
Chiasmus

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## Abstract:

Chiasmus is a responsive and dynamically reflective, two-sided volumetric projection surface that embodies phenomenological issues such as the formation and reception of images, observer and machine perception and the dynamics of the screen as a space of image reception. It consists of a square grid of 64 individually motorized cube elements engineered to move linearly. Each cube is controlled by custom software that analyzes video imagery for luminance values and sends these values to the motor control mechanisms to coordinate the individual movements. The resolution of the sculptural screen from the individual movements allows its volume to dynamically alter, providing novel and unique perspectives of its mobile form to an observer.

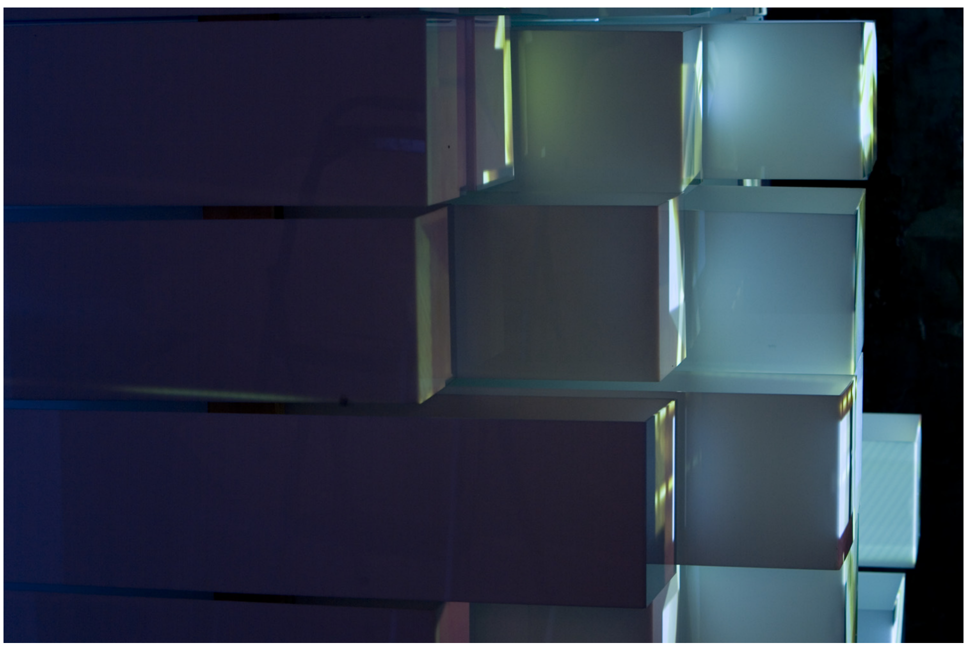

*Figure 1.0: Chiasmus during Perceptive Phase, 2008*

## KeyWords:

Responsive Architecture, Kinetic Sculpture, Video Installation, Perception

## Beginnings:

*"All my life I've asked myself questions: Why is it necessary to project onto only solid surfaces and not onto a mobile cluster of lines, on fragmentary surfaces, or on sticks or rods? Why isn't it possible to introduce light into their layers as well as onto their surface?" – Josef Svoboda*[1]

My interest in building this project started from studies in programming and building physical computing applications, and the idea of the translatable nature of digital data that would allow for the generation of physical movement. Working primarily with visual media, I'm also interested in the formation of imagery and its aesthetic reception and perception. From this basic starting point, I discovered other artists' explorations into image projection onto three-dimensional surfaces as an interesting mode of inquiry. I was especially drawn to the stage designs and World Expo installations of Josef Svoboda and the expanded cinema environments of Peter Weibel, Jeffrey Shaw, and Stan VanDerBeek. I became very interested in the dynamics of light as it interacts with the different depths and materials of the unique surfaces and the result it had on the projected image. This discovery subsequently led to the idea of projecting video imagery onto a three-dimensional surface that was also dynamically mobile and kinetically responsive to the projected light source. Establishing such a dialogic exchange between the moving surface and the projected imagery would form a generative process and produce an evolving and ultimately unknown outcome. Working within this parameter became an additional area of interest for me: to let a work unfold and become something unexpected.

[1] The Secret of Theatrical Space – The Memoirs of Josef Svoboda – 1993 – Applause Theatre Book Publishers – New York

## Chiasmus:

Merleau-Ponty used the term chiasmus in his study of phenomenology to describe a reversibility of experience that is the "unique space which separates and reunites, which sustains every cohesion."[2] With this idea, I felt it was an appropriate and descriptive title for this project as this dialectical reversibility emerges within both the conceptual framework and the physical structure and presence of the piece.

Conceptually, this reversibility is addressed in the dynamics of the self/other duality brought forth by the established perceptive dialectic between observer/camera/mobilized sculptural screen. Physically, the establishment of a two-sided projection upon the volumetric screen and its resulting opposing movements that simultaneously exist on opposing ends further influenced the piece's title. The push/pull movements towards the extreme linear positions of the volumetric screen are metaphorically representative of the broader oppositional concepts examined by the piece: seeing/perceiving, passive/active, receiver/actuator, singular/multiple, ideology/idealism.

The metaphor of the camera/eye duality as both simultaneous perceiver and creator of meaning is well documented and explored in cinematic theory. For this piece, the metaphor is conceptually extended to the volumetric screen. The dialectical nature of this new three-part combination further influenced and aided the naming of the project.

[2] Vivian Sobchack, The Address of the Eye: A Phenomenology of Film Experience, (Princeton, NJ: Princeton University Press, 1992), p. 4. She attributes the quote to Maurice Merleau-Ponty, "Eye and Mind" trans. Carleton Dallery, in The Primacy of Perception, ed. James M. Edie (Evanston, IL: Northwestern University Press, 1964), p. 187

## Image Instability:

The projected images occupy a transitory physical space through their reception and reflection upon the mobile and dynamic surface(s). Upon this surface, the imagery is intentionally destabilized and unsecured from a static and bound frame by the volumetric screen's response and movements to the projected source. It is a once flat surface that continually gives way to a multiplied and three-dimensional one. This image destabilization is further amplified through the subjective perspective of the observer granted by the potential encompassing movements around the sculptural screen.

The volumetric screen's movements open an additional circuit of meaning for the projected imagery that was once closed with the passive reflectance of the cinematic screen and the immobilized observer. The volumetric screen presents itself as a unique deterministic object and perceptible identity. The additional circuit of meaning for the image shifts between the two viewers/spectators (observer and screen). The screen sees and interprets a function of the digital image formation - the binary data that composes the video stream - and allows for the technological transformation to generate a perceivable and projected image. The observer vacillates between the conceptual and the functional as the volumetric screen continually foregrounds the issue of function. For the observer, the image is unsettled and never allowed to rest solely in one domain. It is a deliberate destabilization of perception and further push and pull of image formation and reception.

