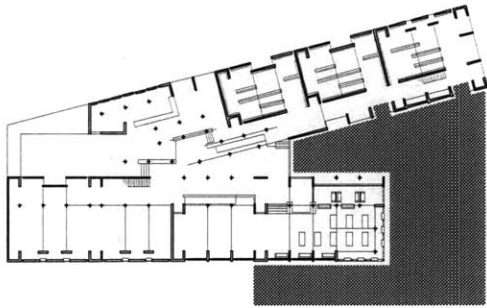


View South to corner.





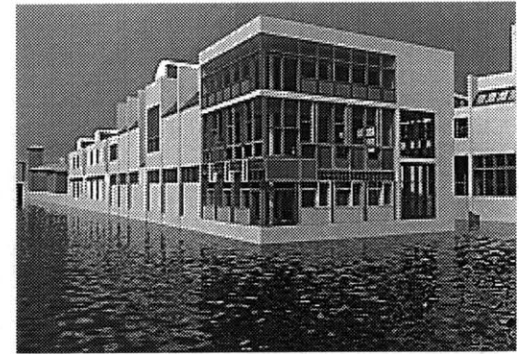
View South.



Inlet.



View Northwest to water corner.



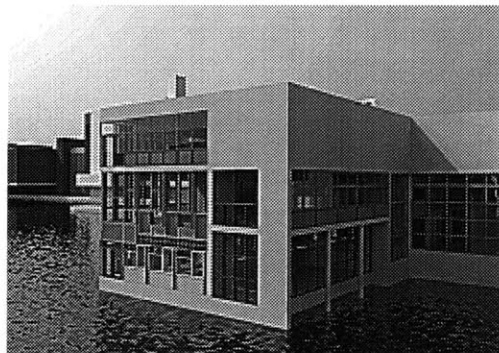
View Northeast to water corner.



View Northeast to inlet.



View North to inlet.



View Northeast to water corner and inlet.



View Northeast to western edge.



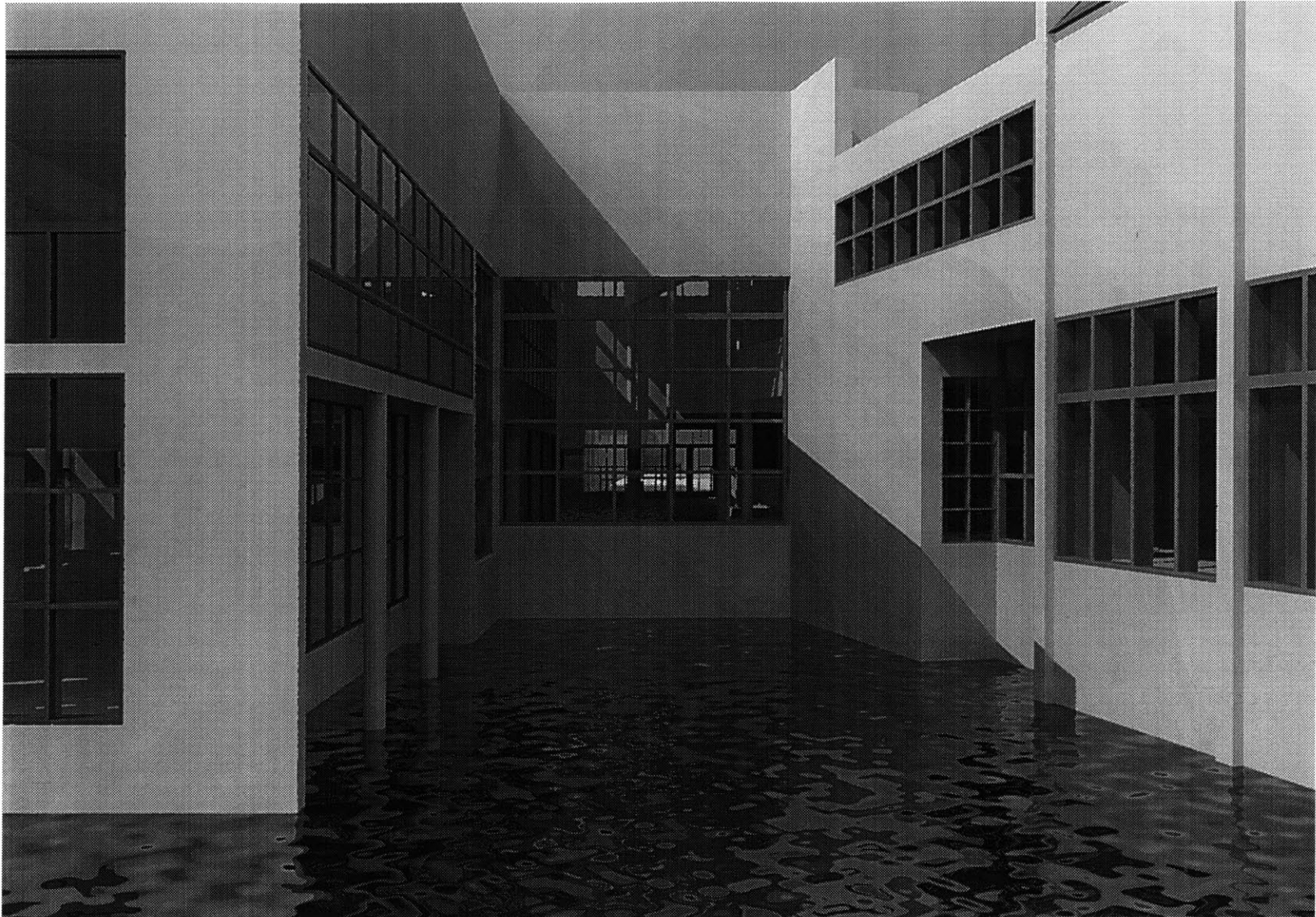
View Northwest to water corner.



View Northeast to water corner.



View Northeast to inlet.



View North to inlet.

