

POLYRHYTHMS AND ARCHITECTURE

by

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Thesis submitted to the Faculty of the Virginia  
Polytechnic Institute and State University in partial  
fulfillment of the requirements for the degree of

Master of Architecture

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December 2003

Alexandria, Virginia

## **POLYRHYTHMS AND ARCHITECTURE**

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### **ABSTRACT**

This paper is an investigation of polyrhythms and their practical application in architecture. It includes a musical definition of the term “polyrhythms” and application of these theories into a design for a multi-story, urban, residential structure to serve Georgetown Law School in Washington, DC with accessory retail and parking components.

*Special Thanks to my advisors Susan Piedmont Palladino, Paul Emmons and Marco Frascari  
for their perseverance and to Nigel Hiscock and Peter Pippin for their guidance and inspiration*

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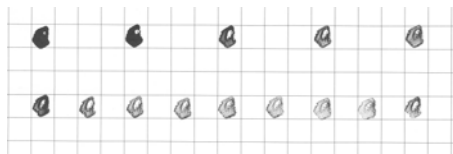
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*“Musicians, designers and dancers and scholars seem to agree that the perception of rhythm is not reducible to the kind of periodic repetition produced by a metronome. It is corporeal and mental activity that on one level acknowledges periodic repetition while on another consciously moves to push, pull, syncopate, disrupt and shift...regular repetition. It is actually experienced as an irregular pattern.”*

**Kent Bloomer, The Nature of Ornament**

# Polyrhythms

To define **polyrhythms**, it is necessary to establish a definition of “rhythm”. The original Indo-European word meant “to **flow**”. Flow requires movement and rhythm requires repetition. Using the standard meaning of the prefix “poly”, polyrhythm would mean “many rhythms”. The pattern created below would technically qualify as a polyrhythm but does not convey the richer meaning that the word has come to suggest. This example shows a second rhythm acting as an even subdivision of the first.



“Sharply contrasting rhythms” is one dictionary definition of polyrhythms <sup>1</sup>. Musicians might disagree with this definition because it fails to recognize the integration of the multiple rhythms that often cannot stand on their own. The importance of the concept is predicated on the contrasting yet complementary aspects of the music.

African rhythms are performed by large groups often in the context of a social event. The group consists primarily of drummers with various types of drums along with a much smaller contingent of stringed or wind instruments. In African music, the embellishment of the rhythm is more important than variations on the melody. The rhythms the drummers play is stratified based on complexity. A “bell” pattern is supplied by one member and is unchanged throughout the piece. Other rhythms are overlaid with the lead drummer responsible for starting the group and providing variations.

*vamp under atsimewu, sogo, kidi*

Written examples of polyrhythms from Ancient Traditions-Future Possibilities

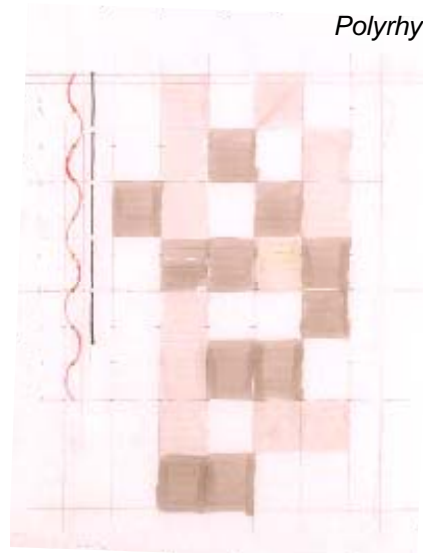
failure is possible because the  $\square$  defines a square and a sq. is inherently unstable  $\infty$  when the structure (vs beam) fails what if tension & compression members are placed to arrest the direct movement of failure.

if all vectors are = the no movement occurs? and the unbalanced lengths are divided in 1/2

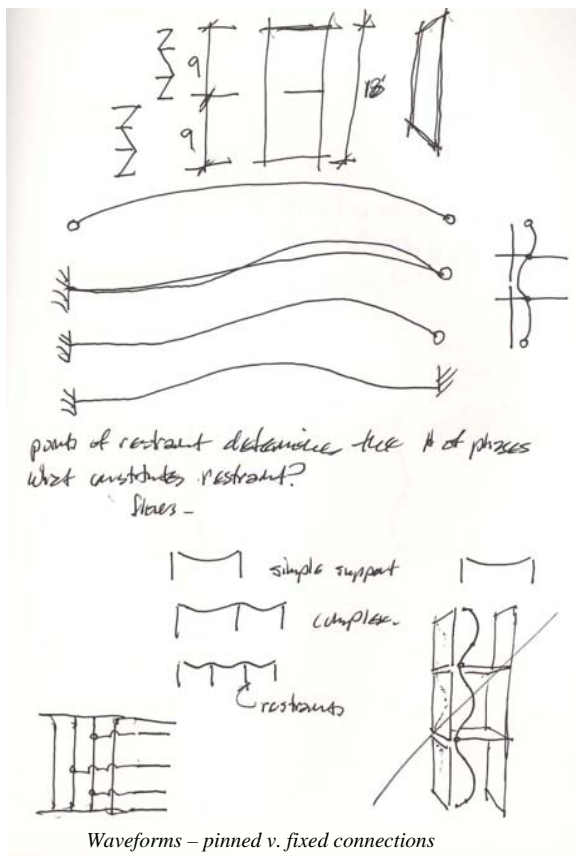
Polyrhythms are dependent on each other, they span the same space but do it together & equally.

"A regionally popular Albanian musician was visiting Austria and was taken to a performance of **Beethoven's 9th Symphony**. At the end of the concert the musician was asked what he thought of the piece. '**Fine**' he replied, '**but very, very plain**'.<sup>2</sup>

To some Western ears Beethoven's 9th Symphony exemplifies a richness and complexity not matched in the musical world. How could anyone possibly consider this piece plain? To understand this viewpoint, it is necessary to review the two basic elements of music and the weight given to each. To the Western ear, melody stars in a composition with the rhythm acting in a strictly supporting role. But in different parts of the world rhythm is the defining element in music. Although Beethoven's symphony is rich *melodically*, it is fairly simple *rhythmically*.



Visual polyrhythmic pattern



There are two main types of polyrhythmic construction; divisive and additive.

Popular in Western Africa, **divisive** polyrhythms are developed through overlapping two patterns, resulting in a third, deeper pattern that can be experienced from either of the individual rhythms or the combination of the two.

In mathematical terms, polyrhythms are reduced to a comparison of two, non-relative primes (numbers that don't have a common divisor) Expressed as a ratio (3:2, 4:5, etc.) and referred to in terms of contrast (three against two, four against five, etc.) this helps describe how the musicians understand the music themselves.

Melody also has its ratios as first described by Boethius in his descriptions of melody as performed on a monochord (an instrument with a single string) during the fall of the Roman Empire.<sup>3</sup> The terms diatonic, pentatonic, etc. are ways of describing the mathematical relationships of a vibrating string, or column of air that produce harmony. Some of these same mathematical ratios are found in Western Music, but in the melody rather than the rhythm. The frets of a guitar divide the length of a string into a ratio of whole numbers, similar to the ratios used to describe polyrhythms.

Another polyrhythmic approach to music can be described as “**additive**”. Rather than dividing a rhythm into separate parts, the rhythm is created in discreet groups that are added together. Variations on these additions produce contrasts as they are played concurrently. The most common way of explaining these is to use simple mathematical diagrams. The standard “measure” of this music is 12 beats. In polyrhythms, as in math, there are many variations that can be combined to add up to 12. If we consider an accented, or louder, note as the beginning of one of these groups, we could use a group of triplets to fill a measure and its mathematical diagram would be:

3+3+3+3

in standard musical notation:



Another pattern would be:

3+2+3+2+2



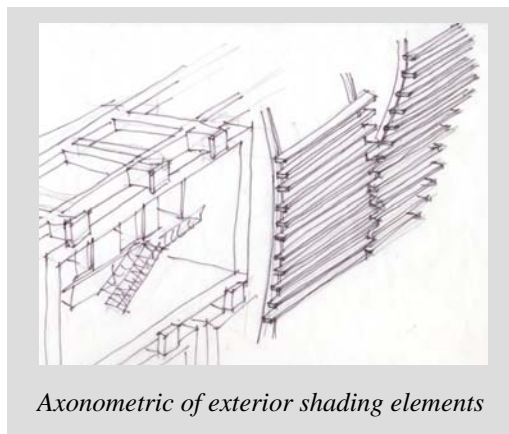
and

2+2+3+3+2

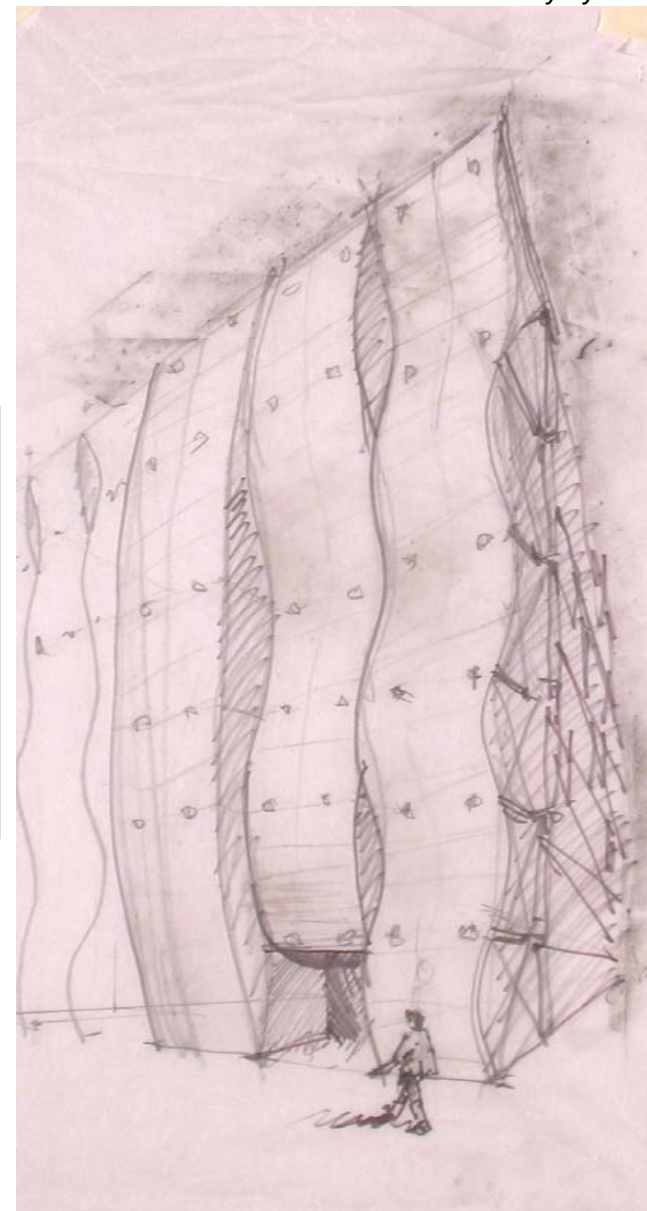


and so on. Voiced differently, these patterns could be played concurrently with each sound and rhythm contributing to a quite different sound and rhythm as a result.

**Additive and Divisive** polyrhythms have provided the basis for the development of music throughout much of the world. As the music has developed so too has culture. Both have informed each others’ progress to become inextricably linked in the societies that perform this music.



*Axonometric of exterior shading elements*



*Perspective of south face showing undulating glass strips.* 4



# *Polyrhythms in Architecture*

“Architecture, in general, is frozen music”<sup>4</sup>. music, in particular rhythm, suggests movement. Just as a single column can hold nothing effectively, a single beat is simply a noise. When used in multiples both the columns and the beats impart a useful rhythm.