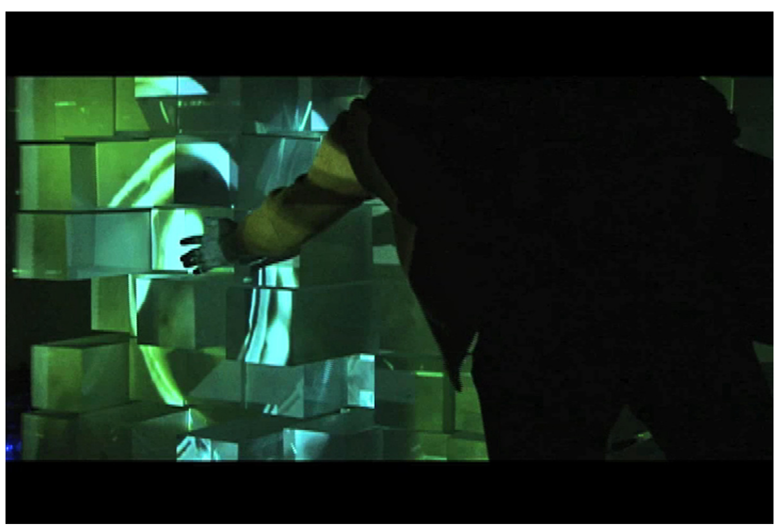

*Figure 1.1: Chiasmus Exhibition, 2008*

## Sculptural Form:

"The eye is already within things, it is a part of the image...The eye is not the camera, it is the screen." – Gilles Deleuze[3]

The volumetric screen is projected onto from two sides and is intended to be viewed in full circumference, necessitating physical movement and imbuing bodily sensation to the observer. Its placement is centered within the viewing space, encouraging the observer to circle the form and realize the multiplicity of points of view. Each individual and potential viewpoint offers a distinct perspective upon the sculpture that is in continual flux created by the individual movements of each cube form. In this way, it provides a "democratization" of vision. There is not one privileged viewpoint that is fixed, but each observer's point of view offers a unique vantage that is separate from all others. Only in that one place and moment does the image and the sculptural screen offer this view. It is both the observer's choice of movement and the dynamics of the volumetric screen that determine focus and attention.

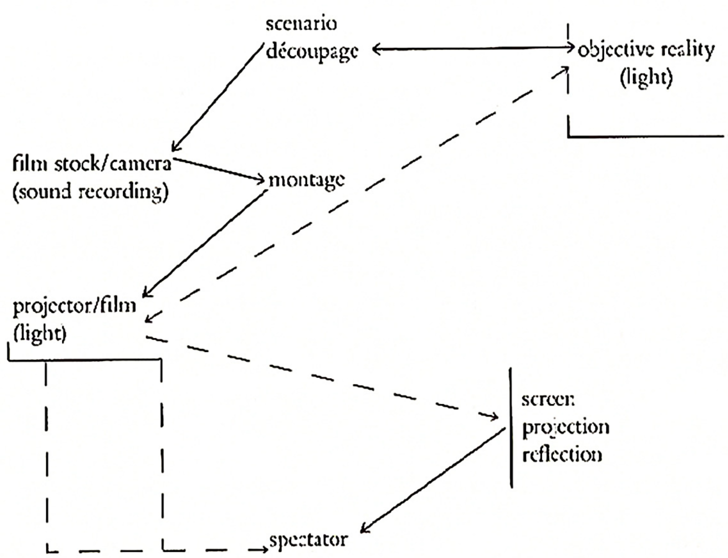


Figure 1.2: Cinematic process proposed by Baudry, 1970[4]

The entire structure of production, display and reception is theoretically tied to cinematic conceptions. Directly examined from these conceptions are the author/camera and projector mechanisms as well as the eye/I of the observer. Missing within this structure and developed with this project is the activation of the screen

[3] Abigail Solomon-Godeau. "Thinking in Images," Art in America (January 2008): p. 77. Attributed to "About the Forms of My Work." L'oeil-écran ou la nouvelle image (Luxembourg, Casino Luxembourg, 2007) p. 11

[4] Jean-Louis Baudry. "Ideological Effects of the Basic Cinematographic Apparatus," in Narrative, Apparatus, Ideology: A Film Theory Reader, ed. Philip Rosen (New York, NY: Columbia University Press, 1986) p. 288. The diagram shows the disposition of elements with the broken lines signifying ideological processes.

as factor and participant within the apparatus dynamic. By utilizing cinematic apparatus theory proposed by Baudry as a basis, it is possible to map the productive movements and junctures of ideology within this work, as follows:

Starting with a selected "objective reality" or a directly-perceptible reality that the camera operation can record —>
the recording of this reality within the technological parameters of the camera —>
digitization and post-production editing techniques through software —>
projection upon the volumetric screen —>
the volumetric screen's interpretation of the projected data and coordination of its responsive movements —>
the viewer's perception of the visual content upon the responsive volumetric screen in motion dependant upon their physical perspective.

In such a structure, distinct ideological junctures exist that allow for the transformation of meaning to take place. The movement viewed by the camera within "objective reality" is transformed through the recording and editing process until it is visually restored through its projection. A place of further and unique transformation for this movement and meaning is with its amplification/abstraction from the logical movements of the screen, generating a new "objective reality" scenario. An ideology is thus incorporated at three distinct junctures: the selection of "objective reality" for the camera to record, the software-based editing process, and the movement of the volumetric screen.

"More than any other medium of human communication, the moving picture makes itself sensuously and sensibly manifest as the expression of experience by experience."[5] This quote brings to light the concept of the dynamic between the film apparatus (camera and projector) and the observer as mutual perceivers. I wanted to introduce the screen into this dynamic and make it not only a perceiver determined by its responsive movements, but active in the generation of meaning by its interaction with the projected imagery.

Further, this idea brings to light the foundation of language and experience itself, namely the opposition of self and other. With this, I wanted to reinforce the uniqueness of subjective experience by allowing/encouraging spectatorial movement around the sculptural form, thereby creating novel and exclusive perspectives.

[5] Vivian Sobchack. The Address of the Eye: A Phenomenology of Film Experience, (Princeton, NJ: Princeton University Press, 1992), p. 3.

Basing the sculpture's "vision" and resulting response on luminance is directly related to light as both an integral aspect of perception as well as a function of the image recording process. For the camera, it functionally "sees" and records imagery through either chemical or electrical means by distinguishing between luminance values and color wavelengths on a sensitized medium. This mode of "seeing" is transferred to the volumetric screen by its supporting software, analyzing the pixel data of the video image and determining luminance values. These resulting values are then used to position the 64 individual cubes and form the sculptural response. These coordinated movements metaphorically coincide with the physiological process of light reception of the eye. Within the eye's structure are receptor cells, called rods and cones which are light sensitive. These cells are attached to "stalks" that also respond to light intensity and move with variations in luminance. In low light, the rods push forward and the cones recede; conversely, in high intensity lighting, the cones move forward and the rods recede. This push and pull movement is simulated by the individual cubes in the sculpture.