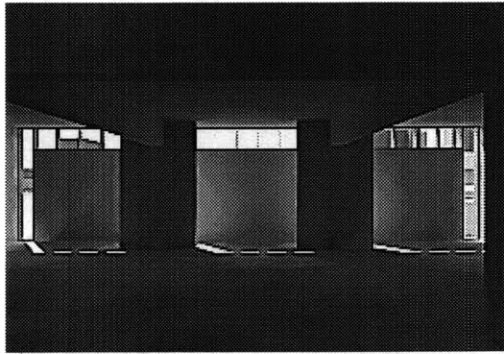


View Northwest to water corner and inlet.

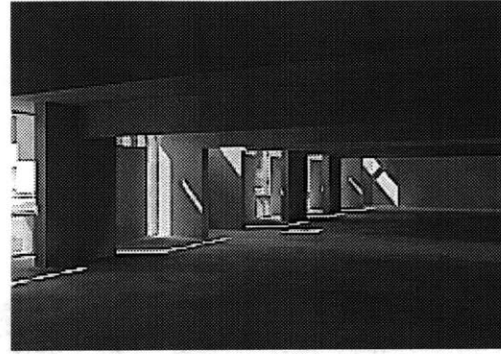




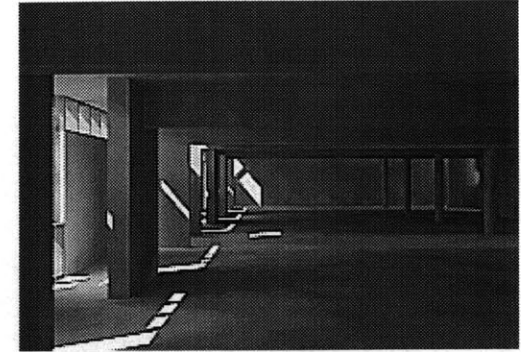
View Northwest to western edge across inlet.



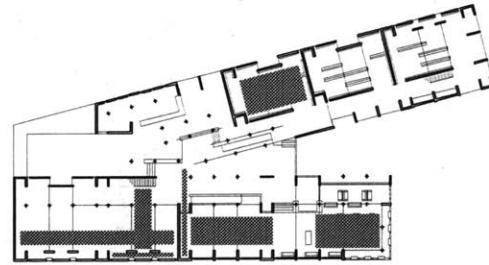
View West, displaced light.



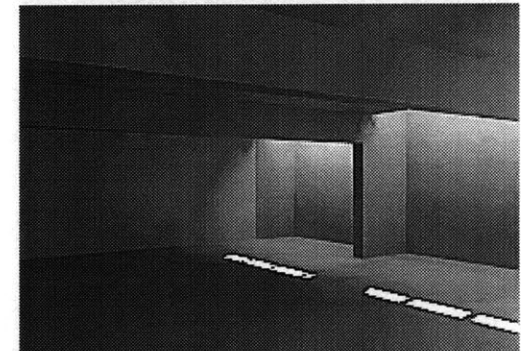
View North, displaced light as screen.



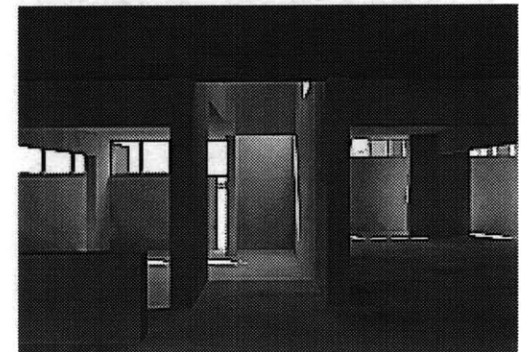
View North, displaced light zone.



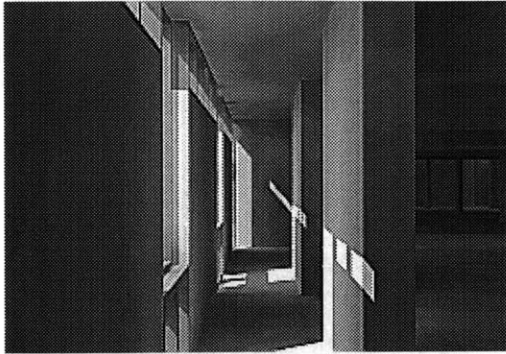
Effects.



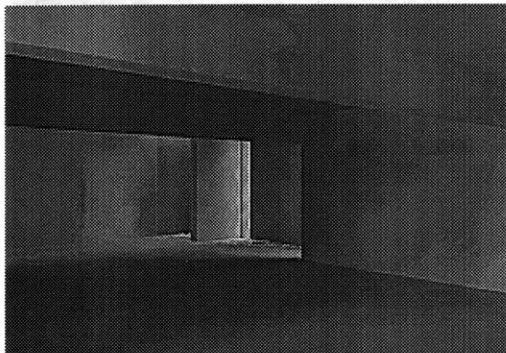
View Southwest, second floor overhead light.



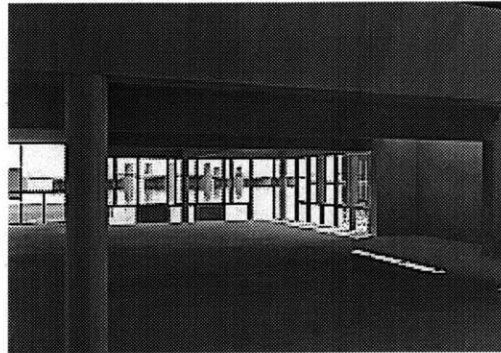
View West, light scoop zone.



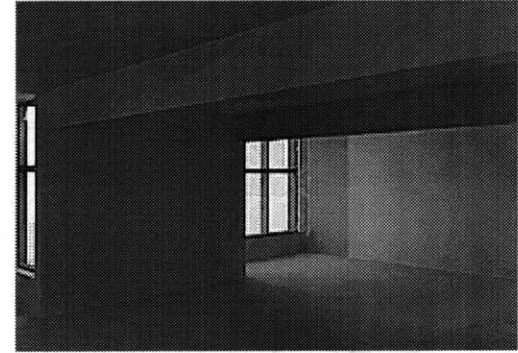
View North in displaced light.