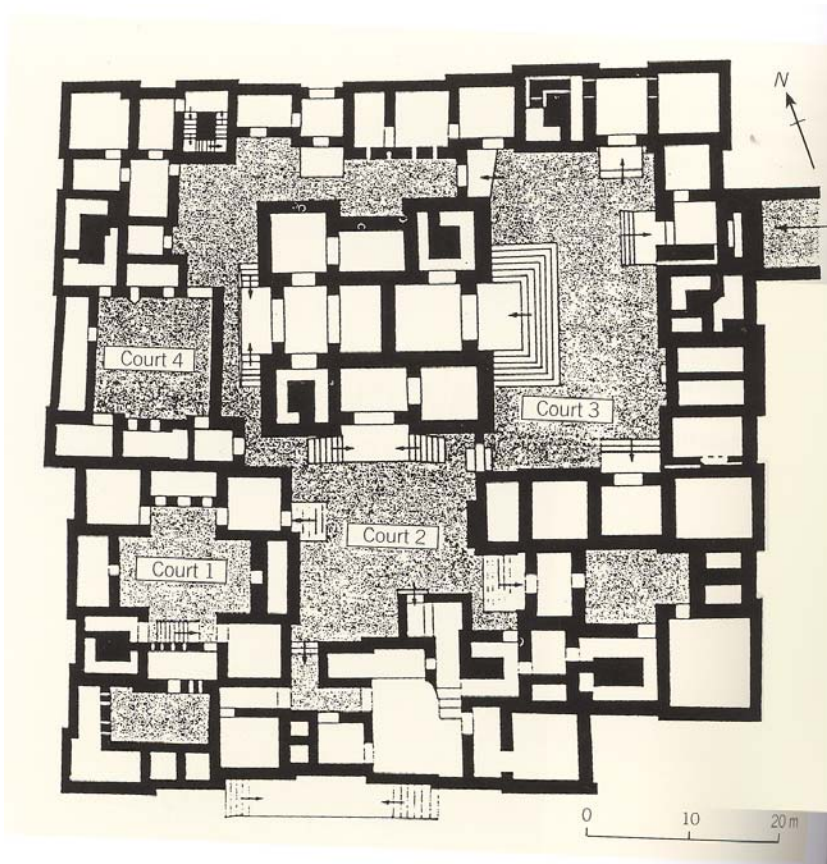
In using polyrhythms to develop a structure, one might look to the sound and social aspects of drumming as a guide. By doing so, the tactile, visual and auditory components of the building become primary to the design.

Experiencing polyrhythms visually can take a number of forms, like a static pattern, observed and experienced **as the eye moves across the pattern**. Or, a pattern spread out over time which, requires a static viewer and the object in motion; for example, flashing lights coordinated with each other creating a pattern that is experienced in the mind, through the eye.

Polyrhythms can also be experienced through touch; **movement becomes an integral part** of this experience either by the object imprinted with polyrhythms or by the person who experiences it.

The core tenets of performing polyrhythmic pieces can be translated into concepts that can be carried into an architectural investigation. These tenets include the following:

*Design drawing for polyrhythmic ribbons*



*Palace at Dungur, 6th Century A.D. Visual example of polyrhythms. Although the central space provides a place of importance, the size and character of the spaces does not change. From Early Art and Architecture of Africa.*

**•Listen and Respond to Others**

The western orchestra is a large organization that requires formal rules to produce the results that the composer or conductor wishes. Spontaneity is not encouraged. Polyrhythms as performed by a West African ensemble, more closely resembles a jazz sensibility in stressing some degree of spontaneity responding to the theme that has been developed.

**•Suppress Hierarchy**

In African drumming virtuosity is unwelcome. The group leader might best be described as “the first among equals”. The sharpest difference between the European and African notion of music can also be applied in the practice of architecture. The European music is often framed around the idea of a virtuosi either as a composer or soloist (instrumental or vocal) where the orchestra plays a subdued, background role.

“ A rhythm which cuts and defines another rhythm must leave room for the other rhythm to be heard clearly, and the African drummer concerns himself as much with the notes he does not play as with the accents he delivers.”<sup>5</sup>



*Decorated Pot from the Cemeteries of Calabar, Visual Example of Polyrhythms. Note a similar rhythmic dot pattern that moves from foreground on the left side of the pot to background on the right. From Early Art and Architecture of Africa.*

•**Provide Transparency**

A polyrhythmic music performance provides a forest of rhythm that may baffle the uninitiated. To the performer, the same music provides a series of semi-transparent planes that are arranged so that they may be viewed through and understood individually, but fully developed as an integrated whole.



*Wall detail, Old Church of Debre Damo, Ethiopia. The rich integration of elements provides a visual and physical interdependence. From Early Art and Architecture of Africa.*

•**Interdependence**

Orchestral performance often consists of “melody” and “harmony” parts. When disassembled the melody can stand alone and be recognized. The harmony parts, on the other hand, are often unrecognizable when separated from the melody. Polyrhythms, however, require that all parts depend on each other to create the whole.

In Africa, music is not only interdependent with the other musicians but with the social context as well. An ethnomusicologist was making recordings for his research and asked if a group of musicians could sing the song their group used to heal the sick. The tribesman looked at each other, each hoping that the other could understand the request. Then one turned to the ethnomusicologist and said, "but no one is sick."

•**Focus on the Unit before the Whole**

Musicians trained in western music often have difficulty playing polyrhythmic pieces because the music needs to be understood from a different point of view. The expectation is that by playing their part the whole will emerge and create its own momentum. The reality is that the momentum of the whole is only possible by a stern focus on the individual components.



*Ghanain weaver creating the narrow patterned elements that are combined to create a larger cloth.*



*The large cloth is made up of discreet strips woven individually and then assembled side by side to provide the finished garment. Wrapper, Asante peoples, Ghana, Mid 20th century, Silk, synthetic dye  
H x W: 209.6 x 130.8 cm (82 ½ x 51 ½ in.), National Museum of African Art, National Museum of Natural History, purchased with funds provided by the Smithsonian Collections Acquisition Program, 1983-85, EJ10583  
Photograph by Franko Khoury National Museum of African Art, Smithsonian Institution*

# Rhythm and Work

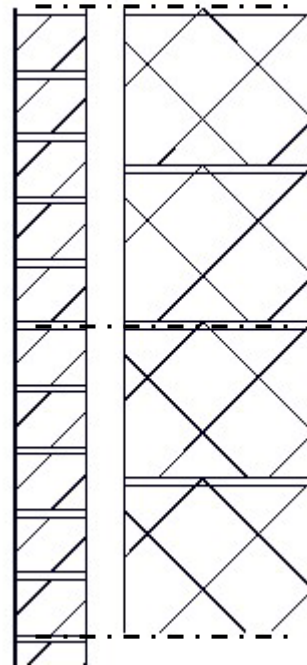
"Work songs had long been part of African and African American tradition. Singing and the playing of rhythmic instruments accompanied field labor in agrarian West Africa. In the United States, work songs coordinated the complex timing of ship-loading gangs and the men who straightened the railroad tracks twisted by the broiling summer sun. In the Southern prison system, work songs served to pace the men who hoed and chopped, to mediate between the strong and the weak, to pacify the prison bosses, to amuse, console, and dignify the men who worked every day from sun up to sundown under the eyes of armed guards." <sup>6</sup>

Sea shanties are divided into *short-haul*, *halyard*, and *capstan* shanties depending on the difficulty and duration of the task.

*Short-haul* shanties were used for tasks that took but a few moments but required coordinated strength to accomplish like trimming sails, for example.

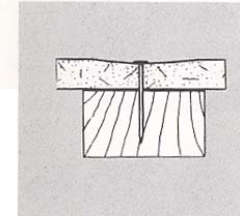
A *halyard* is the line used to hoist a sail. The work may not require more physical strength than the task subject to a *short-haul*, but will take longer to accomplish. So a slower tempo would be in order.

The *capstan* is a large winch that requires the back strength of a great number of sailors to turn. The *capstan* was most often used to weigh, or hoist the anchor. This long, arduous task required strength and endurance necessitating the use of a song with a steady tempo rather than a punchy tune like the *short-haul* needed for short bursts of work.

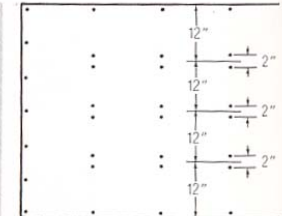


## Single-Nailing Application

1. Drive nails at least  $\frac{3}{8}$ " from ends or edges of gypsum board.
2. Position nails on adjacent ends or edges opposite each other.
3. Begin nailing from *center* of board and proceed toward outer ends or edges.
4. When nailing, apply pressure on board adjacent to nail being driven to insure that board is in tight contact with framing member.
5. Drive nails with shank perpendicular to face of board.
6. Use a drywall hammer with crowned head for gypsum *panels*.
7. For gypsum *panels* (drywall), seat nail so head is in a shallow, uniform dimple formed by last blow of hammer.
8. Do not break paper or crush core at nailhead or around circumference of dimple by over-driving. Never use a nail set. Depth of dimple should not exceed  $\frac{1}{32}$ ".
9. For veneer *base*, set nailheads flush with the base surface. *Do not* dimple.



Proper dimpling of nailhead



Double-nailing in field of board

*Polyrhythmic nailing pattern from Gypsum Construction Handbook.*

*Brick & Block Masonry wall using "economy" bricks where 5 bricks equal 2 blocks.*

“ As an institution, music itself provides a basis for thinking about and ensuring the integrity of a group, like a symbolic characterization of a person’s heritage. So it was, legend has it, that a long time ago some African stevedores, who had their own songs for their work of loading and unloading boats, first understood a machine to be the white man’s music.”<sup>7</sup>

“...I soon got used to this singing, for the sailors never touched a rope without it. Sometimes, when no one happened to strike up, and the pulling, whatever it might be, did not seem to be getting forward very well, the mate would always say, “Come men, can't any of you sing? Sing now and raise the dead.” And then some one of them would begin, and if every man's arms were as much relieved as mine by the song, and he could pull as much better as I did, with such a cheering accompaniment, I am sure the song was well worth the breath expended on it. It is a great thing in a sailor to know how to sing well, for he gets a great name by it from the officers, and a good deal of popularity among his shipmates. Some sea captains, before shipping a man, always ask him whether he can sing out at a rope.”<sup>8</sup>

Different cultures have demonstrated similar approaches to the coupling of music and labor. Tweed has been made on the Isle of Harris since time immemorial and the practice of tweed waulking has been linked with this fine cloth since its early development. After weaving the material, the bolts are soaked and stretched by hand. The most common method of stretching is to have the workers sit around a table with a long piece of continuous cloth held among them. In rhythm they grasp the cloth, alternately bringing their hands together to pass and then moving them apart to stretch the fabric. Passing the material around in a circle creates a rhythm of hand movements as they hit the table.