*Figure 1.3: Chiasmus*

## Video Images:

The video images are formally created to generate contrast in luminosity, dynamic shapes and patterns as well as temporal changes. Conceptually, there is an evolutionary progression and transposition into four distinct phases that reference conceptual points along the continuum of apparatus and spectator theories in cinematic inquiry and vision in phenomenology.

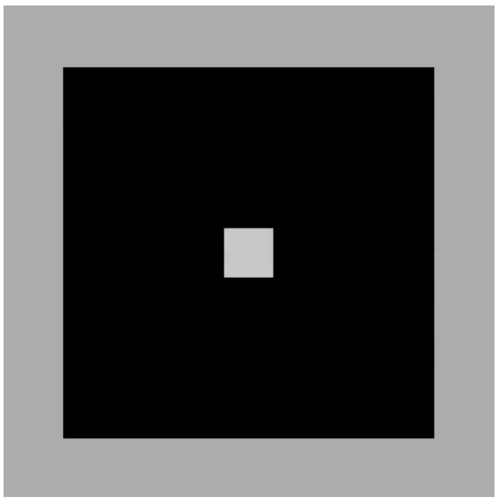

*Figure 1.4 Basic Vision*

Phase 1 – Basic Vision:

The beginning imagery introduces the basic ability of structural vision to apprehend and distinguish between shapes and luminosity. The video content foregrounds itself as formally significant to establish for the observer the causal relationship between the screen's movement and the imagery's luminosity and contrast. It consists of simple squares of either pure black, pure white or middle gray luminosity that scale in a repeatable pulsing pattern.

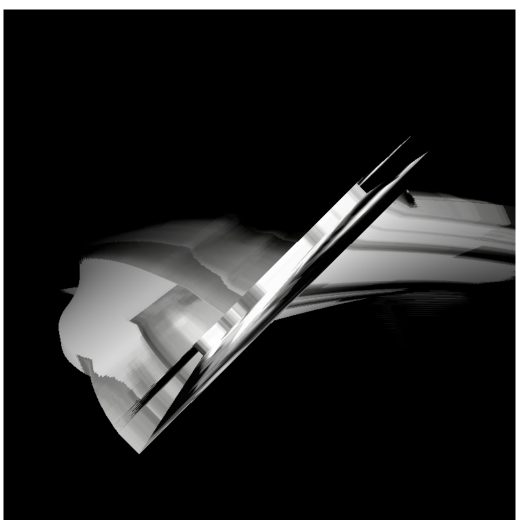

*Figure 1.5 Gestalt*

Phase 2 - Gestalt

This phase maintains the luminosity context established in Phase 1, but is more sophisticated with its movements. Its purpose is to generate abstract patterns, both with the projected imagery and the resulting sculptural forms created through the screen movement and positioning. With this imagery, the differentiation between the mechanic vision of the sculptural screen and the observer become apparent, which is further emphasized by the spectral variations afforded by the observer's movement, position and unique point of view.

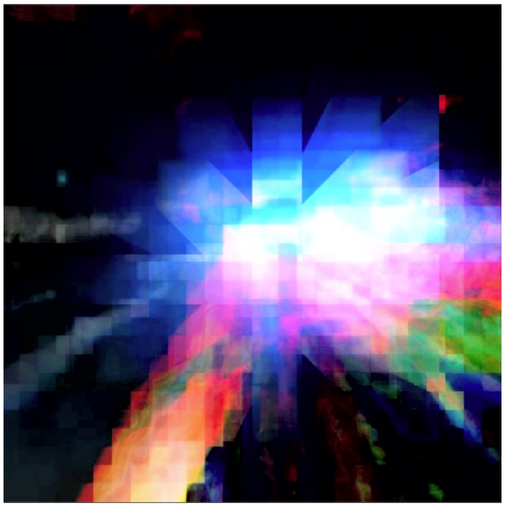

*Figure 1.6 Mobilization*

Phase 3 – Mobility

Color is introduced during this phase and incorporates the camera as a third perceiver/ viewer in the dynamic between the observer and the screen. The camera was mobilized during the capture process and the resulting imagery also places the subjective perception of the observer in motion. The post-processing techniques chosen and the creation of deliberate "camera" effects through software – such as lens distortion and flare - foreground the production dynamic of the project and the injection of ideology into the resulting imagery. The use of a "mobilized" image – the image that is historically juxtaposed in cinema theory with the immobilized viewer – is used to playfully relate to this concept through opposition. In this projection system, the participation and active mobility of the observer is now required.

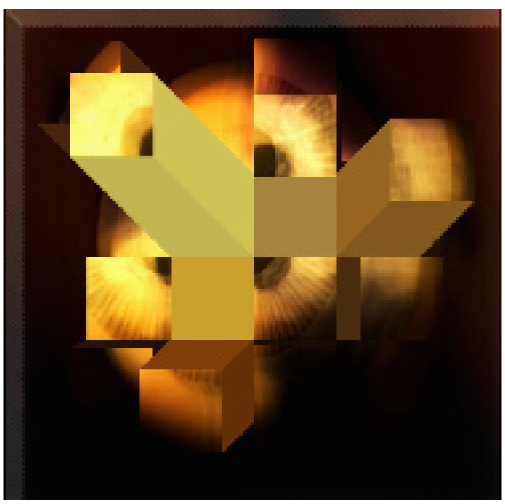

*Figure 1.7 Perception*

Phase 4 – Perception

This phase utilizes the appropriation of found archival footage to conceptually serve as both illustrative of the memory structure inherent with perception and the very nature of the camera itself as "preserver," and to compare the parallel optical and mechanical operations of human and camera vision. Altered and recontextualized through editing and post-production, the superimposed imagery struggles for attention and attempts to provoke viewers into an opportunity to perceive legible patterns and imagery amid visual chaos.

Footage used:

Eyes and Their Care (An Introduction), The - ERPI Classroom Films, Inc.1941

How the Eye Functions - Bosse (Karl Kurt).1941

Communication - DeVry School Films, Inc. 1927

## Mechanics:

The physical realization of this project was not a light undertaking. I soon discovered upon embarking on the design and engineering phase that the expense and complexity of realizing linear motion in two directions is not to be underestimated. Many design iterations to engineer the sculpture's movements were attempted over many months, until finally arriving upon what is (and often so with complex problems) the simplest solution. Speaking with an engineer, who more importantly is also a sailor, I realized the elegance of a winch. Its circular winding translates into linear movement when hoisting a sail up a mast. Similarly for this project, the servo motor rotation winds and releases a cable spooled around it. The ends of this wire attach to opposing ends of a straight wooden support spine that is mounted to a linear drawer slide, which acts as a track for this spine to glide upon. Rotating the motor spool clockwise (when viewing the spool mounted to the motor top) propels the spine mechanism backwards; counter-clockwise moves it forward.