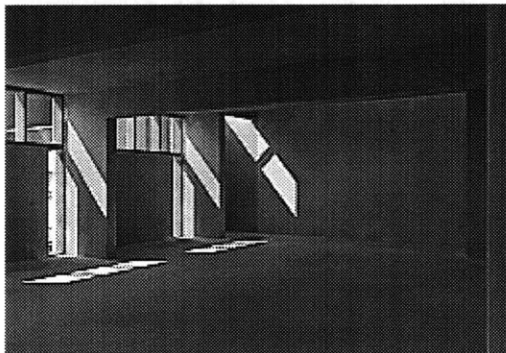
View Northeast, side light.



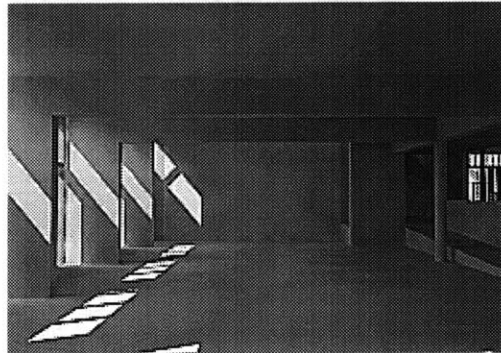
View Southwest, second floor screen.



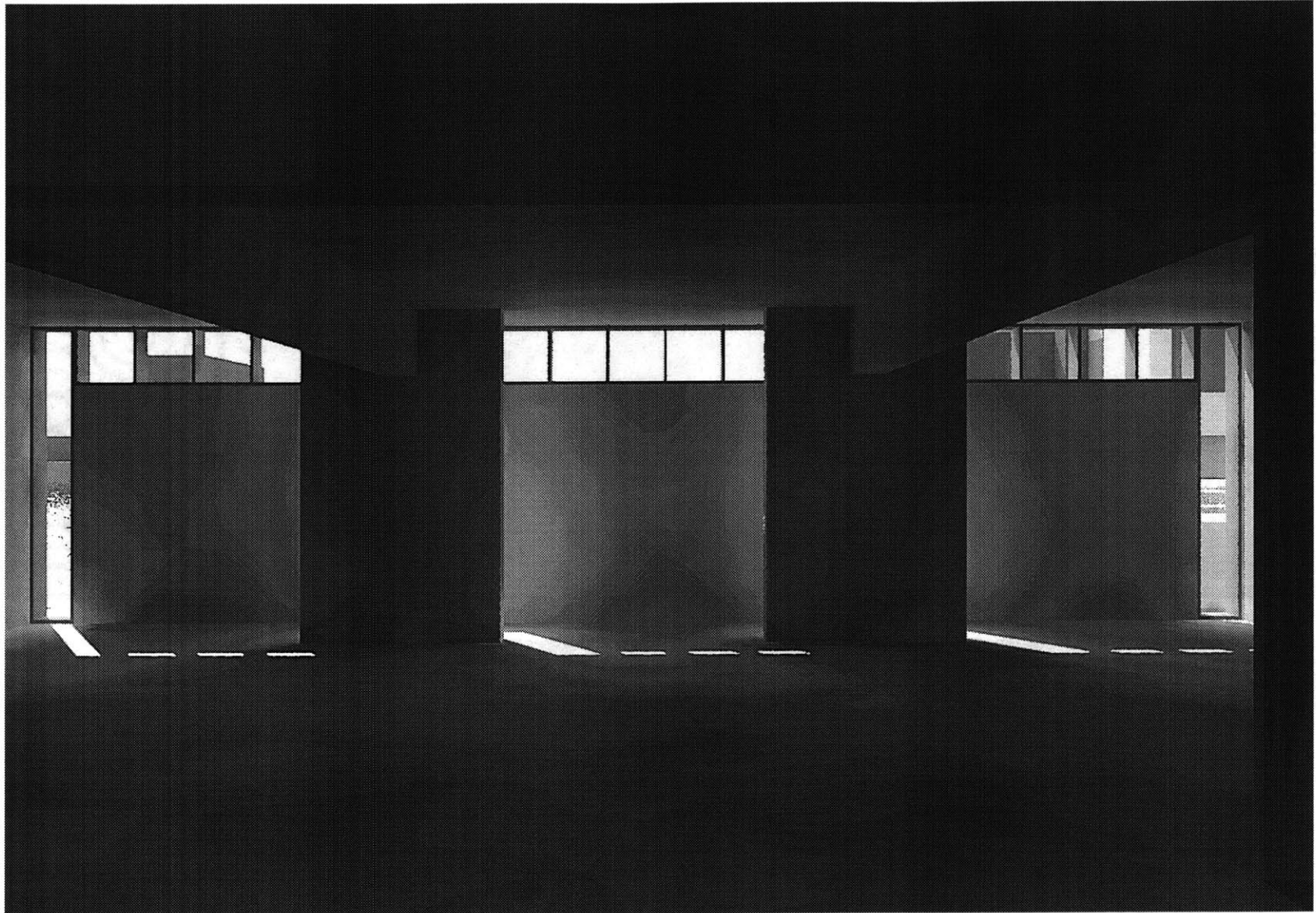
View Southeast, screen territory.