In Newport News, the task of caulking between the planks of a ship was a tedious job, often held by members of the black community. To relieve the tedium, and speed the work, the workers would sing in a rhythm that would match a halyard shanty tempo; music for repetitive tasks that take a long time to complete. It was recorded that at one point, the ship owner was on site and was irritated by the singing and asked that the foreman stop the workers from singing. **The efficiency declined so dramatically that before the owner left, the workers were given the go-ahead to sing as they worked.**<sup>9</sup>

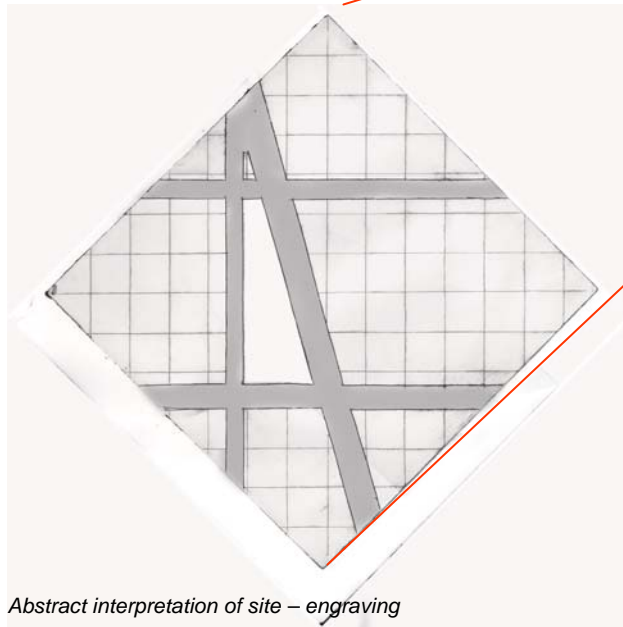
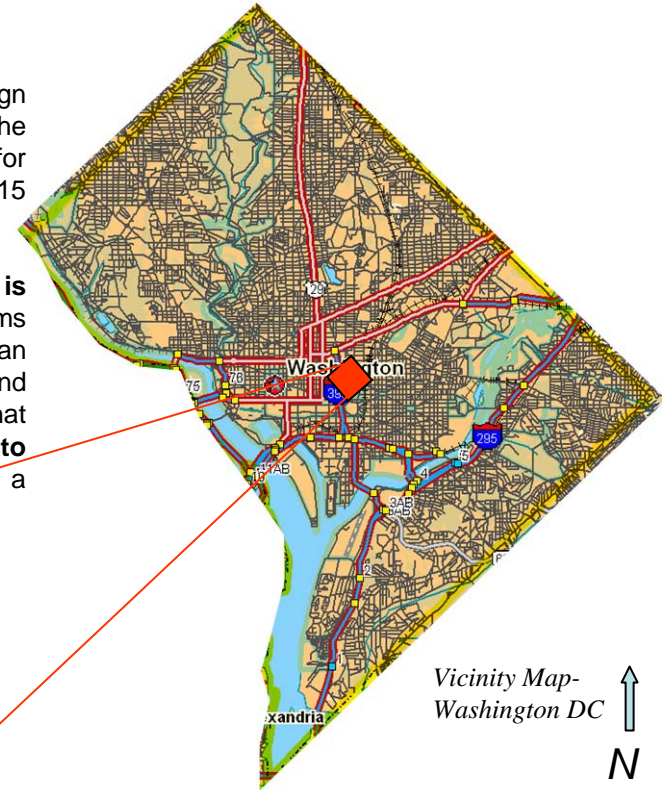
Although coordinated rhythm is no longer incorporated into most work sites - and boom boxes and the sounds of heavy machinery have replaced the human voice - the ship caulking example suggests that **a rhythmically coordinated work force could increase production.**

In visiting two local worksites during the pile driving stage, the tempos were almost the same. One is a multi-billion dollar federal bridge project over the Potomac River, the other an office building in Arlington. The tempos of the driving were between 44 and 48 beats per minute (bpm). Both could be arranged in multiples of 12, the most common rhythm grouping for additive polyrhythms. Perhaps these otherwise distracting and sometimes offensive sounds could be used as a base from which other work could be regulated thus creating an efficient and engaging project.

# Site

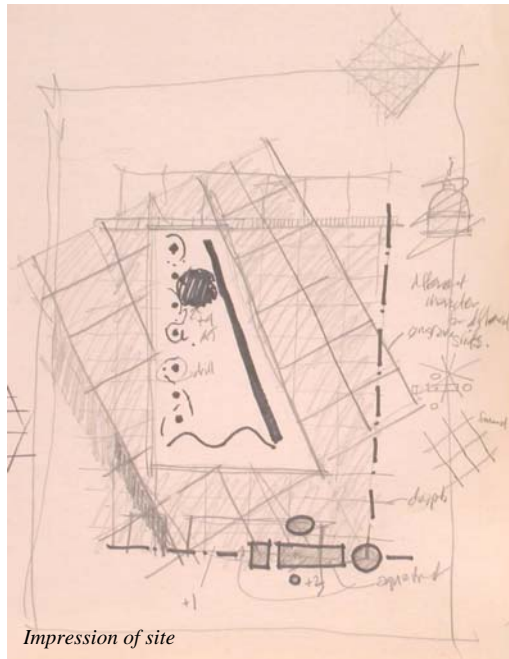
The plan of Washington DC is composed of superimposed grids the design creates an excellent example of polyrhythms on an urban scale. The orthogonal north-south/ east-west grid of the city reflects an efficient layout for day-to-day business. The second grid, composed of wider streets and 15 degree rotations provides the basis for ceremonial Washington.

**The focal points in polyrhythms and in the urban fabric of the District, is what occurs when these two polyrhythms meet.** When two rhythms recognize each other they are linked whether in polyrhythm or in the urban fabric. In music , this intersection provides a turning point for the rhythm and an opportunity for a third level of cognition with the creation of “nodes” that provide **a connection point that allows crossing from one rhythm to another.** In the city it is the turning point for circulation and often results in a grand square or circle.



*Abstract interpretation of site – engraving*

The site selected for this Project falls at one of the **intersections of the two grids.** Forced to respond to the grand view of the capitol on the ceremonial grid (New Jersey Avenue), the building must also show a commercial face as it addresses the orthogonal grid of 1<sup>st</sup> , E and F streets.



*Impression of site*

The site, located in Washington DC, NW, is surrounded by medium rise office buildings. Georgetown Law School has a considerable presence in this neighborhood with its main law school building, several secondary structures and classroom facilities nearby. Housing, on the other hand is in short supply. The structure proposed for this site will include living quarters for the law students, with features that fill gaps in day-to-day campus life caused by its remoteness from the main campus, knit together with features to benefit the nearby office workers. The intent is to juxtapose academic and urban life, much in the same way that the official and urban Washington have been superimposed on each other.



*Aerial view of site from the northeast*

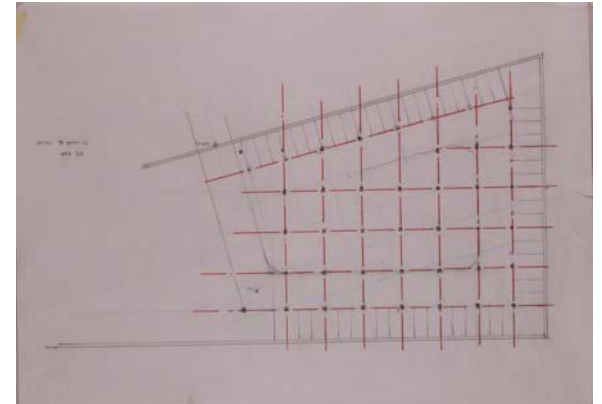


# Garage

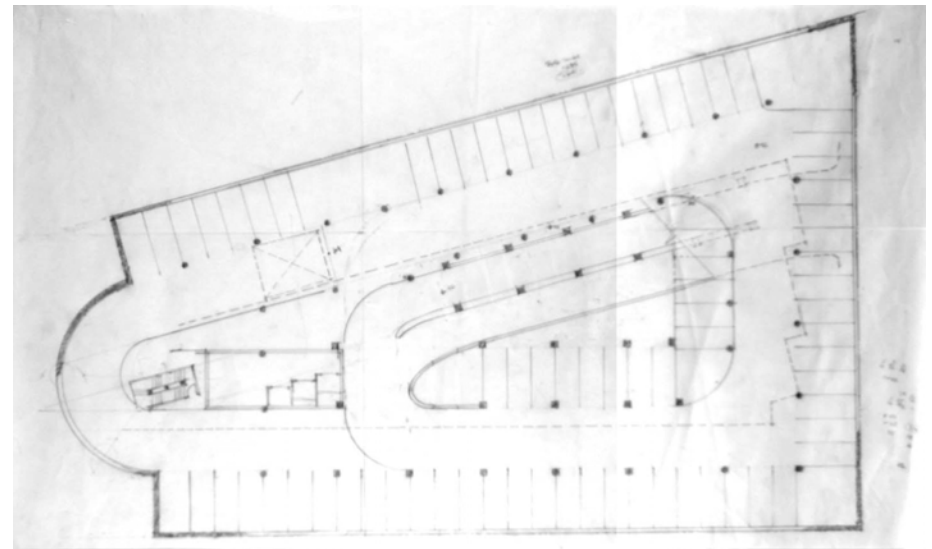
Underground parking is normally allowed to extend to the boundary of the lot and is not affected by setbacks.

Patterns of construction often produce contrasting rhythms. The **parking garage** must fit a whole number of cars in a standardized construction bay that suits an economical building span. Specified in the zoning code, the average width of a parking space is about 8'-0" with a length of 20' and a two-way drive aisle of 20' with a double loaded parking lot, the rhythmic unit takes the aspect of 8' long and 20' across. This defines the column rank and file.

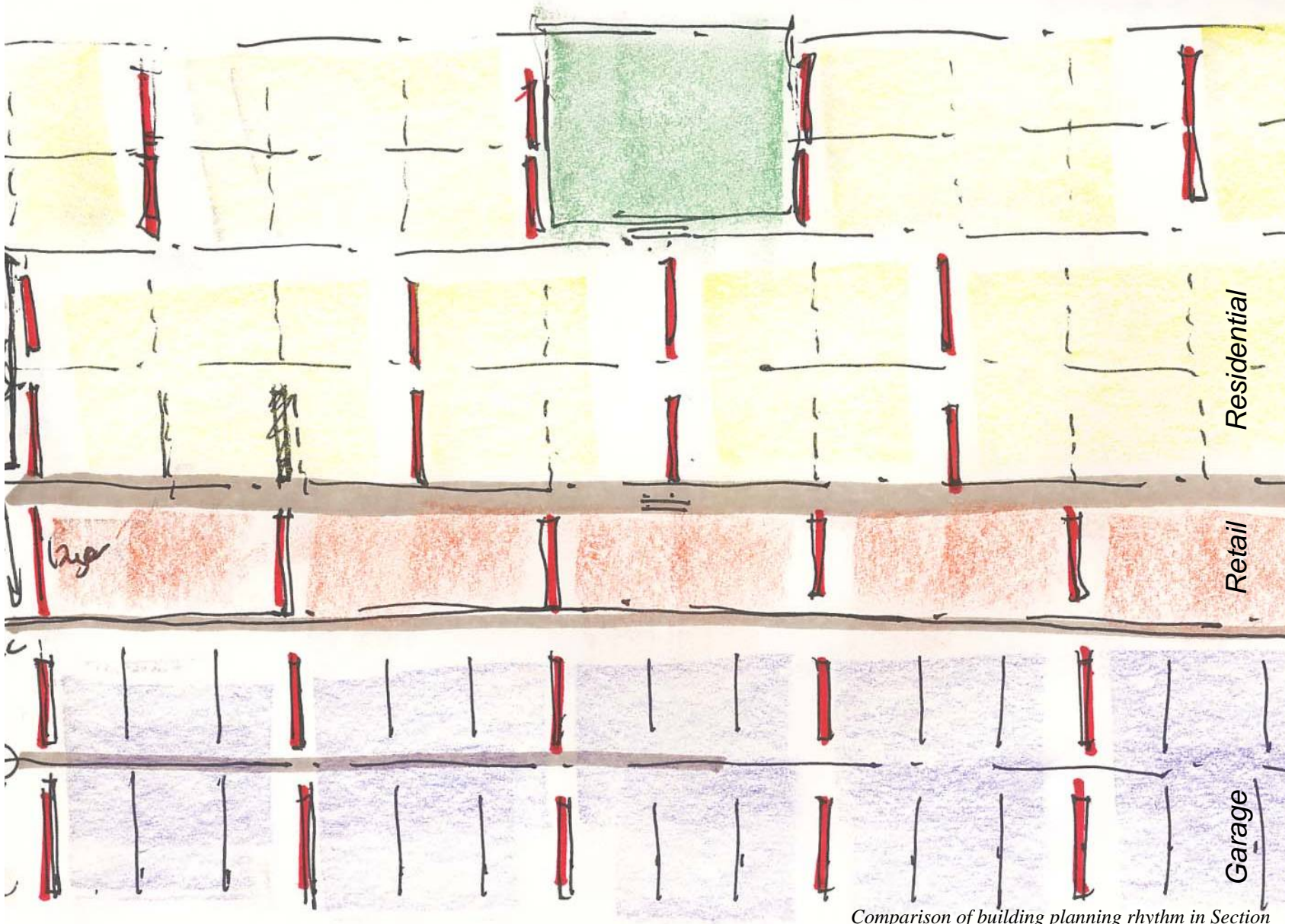
24' bays will allow three standard cars between each column. A double loaded parking aisle composed of 20' parking length, 20' two-way traffic and 20' of parking results in a 60' module in the transverse direction.