*Figure 2.0: Mechanics during installation, 2008*

The other complex problem was devising a solution that would allow for the support of the acrylic skin throughout its forward and backward movements and not hinder its visibility. I knew I wanted to have a sufficient distance of travel that would generate distinct and unique forms of the sculpture and provide deconstructive space for the projected imagery. From experimentation, I decided the minimum distance necessary

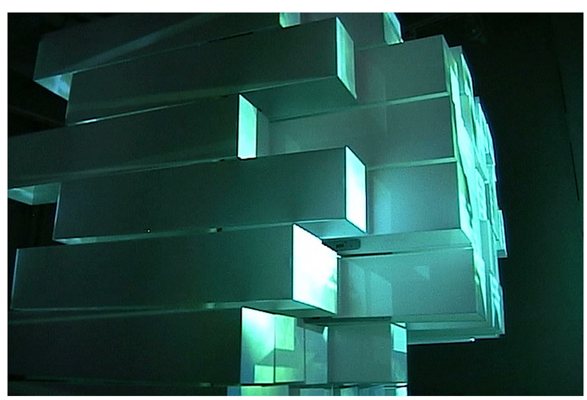

*Figure 2.1: Chiasmus Exhibition, 2008*

between extremes was 24 inches. I wanted to avoid a horizontal “shelf” as support and have the cube forms float in space. This would allow individual movements of the cube forms to hide or reveal its neighbors, depending upon the perspective angle of the observer. Removing the “top” and “bottom” sides of the cube, leaving only the four vertical sides and centralizing the mechanics within the hollow of the cube, accomplished this. With this configuration, the cube is free to move to the extreme limits of the horizontal slide mechanics.


*Figure 2.2: Motor, slide and spine support assembly, 2008*

The motor used to position each individual cube is a Hi-Tech HS-785B heavy-duty sail winch servo motor. It has strong Karbonite gears that provide for accurate positioning and repetitive use. It also contains an integrated circuit to provide a strong standing torque which was crucial for this project. It can accomplish 3.5 rotations (1260º total) with a stall torque of 183 oz/in operating at 6 volts.

What is great about this particular motor is its ability to turn three full rotations in either direction with incredible positioning accuracy. Where other motors failed was in their inability to hold a “stall current” for any length of time. The originally developed code would send a pulse-width modulation current (PWM) to move the motor to a particular coordinate and then another PWM to hold the motor rotation still in that required position. This not only required a considerable amount of additional code, but over time the cube form would pull itself out of alignment. This ultimately caused the motor to strain against the mechanical stops of the slide mechanism and pull the entire form out of calibration.

The PWMs are controlled and messaged to each individual motor through the Parallax

Servo Controller (PSC) Board. Sixteen motors are attached to each unit and two units can be networked together to allow for the control of 32 motors over one I/O serial line from the microcontroller. For this project, there is a total of four PSC board units with individual power running to each from four 150W, +5V @ 30A power supplies.

The microcontroller is a Parallax BASIC Stamp 2px Module. I chose this chip because of its processing speed and the 128-bytes of Scratch Pad RAM memory that was crucial to store incoming serial data from the video analysis program.

Linear motion of the cube forms was accomplished mechanically with the connection of two 16-inch horizontal drawer slides mounted on top of each other in opposing directions. They provide smooth movement plus precision through rubber stops with 12-inches of horizontal movement. Attached together in this way, they allow for a total of nearly 24 inches of linear travel.

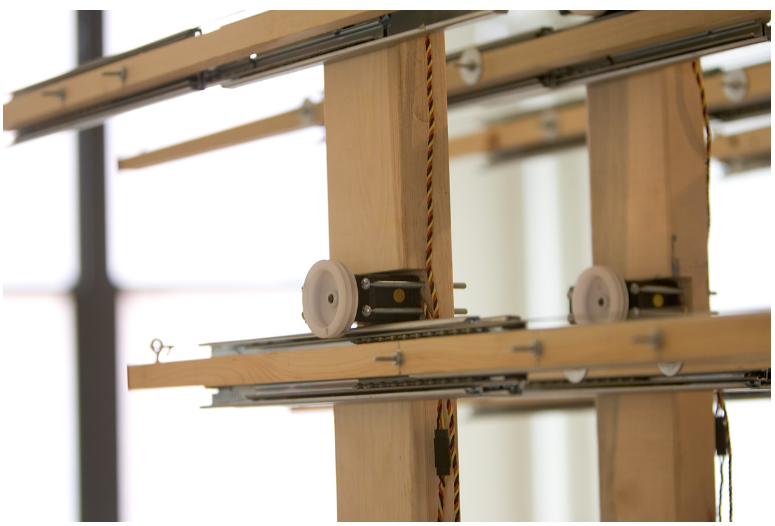

*Figure 2.3: Motor, spool, spine and slide detail, 2008*

Mounted to the drawer slides is a 36-inch square wooden dowel that acts as “spine” to hold and support the acrylic cube.

The acrylic cube is 0.25-inch thick with a dimension of 8x8x36 inches, collared around the central support stud and attached to the horizontal support spine.

A 2-inch plastic spool is attached to the motor shaft. Wire rope is wrapped around this and mounted to eyehooks on the front and back of the dowel, with oval couplers on both ends of the wire controlling tension.