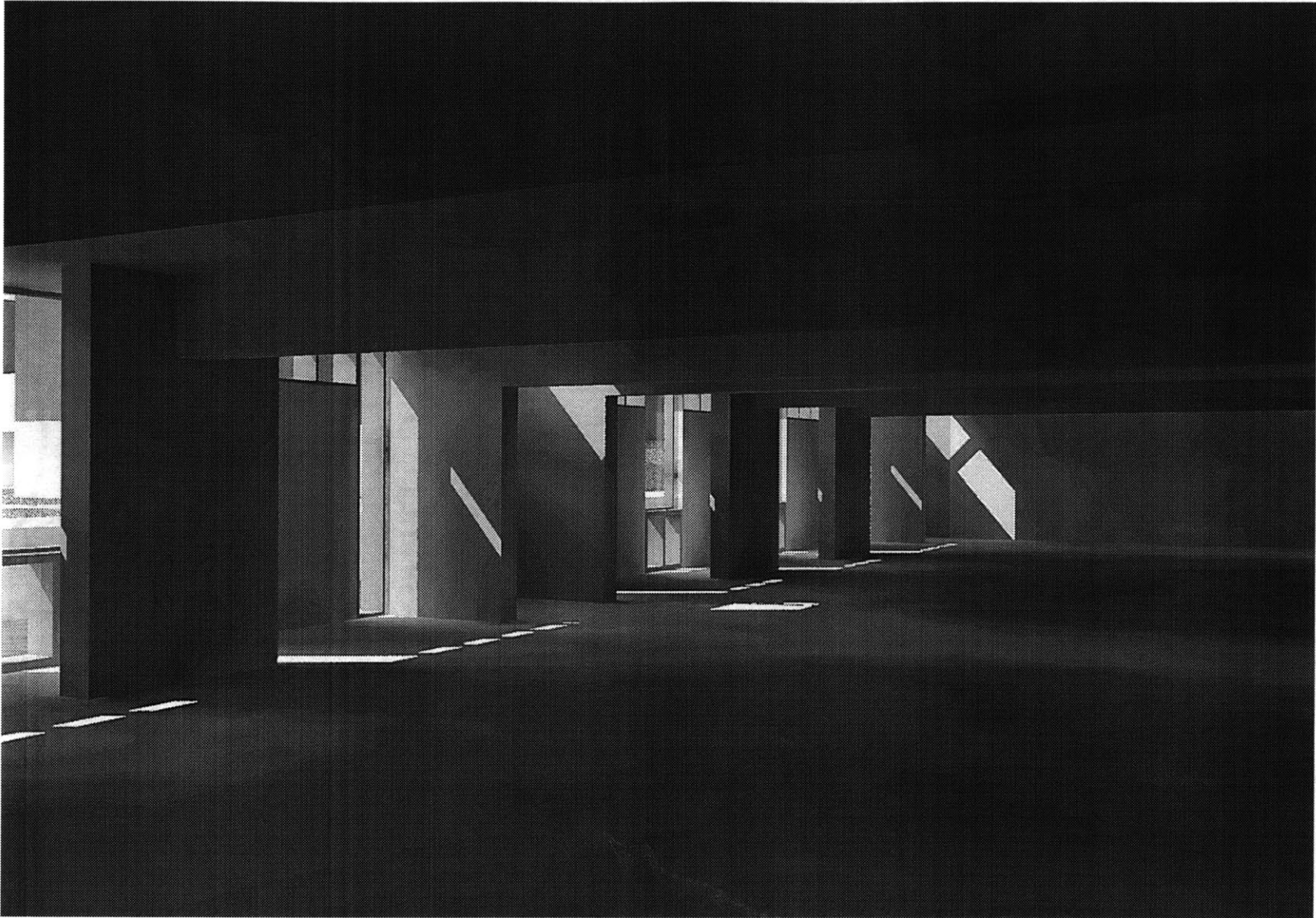
View Northwest, light territories.



View North, light scoop wall.



View West, displaced light.



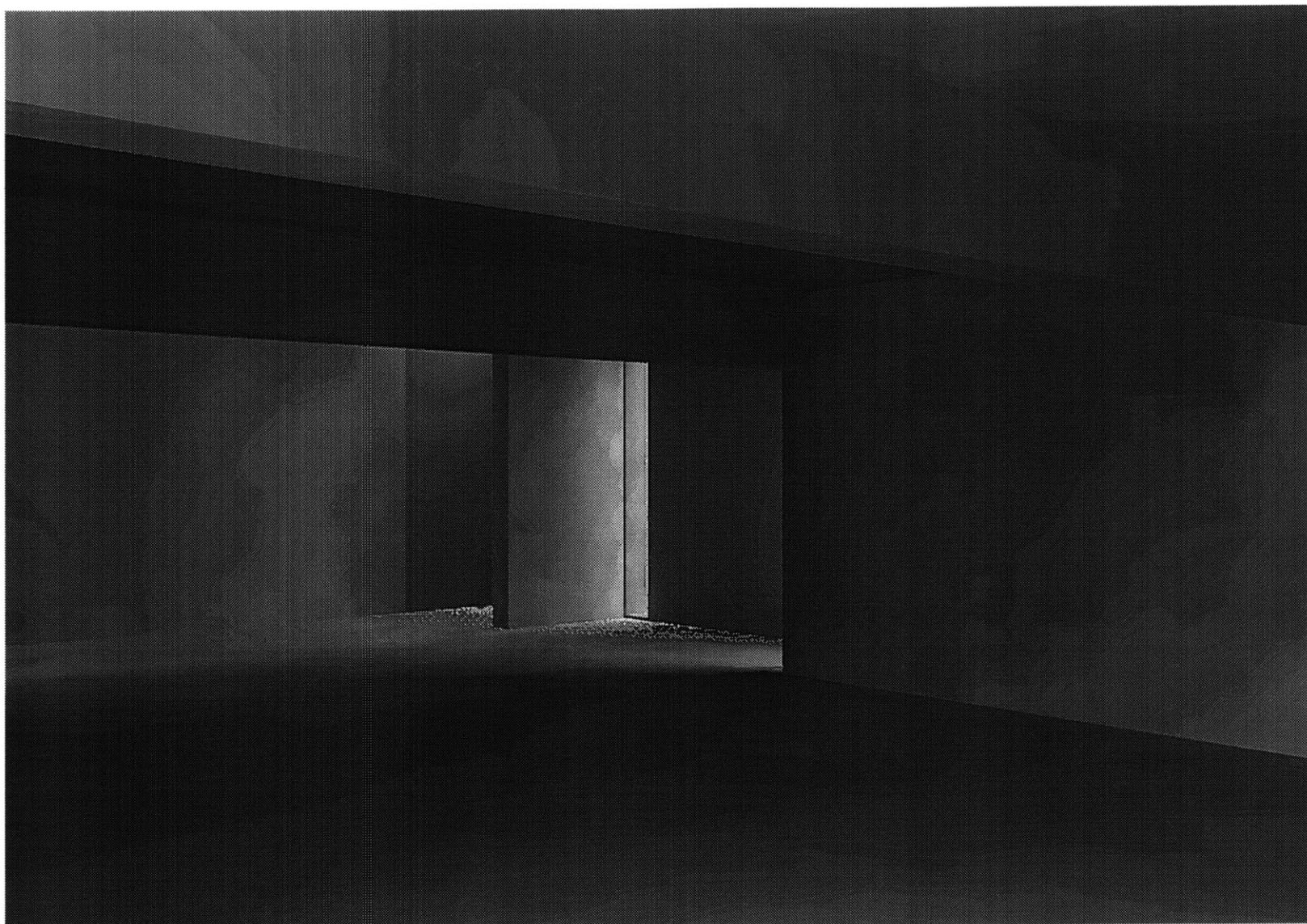
View Northwest, displaced light as screen.