*Partial Column Grid, parking level*



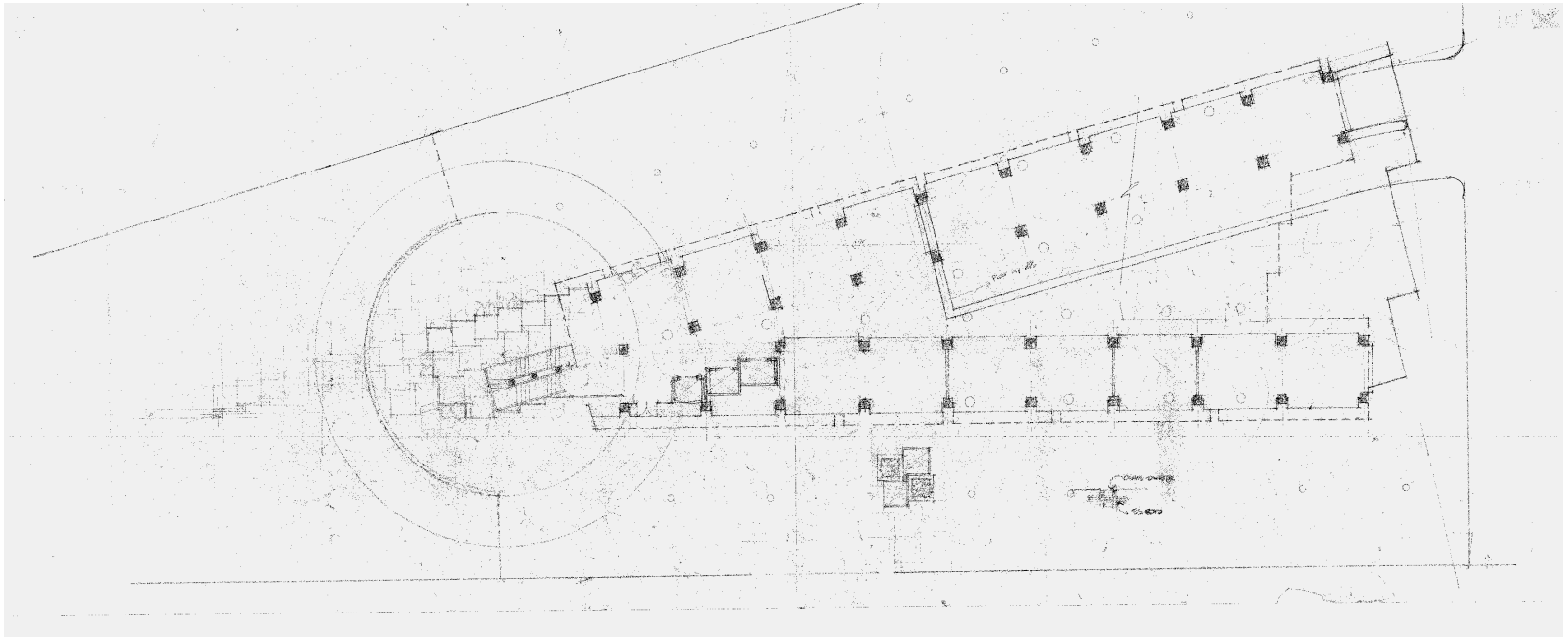
*The garage rhythm is based on the spacing of the parking spaces and drive aisles.*



Comparison of building planning rhythm in Section

# Retail

**The Retail** space of the structure can accept a much more flexible bay since the products themselves are most often measured in inches rather than feet.



**Ground Floor Plan** Retail shops easily fill the intercolumnal spaces in the plan. The center area houses storage for the retail shops. The North (left) end houses stairs that reflect the polyrhythmic paving pattern that reflects the 15 degree rotation of New Jersey Avenue from the N-S city grid.

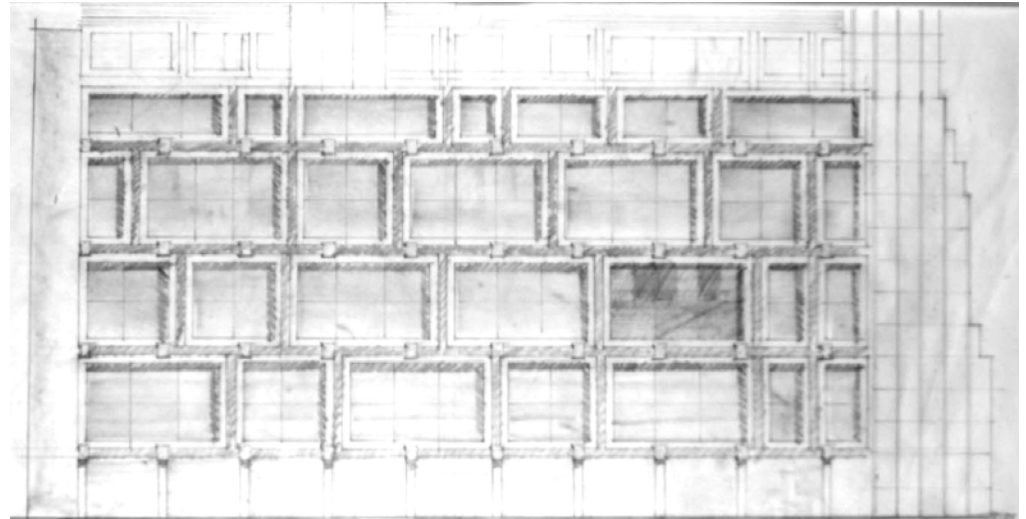
# Living Units

In the **residential** component of the building, many living combinations are available with the “unit” being a single resident. Code disallows any “habitable” space with a dimension less than 7’, so a 10’ unit might well serve as the building block. Groups of students would then prompt architectural responses in multiples of 10’.

Precast **living units** with hollow insulated cores create the exoskeleton for the living space.

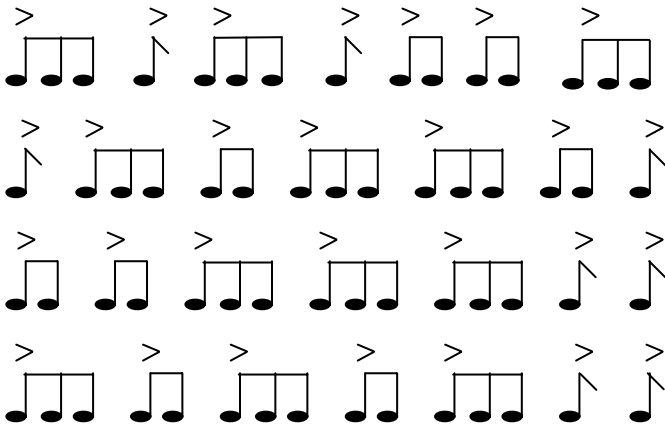
Suspended slabs serve as the second floor in the double height units.

The interior of the living spaces are arranged with a privacy gradient. Series of parallel walls provide depth and rhythm to the space as a unit from the inside and as a 2-D composition when viewed from the street.

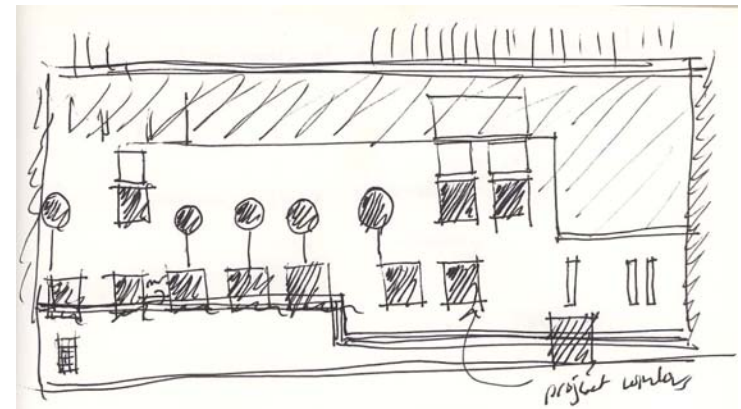


*East Elevation (New Jersey Avenue)*

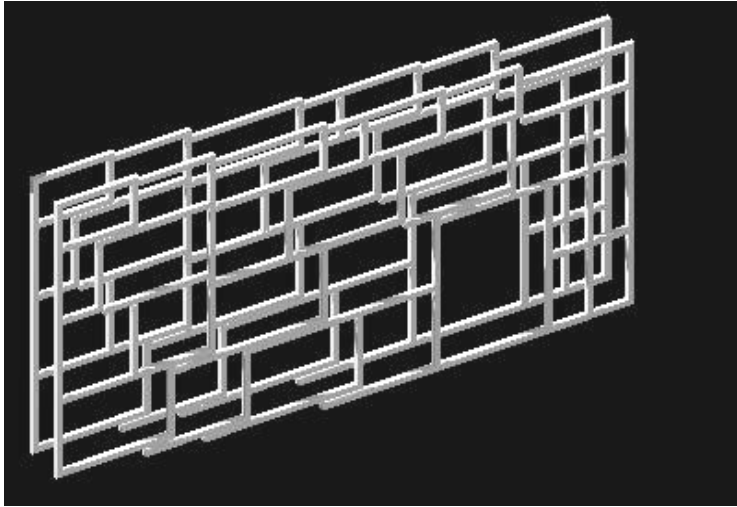
The separating walls, normally the structure and rhythmic form-giver for construction, have been separated into two components. The structural web supports the living units and is recessed from building face. The units now stand on their own and all their components are recognized as belonging solely to that unit.