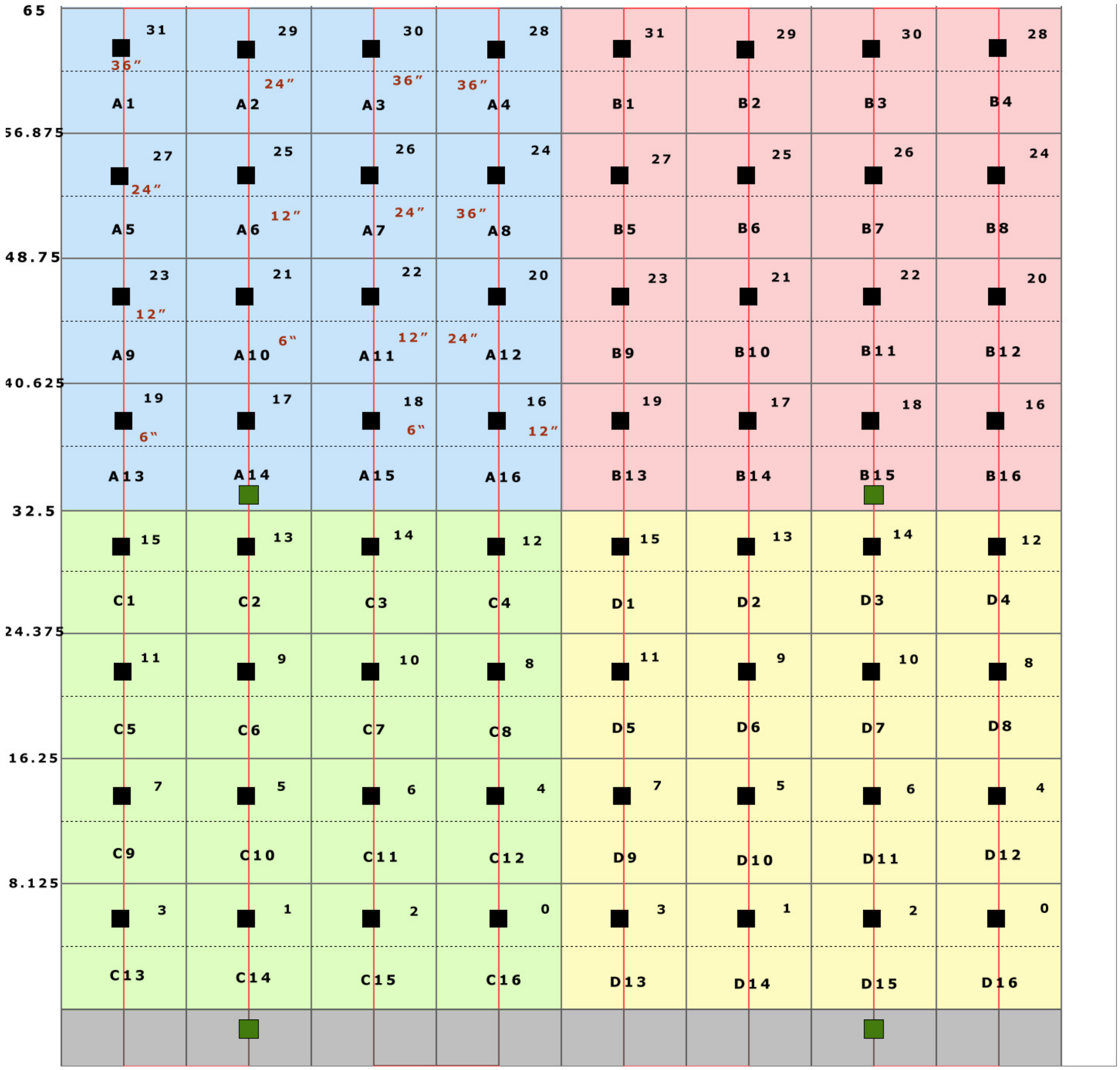


*Figure 2.4: Wiring diagram illustrating motor pin position and distance to PSC board*

## Video Analysis Software:

I employed the graphical programming language max/msp/jitter to develop the program that analyzed the video luminance and controlled the serial messaging to the Basic Stamp microcontroller. I wanted to evaluate the video for average luminance values and translate these values into three distinct motor positions.

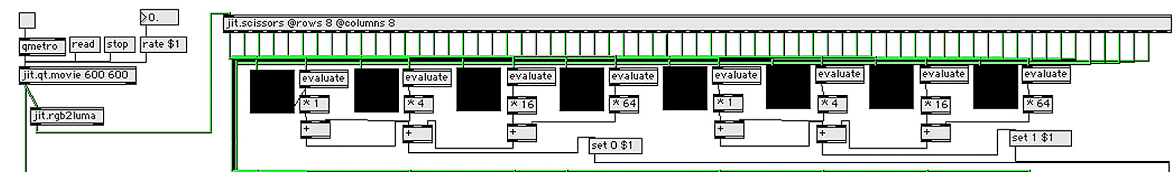


*Figure 2.5: Video Analysis Software, Level 1*

The incoming video is first processed by the jitter object *jit.rgb2luma*. This converts the color space of the video into a single plane grayscale image for easier evaluation upon the 0 (black) to 255 (white) luminance scale. This new grayscale video signal is then partitioned into a matrix of 64 distinct elements (8 rows and 8 columns) with the *jit. scissors @ rows 8 @ columns 8* object to correspond to the 64 physical cube forms of the sculpture. This slicing into distinct, individual matrices allows for the analysis of each segment and the ability to provide the motor coordinate message for each motor. This was accomplished with the custom *evaluate* subpatch.

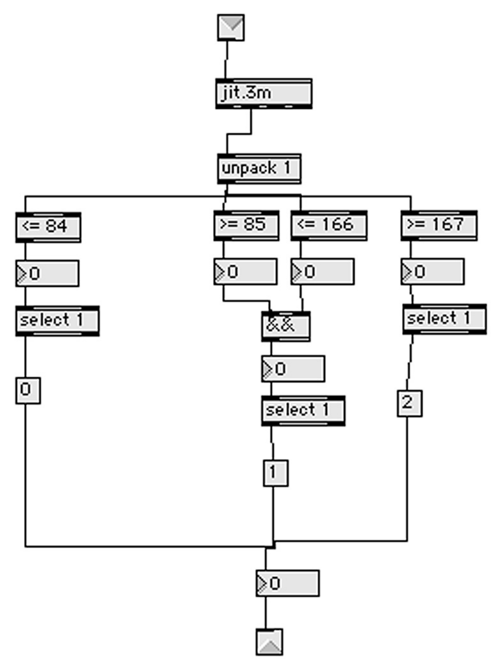


*Figure 2.6: evaluate object detail*

The pixel values sent from the *jit.scissors* object into the *evaluate* object are first evaluated with the *jit.3m* object. This object sends the mean pixel values out the second outlet from the left, which are then made available for further analysis with the *unpack* object. As I only wanted to create three distinct motor positions, I needed to evaluate this new mean value upon a three-part scale and accomplished this with the comparison functions. Values ranging from 0 to 84 would correspond to black values, values from 85 to 166 would correspond to grey, and values greater than 166 would correspond to white. The comparison object evaluates true comparisons as "1" and false as "0". The select 1 object is looking for a true message and passes another number message when this occurs.

- The <=84 object passes a message of "0" when it evaluates as true.
- The >=85 and <=166 objects are compared together and pass a message of "1."
- The >=167 object passes a message of "2".

These new values provide easy binary conversion to simplify the serial message sent to the microcontroller. Whichever value is evaluated as true as the measure of the mean pixel value is passed back into the main patch.