View North, displaced light building zone and territorial definition.

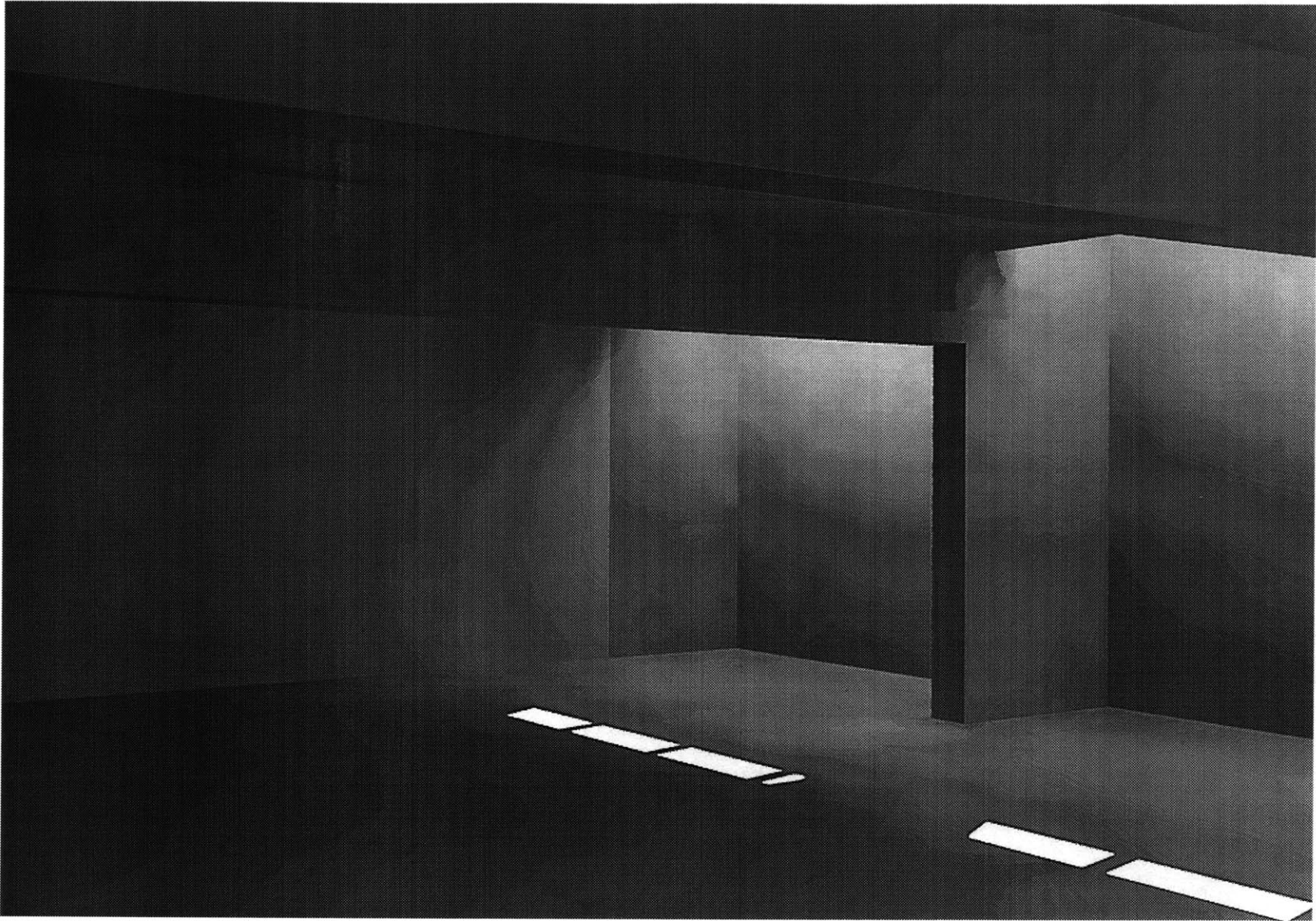


View North in displaced light territory.