*Rhythmic Interpretation of the elevation at upper left.*



*Elevation for polyrhythmic design  
Banca de Verona, Carlo Scarpa*

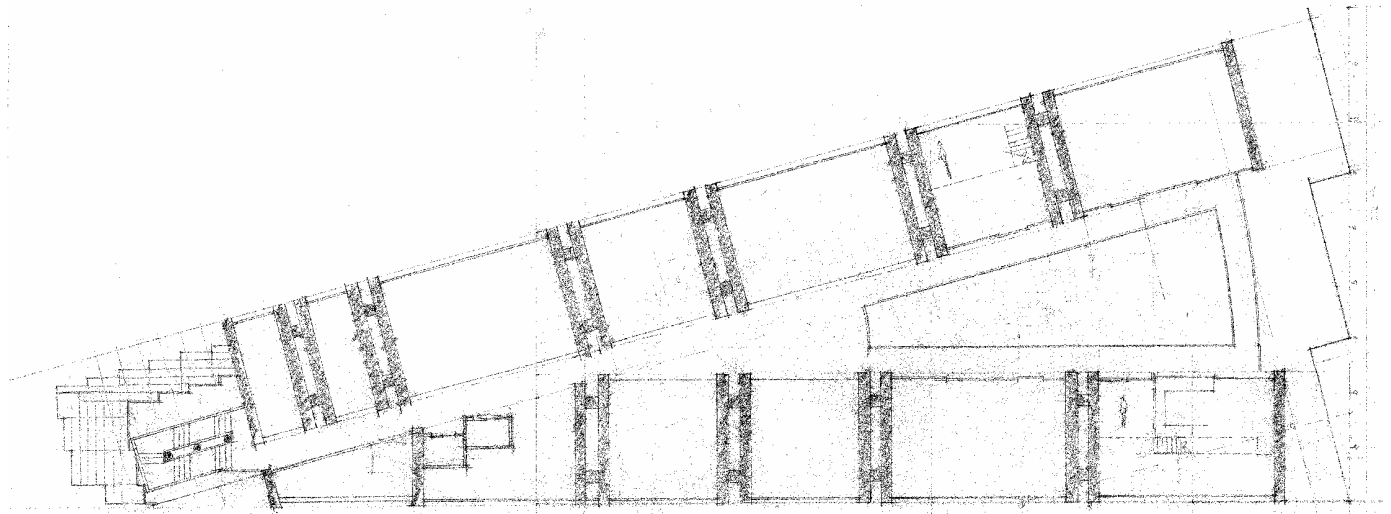


*Pair of structural "webs" that, when paired, support the living units*

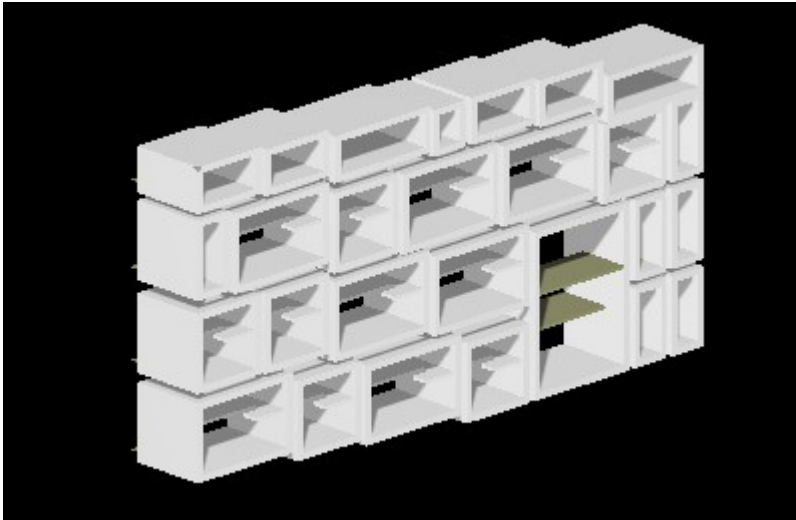
The tectonic elements of the units are singular. A ceiling in one space does not become the floor of another. The wall serves the inhabitant who can touch it and none other.

Cast in place concrete with steel reinforcements is used to create the paired **structural webs** that support the living units. The pair of webs provides a strong sense of interdependence.

When a researcher was trying to record the separate parts that make up a "Takai" dance. He had asked a takai drummer to play only his part. The drummer replied that **he could not "hear" his variations when he played without a second dondon.** He regarded the counter-rhythm which would tend to throw Westerners off the beat as the only thing that kept him on time and enabled him to hear what he was playing and to be creative. <sup>10</sup>



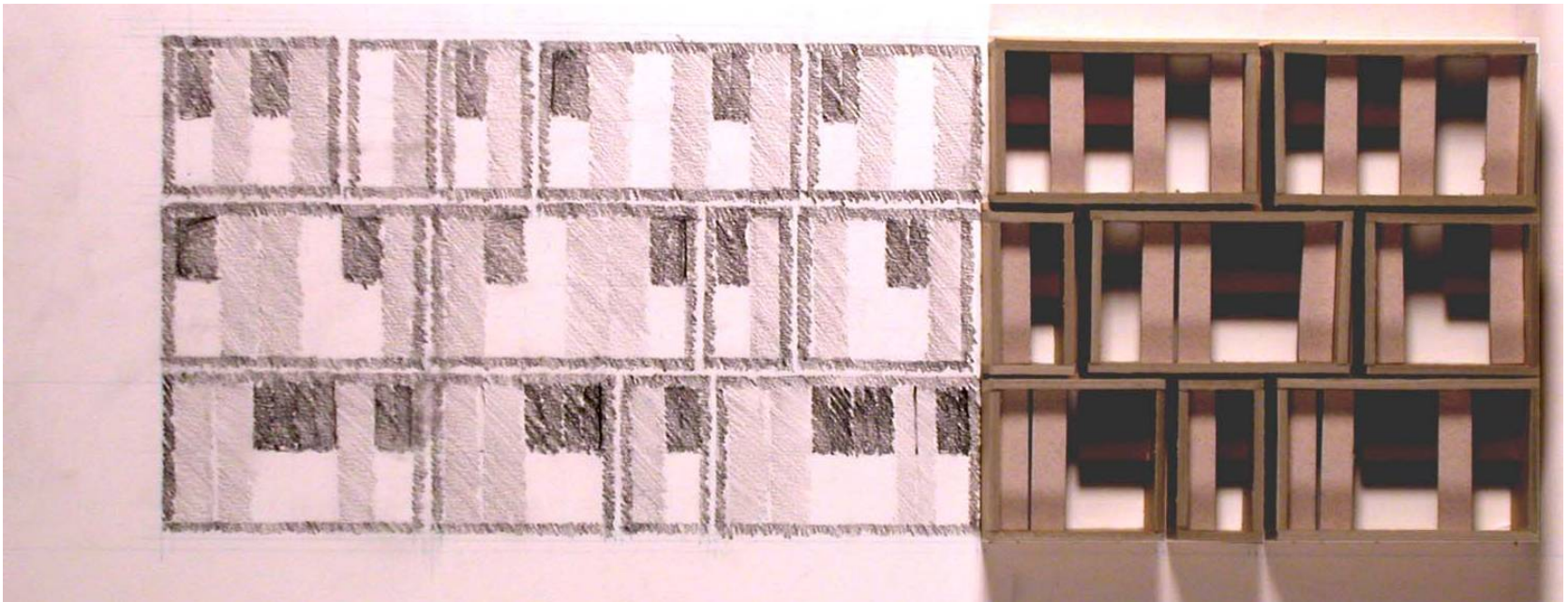
**Residential Floor Plan** – Living units based on a 10' module are inserted into the paired structural web members. A walkway exterior to the living units suspended over the interior courtyard provide access to the units as well as facilitating the delivery of utilities.



Living Unit grouping, West Elevation

“... the world is divided into two cultures, **downbeat and offbeat** and basically it’s not an issue of black and white because Japan and Okinawa will bear this out as well *colonizers tend to be interested in the beat, and the colonized tend to be interested in the “and” between the beats* and so when you are focusing on the “and” you stop seeing the beat as something to follow and more something to react to.” <sup>11</sup>

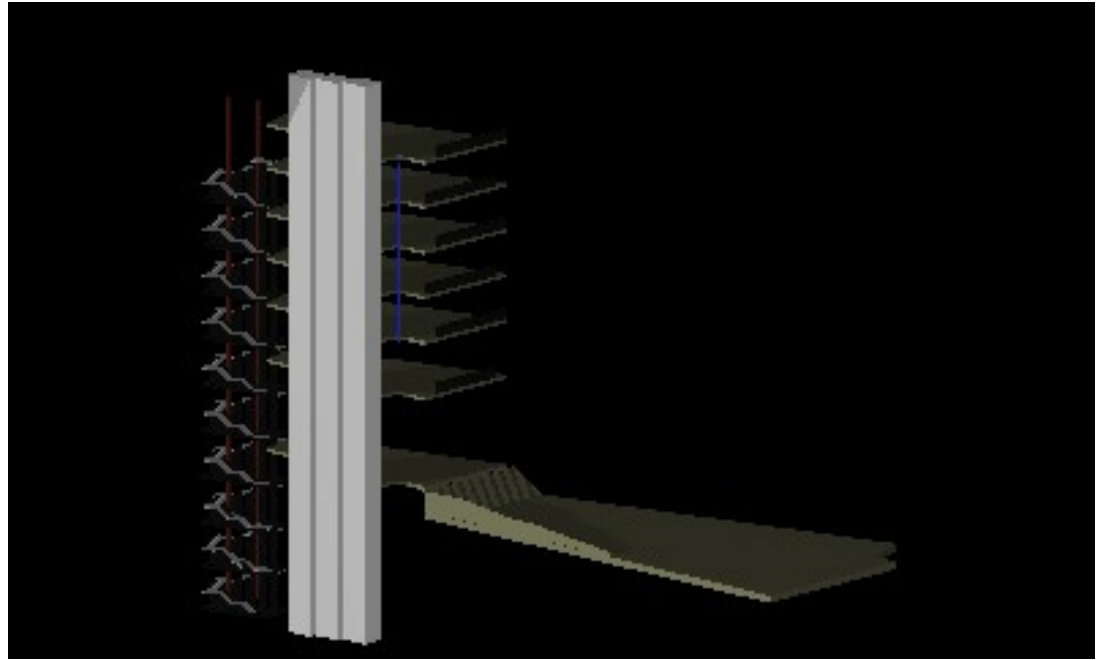
“The intellectually rich part of this music consists of **flipping your mind back and forth between those two ways of hearing it** and the musicians are constantly dividing and multiplying off those two times whereas European music is usually just in one meter.” <sup>12</sup>



Screening patterns as seen from street

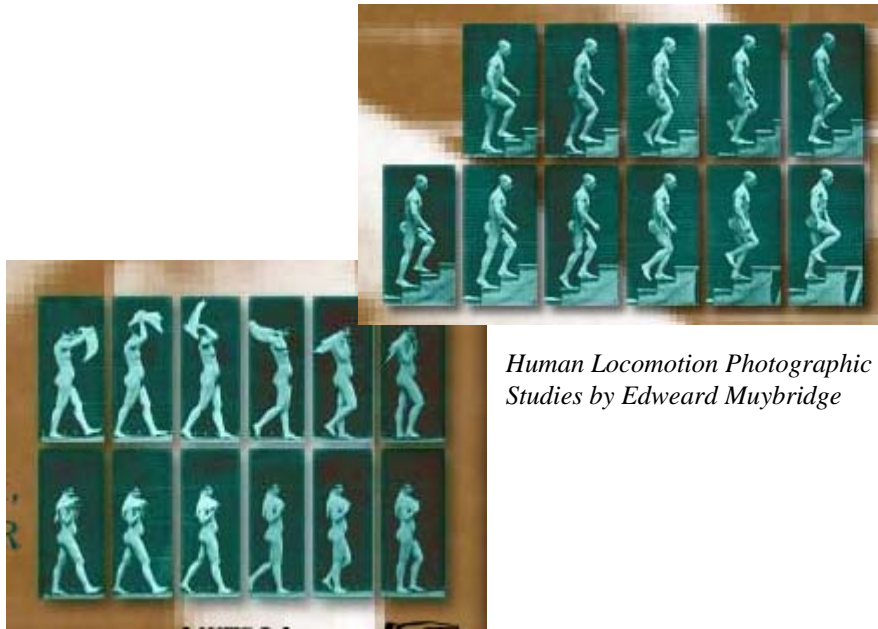
## Public Areas

The elevator core is constructed of a brick/block assembly using economy sized bricks and standard block (5 brick courses = 2 block courses) to provide a 2:5 polyrhythm in the wall construction.



*Core of Building highlighting elevator shaft*

“Whether or not one is looking from the point of view of a social scientist, one of the most noticeable features of African cultures is that many activities-paddling a canoe, chopping a tree, pounding grain, smashing up the yams for dinner , or simply moving- seem set within a rhythmic framework which can and often does serve as the basis for the music and songs. On one of my first afternoons in Accra I went to the airport to fill out the many forms I needed to clear my tape recorder, which had been sent as unaccompanied baggage, through the bureaucratic tangle of customs... Eventually one of the chief inspectors, with whom I had by that time become friends, called another clerk to prepare typed copies of the invoices and other papers...the man began typing. I flipped. **Using the capitalization shift key; with his little fingers to pop in accents between words, he beat out fantastic rhythms.** Even when he looked through the rough copies to find his next sentence, he continued his rhythms on the shift key.”<sup>13</sup>



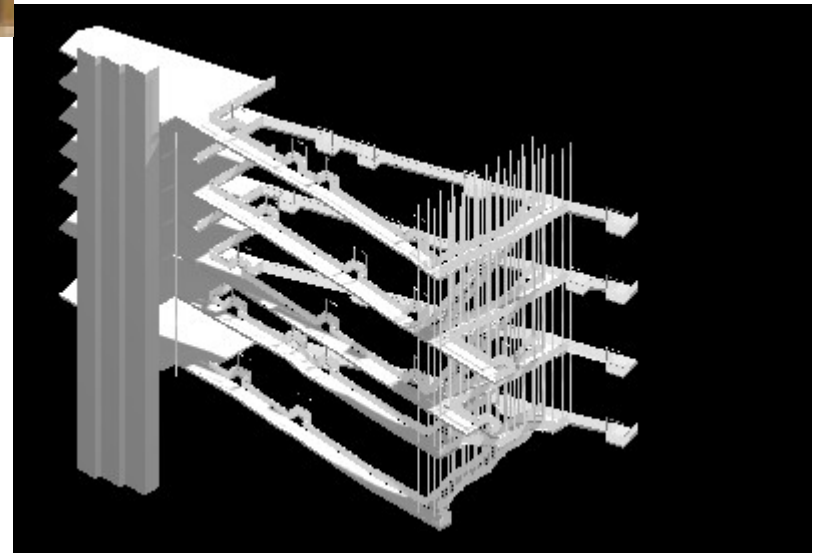
*Human Locomotion Photographic Studies by Edward Muybridge*

The circulation areas are constructed of an insulated metal to provide a tonal sound as residents move throughout the building.