### Bit Packing

I decided to pack the evaluation data to simplify the messaging and reduce the number of bytes sent out to the microcontroller over the serial cable, thereby speeding up the process and responsiveness of the motors. Operating on the crumb level, I took four values from the scissored matrix areas and combined them to produce one single value. This was accomplished by simple arithmetic. I took the first value and multiplied by 1, the second by 4, the third by 16 and the fourth by 64, and added these values together to create one sum. Doing this packed the bits into their respective positions for extraction on the microcontroller.

This total sum is then stored with an addressable index number in the table object by the set message. The table acts as an indexed array, storing the 16 bytes (4 motors to a byte X 64 motors) that are sent to the microcontroller.

### Serial

The metro object, acting as a timer, controls the table object by sending a "dump" message to it at a rate of 420 milliseconds (0.42 seconds). This clears the table's memory and sends the stored values out through the serial object set at a 9600 baudrate for effective communication with the microcontroller.

## Bit Shifting in PBasic:

This project requires sending luminance information as values over a serial cable from software that determines the image luminosity, to a microcontroller that contains a program which controls the positioning of 64 individual motors. Therefore, the program stored on the microcontroller must accept values sent to it and parse this information into single coordinate positions, which are then sent as individual messages to each appropriate motor in the linear PBasic style. In order to control memory capacity, speed and responsiveness, I realized packing information to streamline the original message would be necessary for increased performance. In order to accomplish this, I decided to incorporate bitwise operations into the program.

By design, I decided that only three distinct motor positions would control the movement of the individual sculptural cubes (fully recessed, centered and fully extended), which made it possible to use single digits as values to coordinate motor rotation. A "0", "1" and "2" would substitute as variables for the PWM (Pulse-Width Modulation) frequencies that the motors require for movements, and these values translate into binary very nicely: "0" = binary 00, "1" = binary 01, and "2" = binary 10.

PBasic has inherent functions to save nibbles (4-bits) and a single bit, but not crumbs (2-bits). So, my first experiments were packing two motor positioning messages into one byte (2 nibbles = 1 byte or 8-bits) and sending this 32-byte message from the jitter program to the microcontroller. Once received, the microcontroller would sort this message into memory and break apart the byte into its nibbles, which would translate into either the "0", "1" or "2". Two motors could be controlled by one byte of information respectively. This was still slow, both to transmit the message over the serial cable and to send the messages to the motors sequentially. In a 16-motor experiment, the last motor in the series was delayed between 5 -10 seconds. This would only get exponentially worse by adding 48 more motors.

With this challenge, it was apparent that further packing and unpacking was necessary on the crumb level. Doing this would allow for a byte, once extracted, to produce four distinct numbers and therefore control four different motors. The following code was extracted to illustrate the program's abilities.

## Code Snippet:

```
mask(0) = 3
mask(1) = 12
mask(2) = 48
mask(3) = 192

shift(0) = 0
shift(1) = 2
shift(2) = 4
shift(3) = 6


INTRO:
SERIN 16, 16780, [SPSTR 16]
FOR index = 0 TO 7
GET (index), Sdata(index)
NEXT

MAIN1:
FOR index = 0 TO 3
temp(index) = Sdata(0) & mask(index) >> shift(index)
NEXT
GOTO MOTOR1

MOTOR1:
Branch temp(0), [A1_1, A1_2, A1_3]
A1_1:
pw = 850
SEROUT 15, Baud+$8000, ["!SC", 15, 0, pw.lowbyte, pw.highbyte, CR]
GOTO MOTOR2
```

## Breakdown:

DECLARED VALUES

```
mask(0) = 3
mask(1) = 12
mask(2) = 48
mask(3) = 192
```

These values are loaded into the mask() array and will operate as masks using the & operation. (See Bitwise Operations section for more explanation.)

```
shift(0) = 0
shift(1) = 2
shift(2) = 4
shift(3) = 6
```

The shift() array holds values that are used to “shift” the bits.

```
INTRO:
SERIN 16, 16780, [SPSTR 16]
```

The “INTRO” section of the program is used initially to bring in the values from the serial cable and store them into an accessible memory structure. The “SERIN” function is used to read values on the serial with a baud rate of 9600 (the BASIC Stamp 2px Module chip uses 16780 as this translation). In this case, it is looking for a 16-byte message. The [SPSTR 16] function will write each individual byte to an address in scratchpad ram starting at index 0.

```
FOR index = 0 TO 7
GET (index), Sdata(index)
```

The FOR loop structure will retrieve the first 8 bytes of data from the scratchpad ram and load the values into an 8-byte array called Sdata.

```
NEXT
MAIN1:
FOR index = 0 TO 3
temp(index) = Sdata(0) & mask(index) >> shift(index)
```

## Bitwise Operations

This section is extremely important. Once again, a FOR loop set to loop 4 times, loads the first byte in the Sdata array (index 0), parses the value into the 4 crumbs with the mask and shift arrays, and saves into a temp array. EXAMPLE: During the first loop, index will equal “0” so the function will read as; the first byte in the temp array, temp(0), will equal the value derived from taking the value stored in the first byte of the Sdata array (Sdata(0)) and applying the “&” operation with the first byte in the mask array (mask(0)), which is 3. The result is then shifted to the right by the value stored in the first byte of the shift array (shift(0)), which is 0. This resulting value will either be a “0”, “1” or “2”. If the byte value stored in Sdata(0) were 100, the operation would work thusly:

100 in binary is 01100100 and 3 is 00000011
temp(0) = 01100100 & 00000011 >> 0

```
        01100100
&       00000011
        00000000 >> 0 = 00000000
```

temp(0) = 0

temp(1) = Sdata(0) & mask(1) >> shift(1)
temp(1) = 01100100 & 00001100 >> 2

```
      01100100
&     00001100
      00000100  >> 2 = 00000001
```

temp(1) = 1

temp(2) = Sdata(0) & mask(2) >> shift(2)
temp(2) = 01100100 & 00110000 >> 4

```
      01100100
&     00110000
      00100000 >> 4 = 00000010
```

temp(2) = 2

temp(3) = Sdata(0) $ mask(3) >> shift(3)
temp(3) = 01100100 $ 11000000 >> 6

```
      01100100
&     11000000
      01000000 >> 6 = 00000001
```

temp(3) = 1

```
NEXT
GOTO MOTOR1

MOTOR1:
Branch temp(0), [A1_1, A1_2, A1_3]
```

The Branch function will switch to a subroutine based upon the byte value in temp(0) to control motor position. If the value is "0", the subroutine "A1_1" will run; a value of "1" will run "A1_2" and "2" for "A1_3". In our example, temp(0) has a value of "0" so the "A1_1" subroutine will run.

```
A1_1:
pw = 850
```

The value "850" is set to the variable pw. This value is used for PWM to control motor positioning. It is called and defined in each subroutine to conserve memory.

```
SEROUT 15, Baud+$8000, ["!SC", 15, 0, pw.lowbyte, pw.highbyte, CR]
```

This function sends the position message to the appropriate motor, in this case the motor control board on serial line 15 and the motor on pin 15.

```
GOTO MOTOR2
```

This moves the program through to the next motor and continues the linear series.