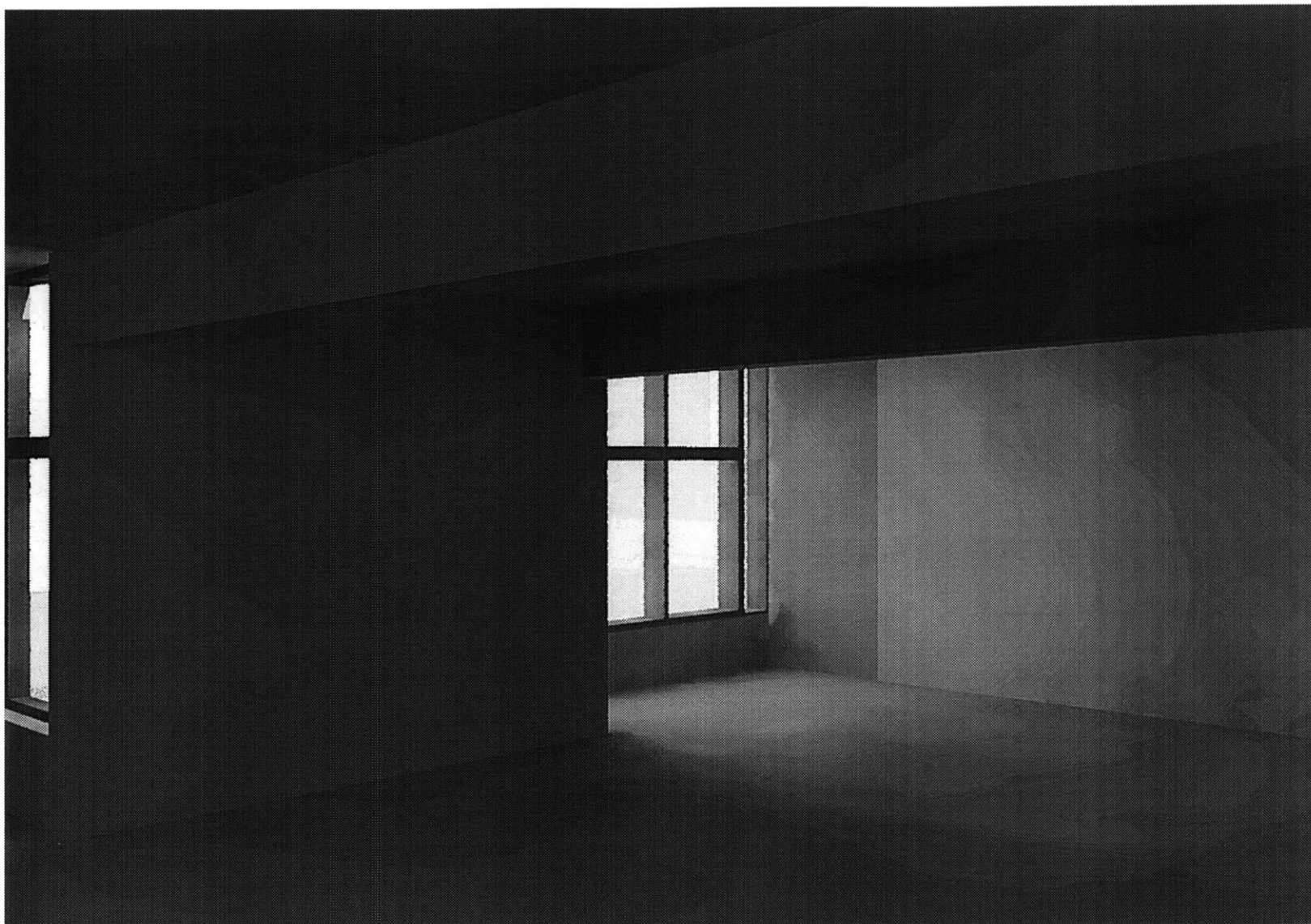


View Northeast, side light.