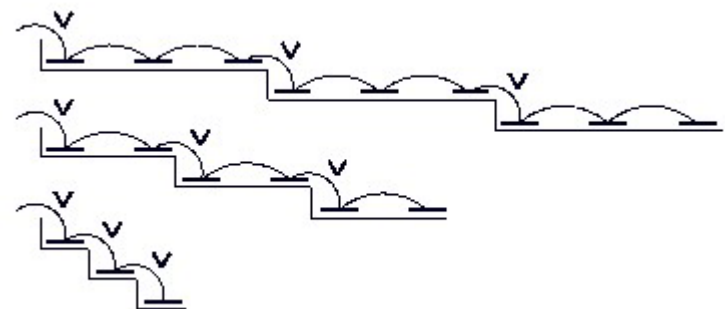
Of particular importance are the stairs which have varied tread depths to force **varied walking rhythms** with an accent on the step up or down the riser.

Aircraft cables support the stairs at the south end of the building and create a **mute Aeolian Harp** to de-emphasize the importance of melody.

The ramps tie together the disparate units but do not penetrate them.



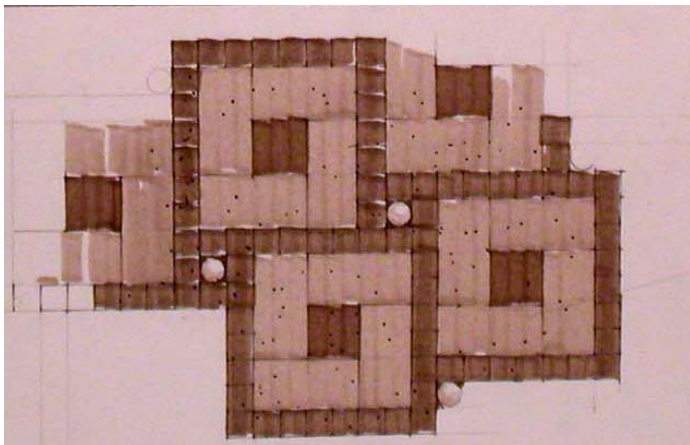
*Circulation elements of project*



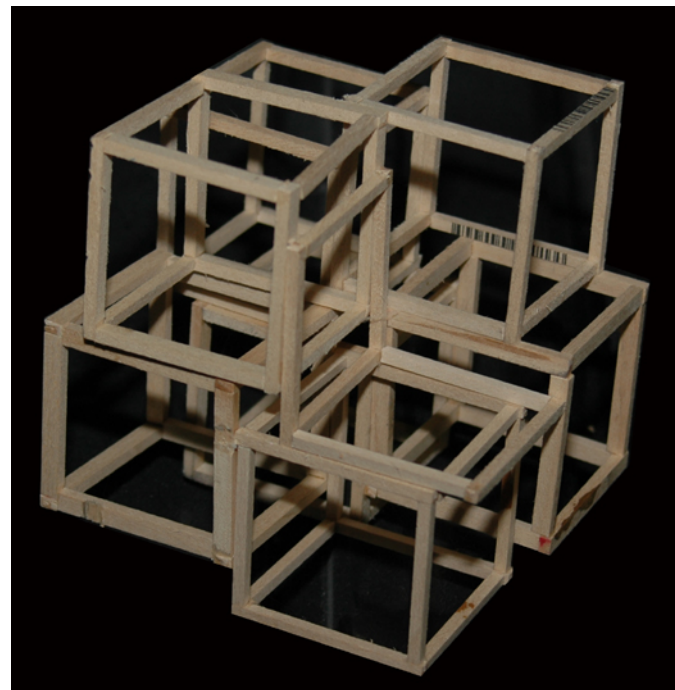
*Diagram of various walking rhythms as determined by tread depth.*



“Well, basically Europe kind of missed the boat in having fun with the waltz. I think they were too busy marching. Europe never really got past 123123 or maybe 1&2&1&2&1& Africa realized that you could count it in six and go 123456123456 and once you’ve done that you can put a two pulse in 123456123456 so you can count this triplet feel in two 1..2..1..2.. or in 1.2.3.1.2.3.1.2.3.1.2.3. The Madagascar and the Reunaise people will actually flip the accent over so that out of 6, 2 and 5 become the loud things 123456123456 123456 123456.”<sup>14</sup>



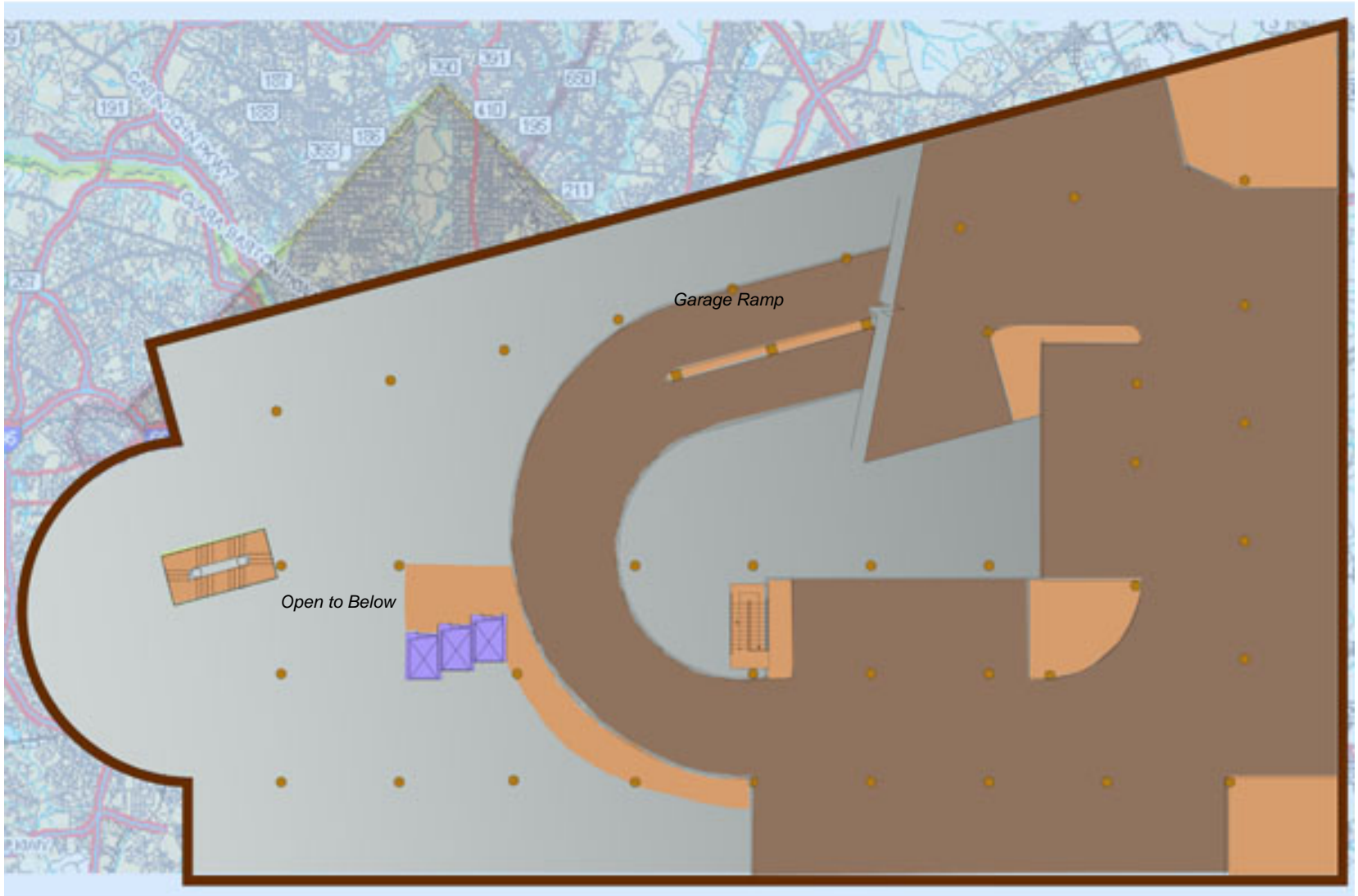
*Paving pattern based on Plecnik design*



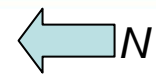
*Paving pattern extended to third dimension*

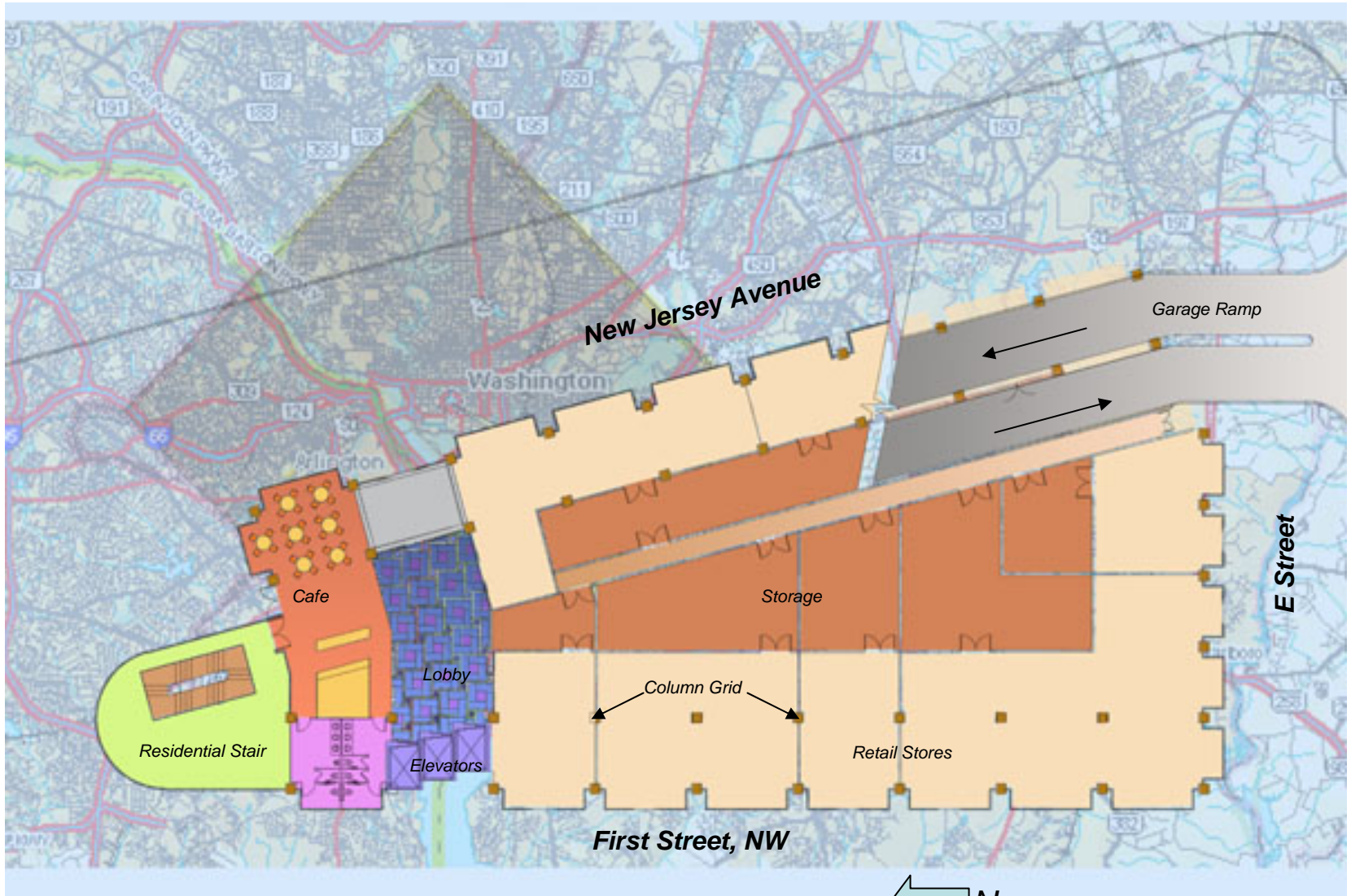
Plecnik, a Czech architect practicing at the beginning of the 20<sup>th</sup> century, devised an ingenious polyrhythmic paving pattern that provides a flexible orthography that can be configured to an angled by manipulating the relationships of orthogonal paving elements.