## Exhibition:

The public exhibition of Chiasmus premiered on April 4, 2008 and continued through April 5, 2008 within the South Gallery section of the Great Space Gallery, located on the Fifth Floor of the CUPPA Hall building, University of Illinois at Chicago, 400 S. Peoria Street in Chicago.

Installation began on April 1 with the construction of the support skeleton. Paramount during this process was providing ample support and stability for the fully completed sculpture as its combined total weight is estimated to be 400 lbs.

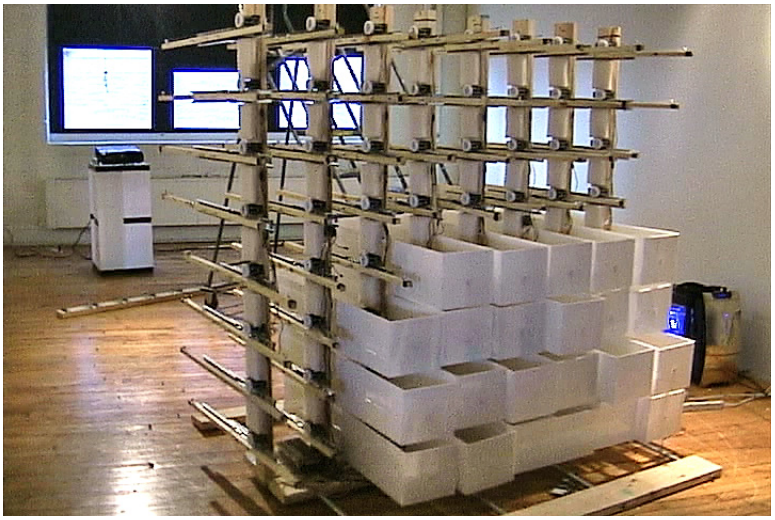

*Figure 3.0: Chiasmus during installation, 2008*

*Figure 3.1: Chiasmus Installation, 2008*

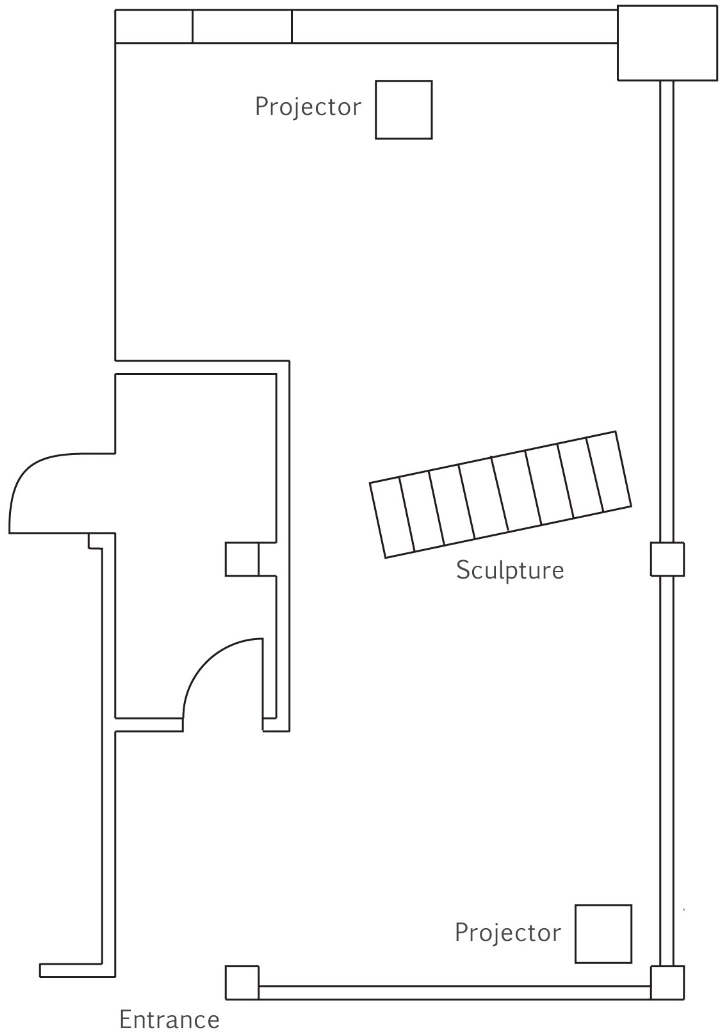


*Figure 3.2: Gallery Exhibit Floorplan*

The gallery size only allowed for a 270º angle of viewing around the sculpture, but this did not appear to pose any significant conceptual problems. The projectors were set at opposite ends of the volumetric screen and adjusted to the center of the sculpture's height. This was done to project light straight onto the surface and minimize shadowing once the volumetric screen was mobilized.