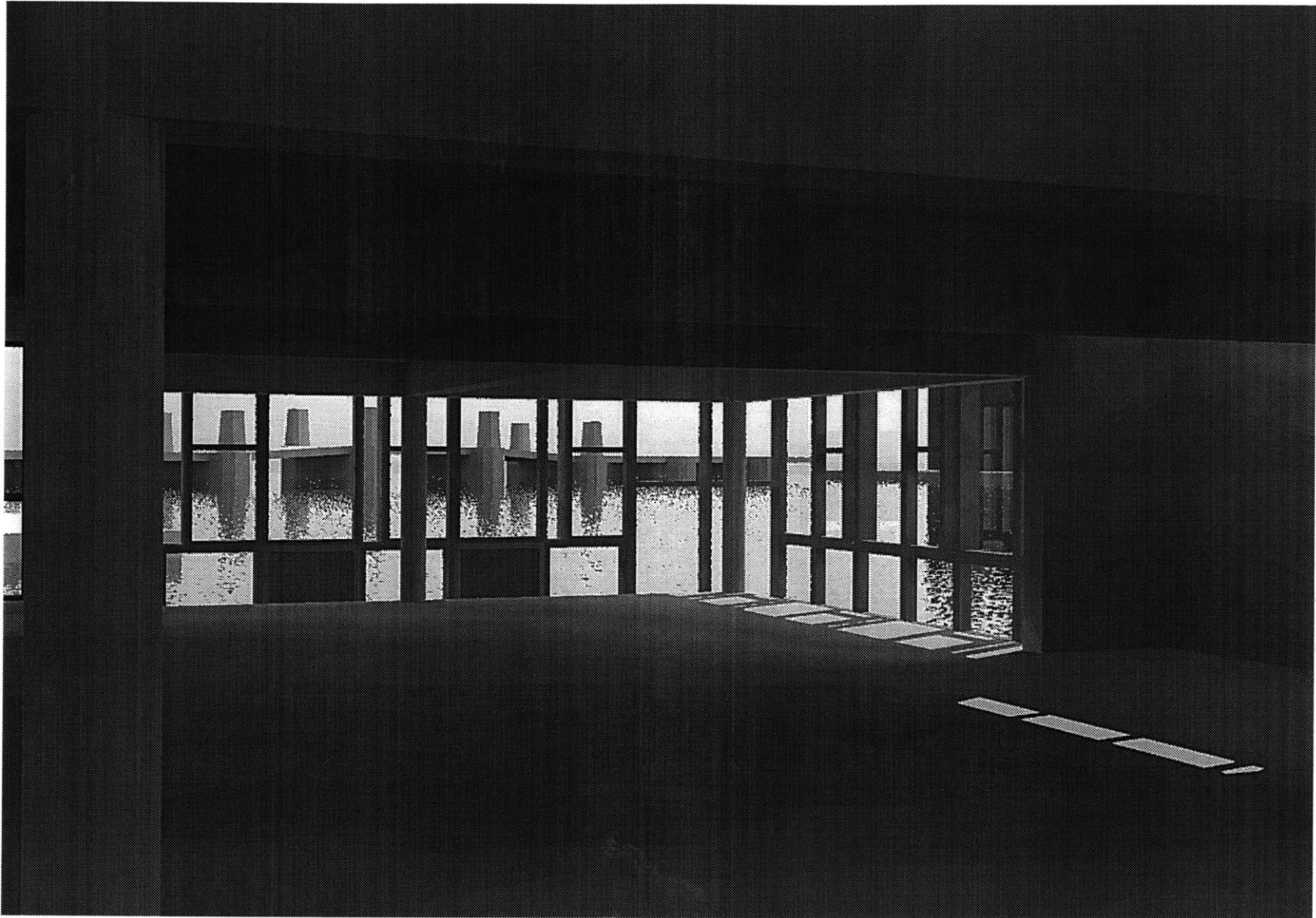




View Southwest, second floor overhead light.



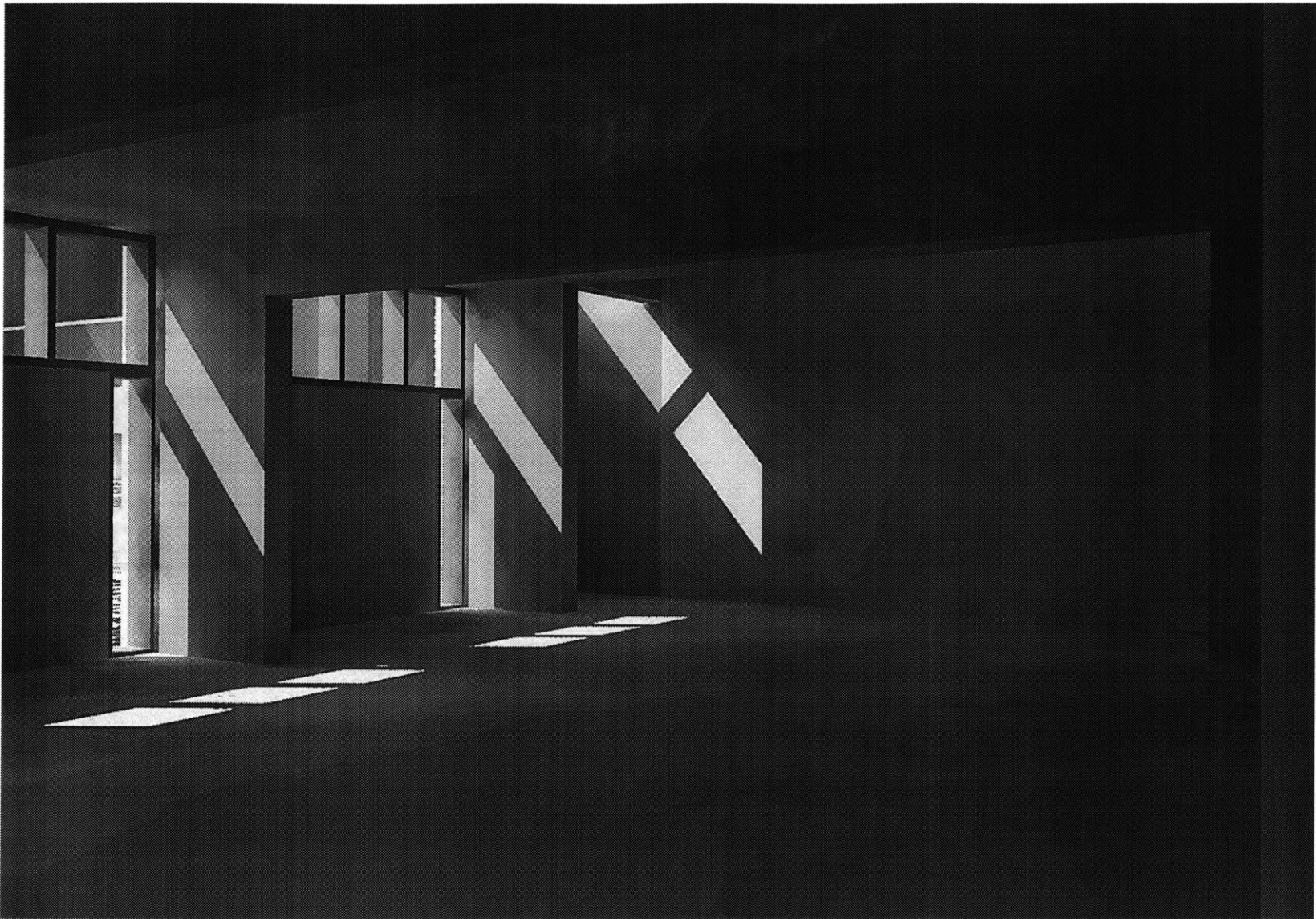
View Southeast, use territory built by screen.