*Project  
Illustrations*

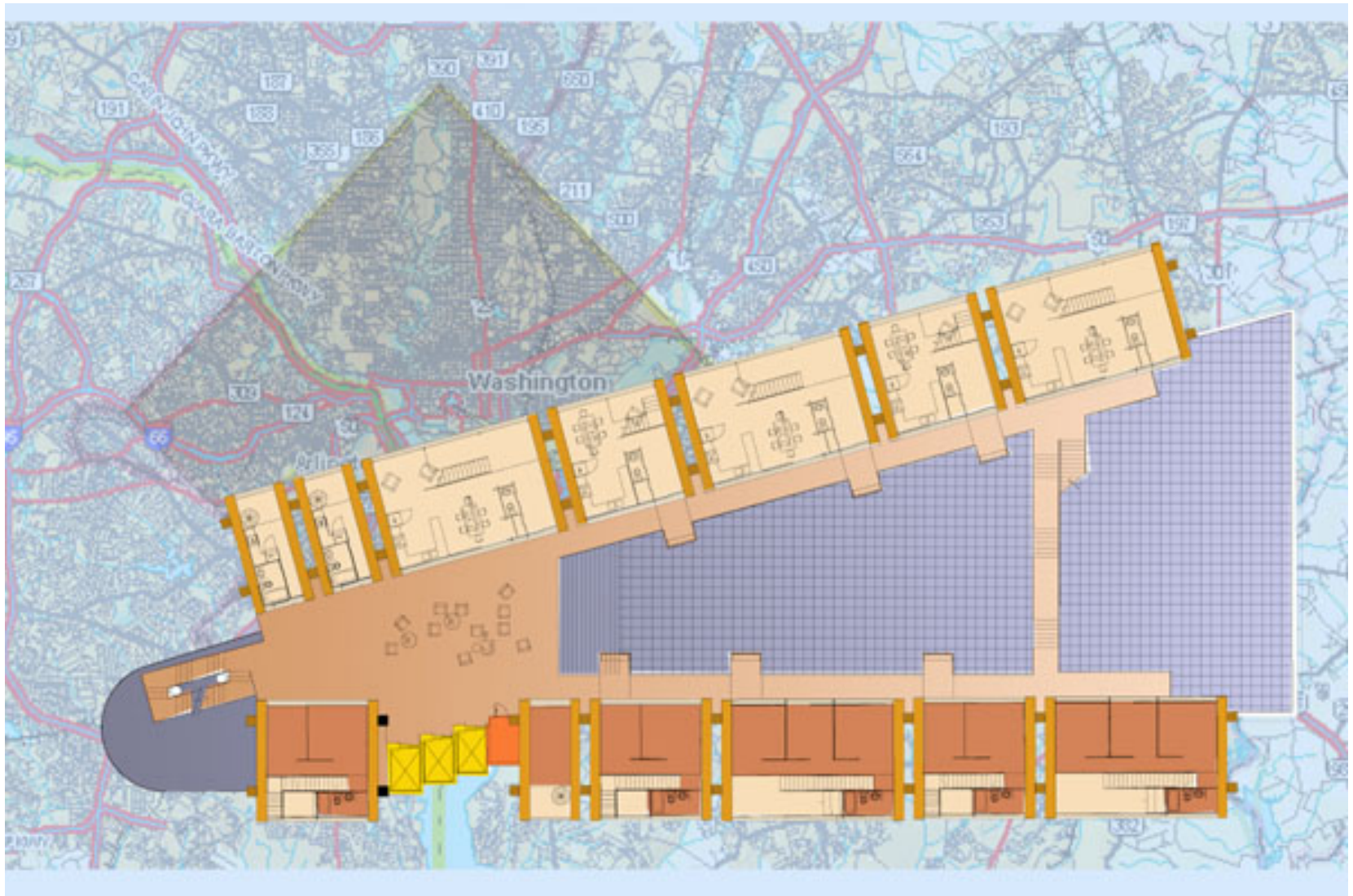


Parking Garage – First Level

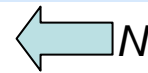


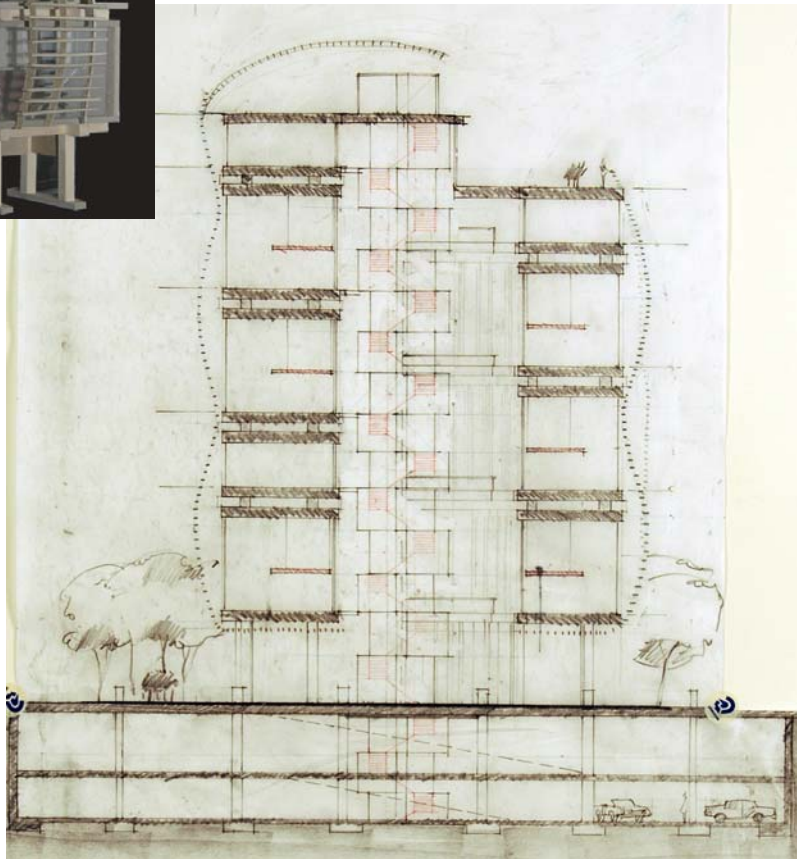
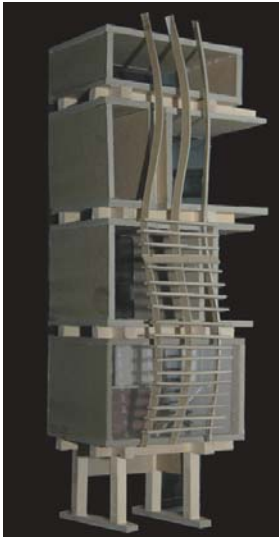


First Floor - Retail



Typical Floor - Residential

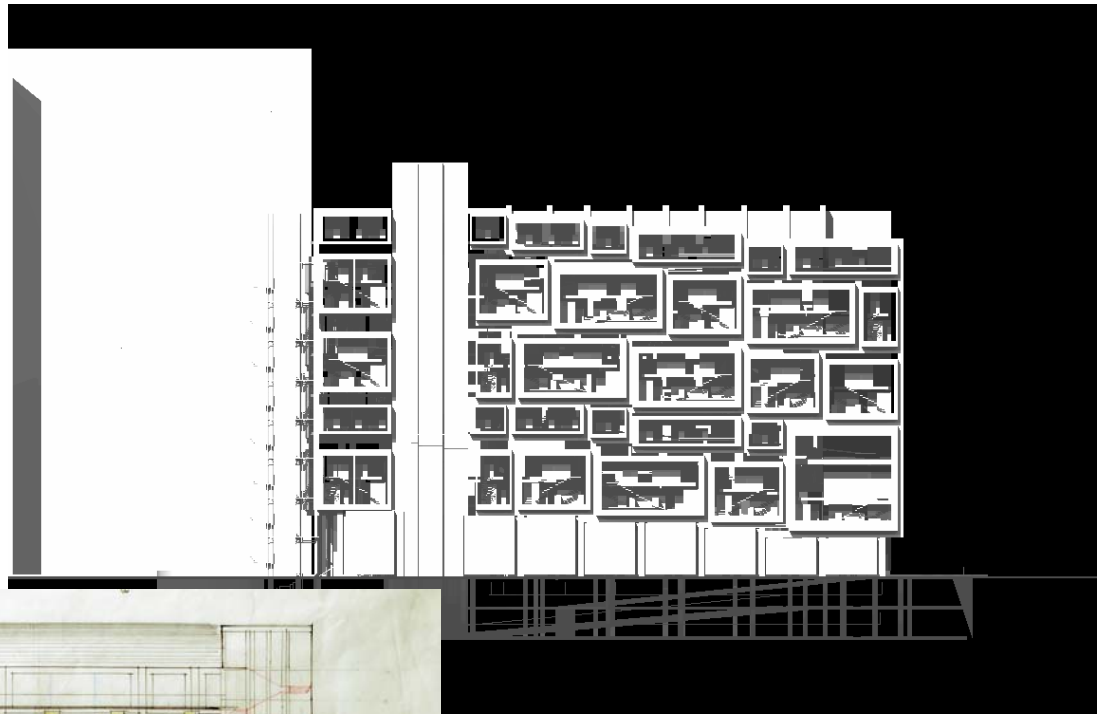




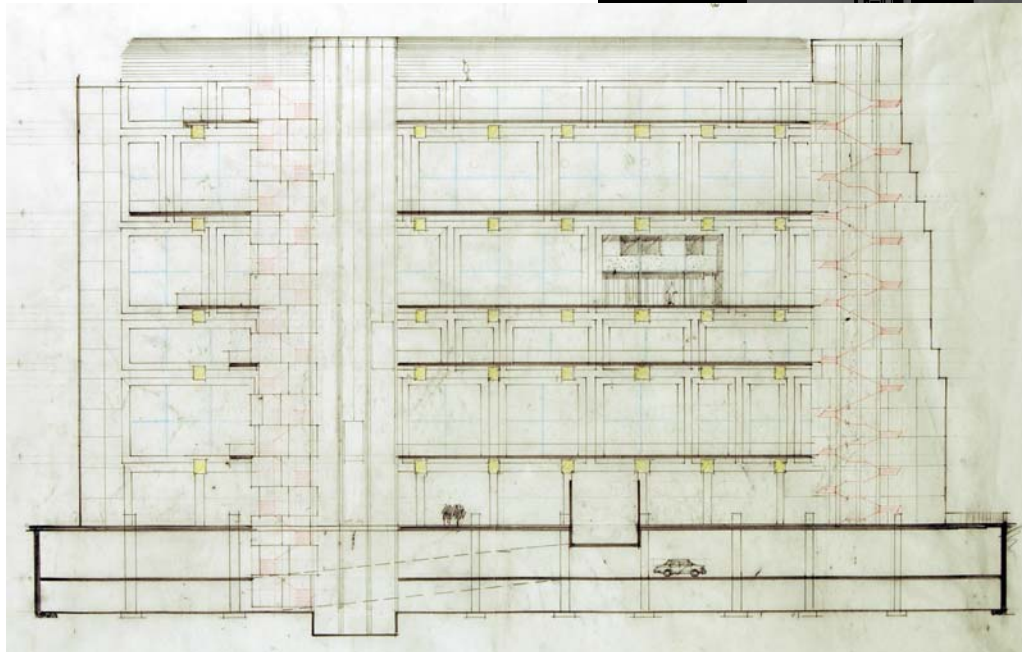
*Building Section echoing polyrhythmic building technique*