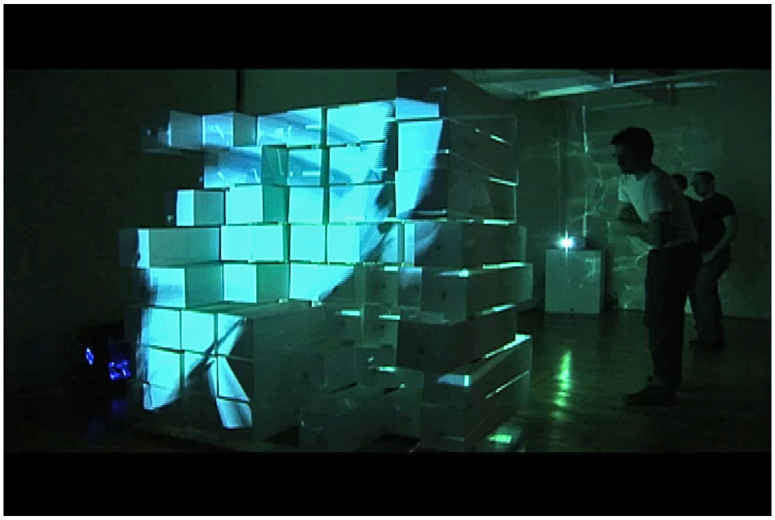

*Figure 3.3: Chiasmus Exhibition, 2008*

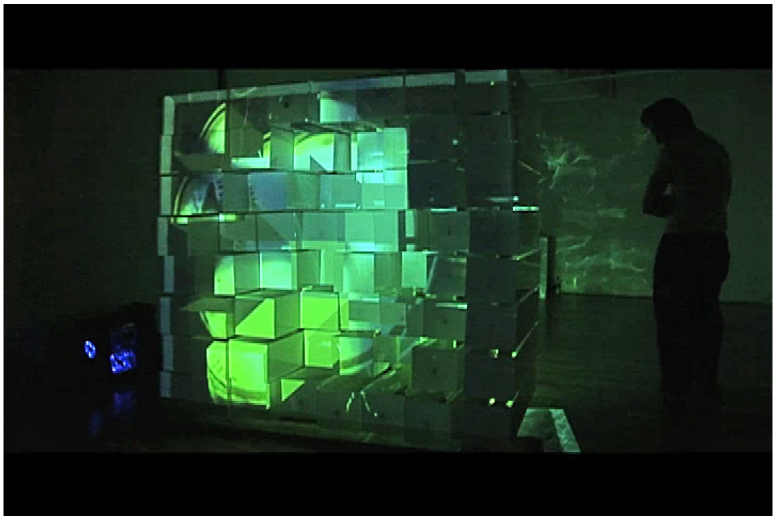

*Figure 3.4: Chiasmus Exhibition, 2008*

An unanticipated and interesting byproduct of the piece was the amount of reflectance the individual cube forms created, casting shimmering light patterns around the gallery space.

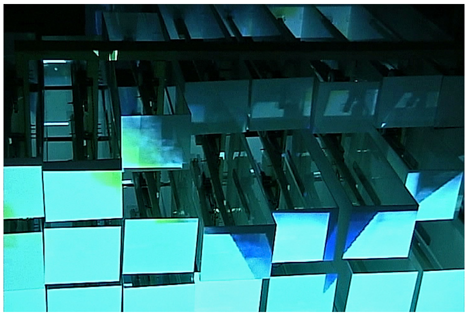
Figure 3.5: Chiasmus Exhibition, 2008

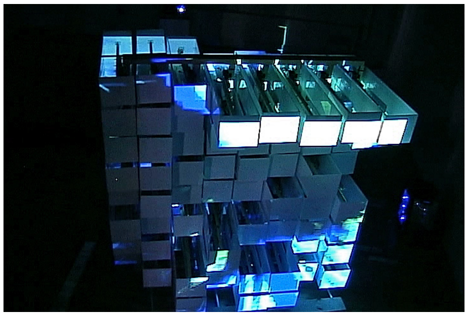
Figure 3.6: Chiasmus Exhibition, 2008

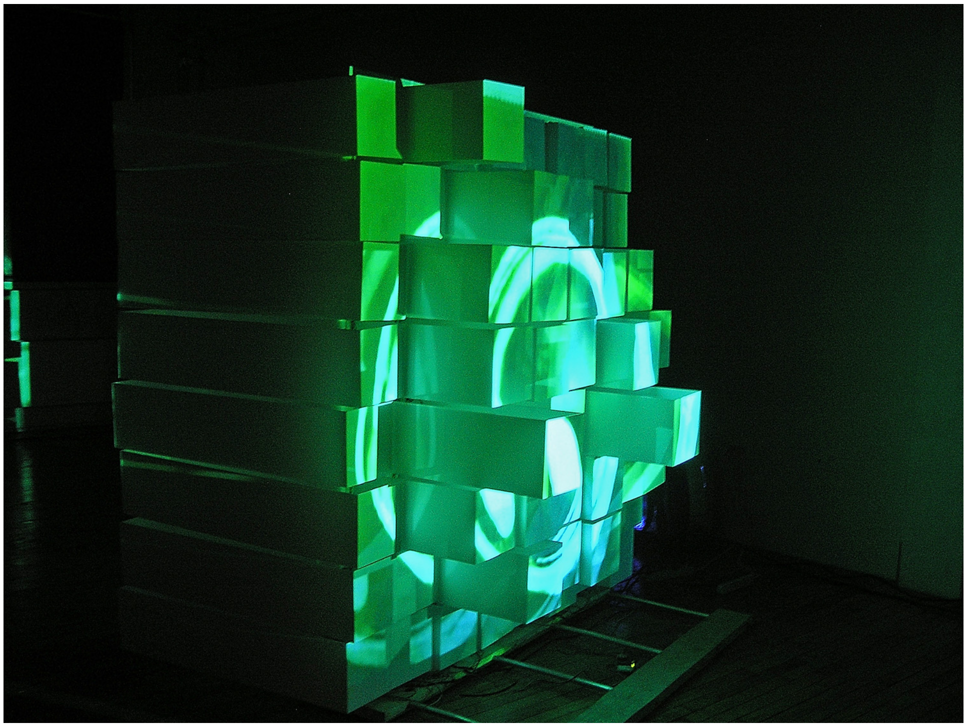
Figure 3.7: Chiasmus Exhibition, 2008

## Conclusion:

Overall, the installation and exhibition of this project went smoothly and was well received. Especially enjoyable for me was the moments where the projected imagery appeared to carve out large volumes form the sculptural surface and the sculpture generatively positioned itself into unexpected and dynamic forms. From this experience, I would like to experiment more with the video sources in the future and discover other modes and visual connections to the sculpture's movements.

The difficulty I experienced with engineering a piece of this size and complexity was maintaining precision. The choice of wood as the supporting material worked financially, but had too great of a tolerance and eventually created alignment problems. It was initially estimated within the design to allow for 0.25-inch gaps on all sides of each cube form. This was done to allow for some expected building tolerance as well as any slight cantilever effect from the linear movements. Ultimately, slight warps and flex in the wood pieces, especially the support spines, pushed some cubes closer together during their movements and pulled others apart. Over time, this created wear and prevented some cubes from moving properly. To prevent this, another choice of support material is necessary in future builds such as aluminum truss. With this, creating precise 90º angles is possible allowing for better stability and long-term use. This rigidity will also create a more uniform spatial presentation of the sculpture's surface

There was some concern with the amount of noise the motors would generate in the space. Attempts were preemptively made to dampen this effect, but applying egg crate foam to the vertical support beams above and underneath each motor. It is uncertain what effect this eventually had, as the motors were still very audible, but potentially was not necessary. The sounds the motors did produce were not only a secondary signifier of the movements but were interesting and compared by some observer's to the sound of moving water or crashing waves.

I would like to show this work more in the future, but space is a significant concern for the installation of this project. The South Gallery where Chiasmus was installed for this exhibition is almost 650 square feet. Each projector is at an approximate distance of 12 feet from the sculpture's surface, totaling 27 feet when factoring in the 3 feet depth of the sculpture itself. This space with its configuration only allowed for a 270º rotational movement around the sculpture because of its placement against one wall. This was done to allow for a large enough gap between the sculpture and the other opposing wall for viewers to comfortably move through. This limit on perspectives did not appear to pose a major problem, but providing more room on this opposing end is desirable to prevent this area from becoming a simple passageway. It was this perspective that personally became the more interesting angles to view the piece and I would like to showcase it more.

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