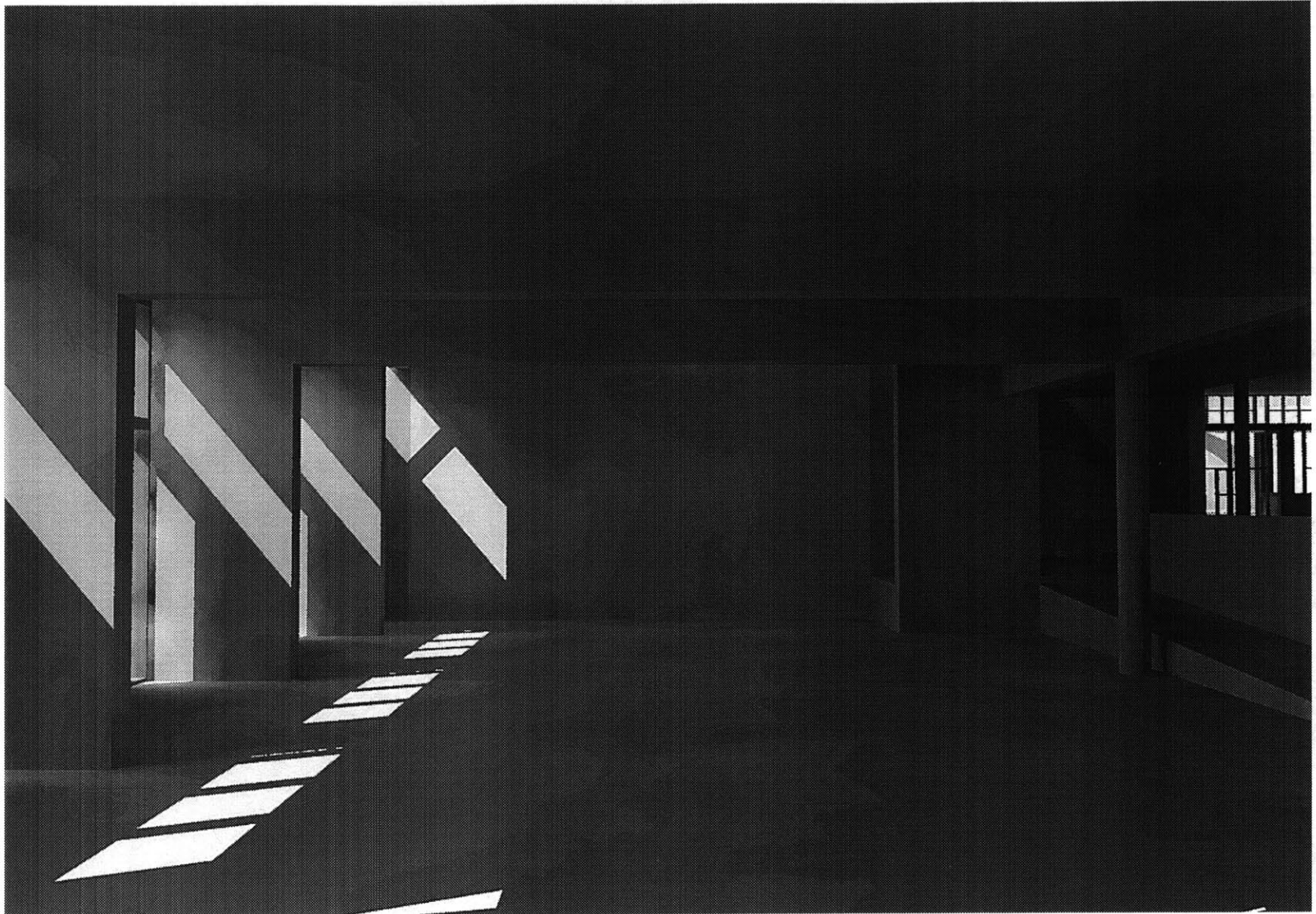
View Southwest, second floor screen.



View West, light scoop zone.



View Northwest, light territories.



View North, light scoop wall.

Careful consideration must be given over to the uses of computer modeling in design education. As demonstrated in this thesis, the so-called 'computer model' is far more than the construction or replication of design geometry in the virtual three-dimensional domain of the computer. Through design driven interactions with a computer model, one can gain an enormous amount of knowledge about a given proposition. One can begin to explore and understand the behavior of light in space; the construction of a detail, part or device; or how some building proposal might actually be put together in the real and physical world. In typical design education, computer modeling is taught largely as a representational strategy, that is, the design is mostly completed and must now be re-presented in a slick fashion. It is not taught as a means for making thoughtful decisions about space, nor is it taught as an exploratory method for developing and evaluating variable propositions.

The computer model is a dynamic medium unlike any other in the designer's repertoire of decision making tools. It allows the designer to "enter into" the space of the design proposition in both an experiential and analytic manner. It can be used to generate an enormous amount of design and process knowledge. One can explore the experiential aspects of a design from a multiplicity of viewpoints in an iterative fashion over the course of the design. The very process of constructing a computer model can help to provide knowledge of how a building might actually come to be built, perhaps more so than normative design methods based on more traditional tools.

The process of modeling in the computer is completely "on site," all decisions are made within the domain of the virtual site. Students must be taught how to make decisions within the scope of such "on site" interactions. They must also learn to evaluate, in a critical manner, the quantitative and qualitative visual information gained from computationally driven design interactions. Given a critical approach to modeling, one can begin to understand the problems associated with putting a building together, getting it to stand up, getting light inside, and generating habitable territory.

This increased design "resolution," caused by the constructive and exploratory uses of computer modeling, removes a level of uncertainty from the outcome of the design proposition. Currently, design criticism takes place within this territory of uncertainty. It is the territory between the designer's expressed intent and the proposition at hand into which the critic steps and projects his or her own propositions for the design. But with an increased design "resolution," criticism in design education must now find new territory in which to operate. It must now learn to speak more directly to the methods and processes of making design decisions based on knowledge gained through a certain class of exploratory interactions.





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All works (sketches, drawings, computer models and renderings) in this document are original works undertaken by the author during the course of this thesis

Modeling:

*Autocad R12* by Autodesk.

*Radout*, developed by Philip Thompson of the School of Architecture and Planning Computer Resource Lab at MIT, used to convert 3D Autocad models to Radiance scene description files.

Rendering:

*Radiance 2.5*, a physically based hybrid raytracer developed by Greg Ward at Lawrence Berkeley Labs, used as the rendering and visualization system for the project.

Hardware:

A Sun Sparcstation 5 with 128 megabytes of ram was used for 3D modeling. Two SGI Indigo 2's and two Sun Sparcstation 20's were used as rendering engines.



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