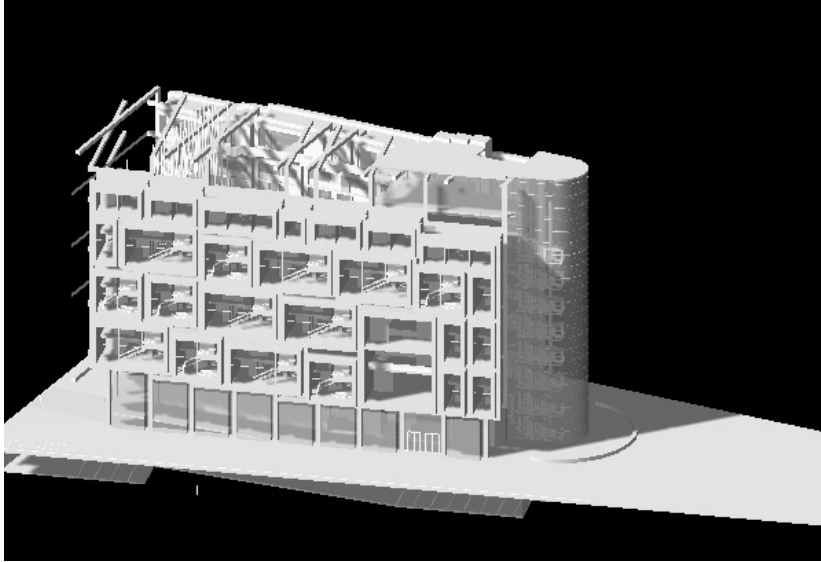
*Partial Building Section showing parking, retail, residential, open space and utility chases.*



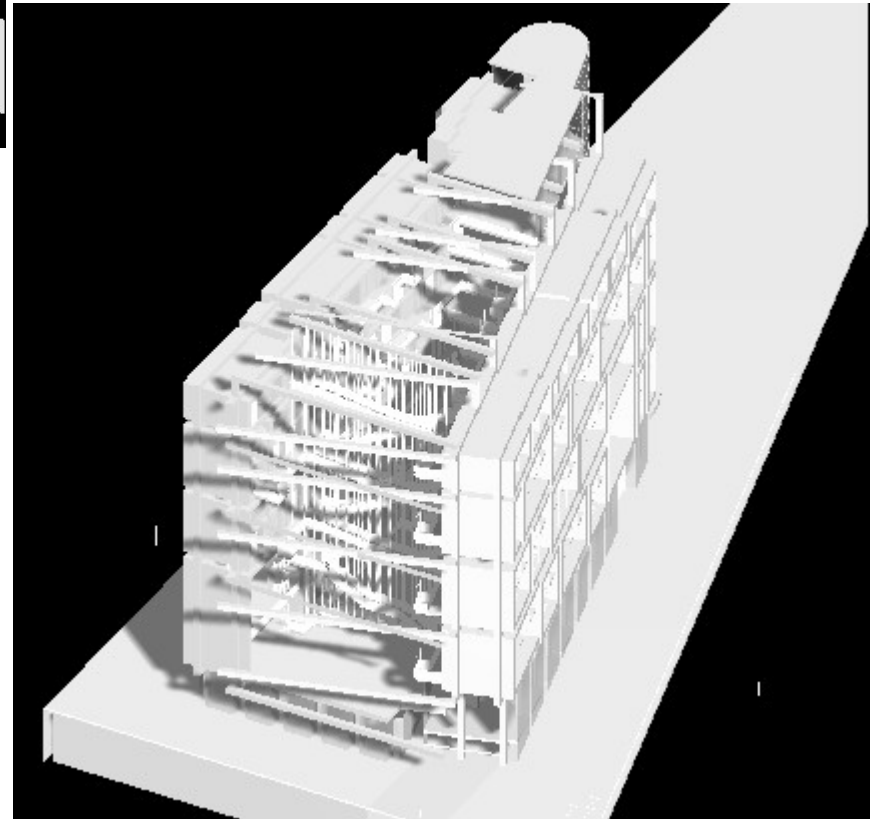
*East Elevation (New Jersey Avenue)*



*Longitudinal Section*

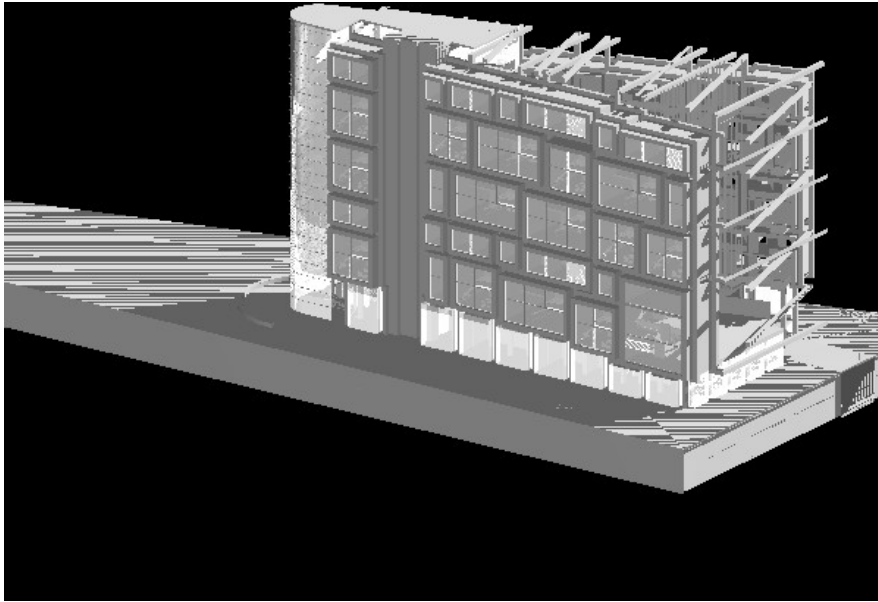


*Aerial view from the East*

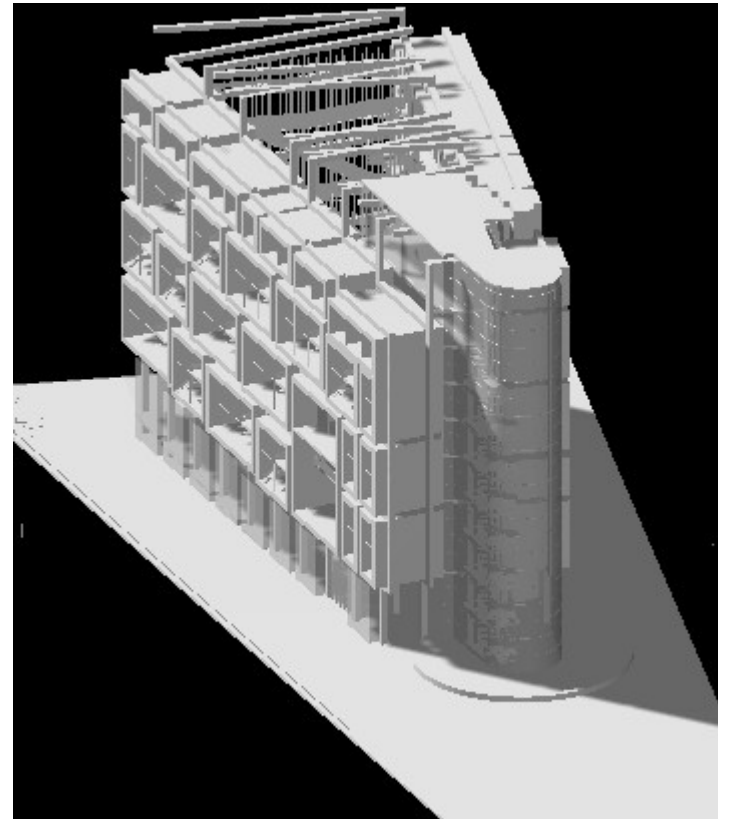


*Aerial View from the south*





*Aerial view from the west*



*Aerial view from the north*



*Aerial view of site showing Proposed Project*



*View from the Southwest*



*View from the Southeast*

## ENDNOTES

1. Philip Gove, *Webster's Third New International Dictionary*, (Springfield, MA: Merriam Webster, Inc. 1993) p. 1760
2. John Kaemmer, *Music in Human Life: Anthropological Perspectives on Music* (Austin, Texas:University of Texas Press, 1993) p. 82
3. Hiscock, Nigel, *Sacred Geometry*, Class Notes
4. Friedrich von Schelling, *Oxford Dictionary of Quotations*, (London: Oxford Press, 1953)
5. John Miller Chernoff, *African Rhythm and African Sensibility*, (Chicago: University of Chicago Press, 1984) p.60
6. Alan Lomax, *The Alan Lomax Collection Sampler*, (Cambridge, MA Rounder, 1997) Liner Notes
7. Chernoff, p 35.
8. Herman Melville, *Redburn, His First Voyage*, 1849
9. Exhibit Label: The Mariner's Museum, Norfolk, Virginia
10. Chernoff, p 53
11. Bob Brozman, *National Public Radio Interview*, June 4, 2002
12. Brozman,
13. Chernoff, p93
14. Brozman

## BIBLIOGRAPHY

- Bloomer, Kent. *The Nature of Ornament: Rhythm and Metamorphosis in Architecture*. New York: W. W. Norton & Co., 2000.
- Calvino, Italo. *Invisible Cities*. Orlando, FL: Harcourt, 1974.
- Chernoff, John Miller. *African Rhythm and African Sensibilities: Aesthetics and Social Action in African Musical Idioms*. Chicago: University of Chicago Press, 1984.
- Crippa, Marie Antoinette and Marina Loffi Randolph, eds. *Carlo Scarpa Theory Design Projects*. Cambridge, MA: The MIT Press, 1986.
- Garlake, Peter. *Early Art and Architecture of Africa*. Oxford: Oxford University Press, 2002.
- Gilfoy, Peggy Stoltz. *Patterns of Life: West African Strip Weaving Traditions*. Washington DC: Smithsonian Institution, 1987.
- Hayen, Geoffrey and Dennis Marks, eds. *Repercussions: A Celebration of African American Music*. London: RMArts Fernseh, 1985.
- Jeans, Sir James. *Science and Music*. New York, The MacMillan Company, 1938.
- Kaemmer, John E. *Music in Human Life: Anthropological Perspectives on Music*. Austin, Texas: University of Texas Press, 1993.
- Koetting, James T.. *Africa/Ghana: The Western Point of View*. IMOL Spring 1998
- Lindahl, Bernhard. *Architectural History of Ethiopia in Pictures*. Addis Ababa: The Ethiopian-Swiss Institute of Building Technology, 1970.
- Montfort, Matthew. *Ancient Traditions-Future Possibilities: Rhythmic Training Thought the Traditions of Africa, Bali and India*. Mill Valley California: Panoramic Press, 1985.  
[www.ancient-future.com](http://www.ancient-future.com)
- Mursell, James L.. *The Psychology of Music*. New York: W. W. Norton, 1937.
- Nketia, J.H. Kwabena. *The Music of Africa*. New York: W. W. Norton & Co., 1984.
- United States Gypsum. *Gypsum Construction Handbook*. Chicago: United States Gypsum, 1980.

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