ABSTRACT

Title of Thesis:	ANFA NYC A NEUROETHICAL ARCHITECTURE
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Our environments have a direct effect on our wellbeing. Science is starting to focus on the human brain and tell us why this is the case. This thesis concerns the integration of the neurosciences with architectural design. It is the stance of this thesis that architects have the responsibility to address the cognitive effects of the environments which they design in an effort to combat the so-called 'diseases of civilization'.

The chosen site, South Point Park on Roosevelt Island in New York City, is proposed to be developed as a NeuroArchitecture research incubator, providing interested groups a place to study the consilience of neuroscience and architecture. Research will be applied through four venues: The chosen site and landscape, a NeuroArchitecture Incubator, Blackwell Tower, and the ruin of a mid-19th Century Smallpox Hospital.

ANFA NYC
A NEUROETHICAL ARCHITECTURE

by

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To Sarah

And to my family

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1 INTRODUCTION

1.1 Mapping out the Pieces

This thesis document is an initial attempt at understanding the emerging impact of modern neuroscience on the field of architectural design and planning. At the time of this publication, as required by the University of Maryland School of Architecture, Planning, and Preservation, it generally outlines the relevant research and design work, but is selective in its thoroughness in the interest of time. The thesis was a process of discovery until the near end of its two-semester completion, developed over a very broad range of topics, listing from architectural ruin to neuroscience. However, its initial drivers to uncover a better way for architects to better manage their role in a changing society, unlock the potential of emerging technologies, and promote a more focused understanding of design, stayed present throughout. This document is a representation of what research remained relevant to the final design project, and is a record of the various thoughts and musings teased out along the way in order to arrive at a final project. It will be developed a great deal and restructured in the coming months.

ANFA NYC: A Neuroethical Architecture is a proposal for a new institution on New York City's Roosevelt Island which will foster the convergence of Neuroscience and Architecture researchers, providing the two groups with a place to work side by side with a rich variety of environmental and architectural conditions nearby that can be used to conduct and facilitate their research. The thesis also attempts to illustrate some of the early findings of neuroscience and architecture in the design of this new institutional structure, while at the same time providing a model for how architects might intuitively take on and advance some of neuroscience's findings.

The first part of this document, *INTRODUCTION*, helps the reader understand the social context, intentions and aspirations of the thesis. Part two outlines an anatomical view of ourselves through describing, in few parts, *THE HUMAN BRAIN*. Part three, *SITE DESCRIPTION*, will explain the environmental context in which the thesis takes place. This section will also define the various alterations and modifications to the existing landscape and urban context which the thesis proposes.

In Parts four through six of the document, I hope to demonstrate the implications of this thesis on the way we design environments. This portion consists of the description of three structural venues: A new *NEUROARCHITECTURE INCUBATOR* (Part four) adaptively reusing Strecker Memorial Laboratory, a new private study tower that is a hypothetical construct which has been titled *BLACKWELL TOWER* (Part five), and minor modifications to the existing *SMALLPOX HOSPITAL* (Part six). In each of these venues I attempted to apply and explore two

Neuroarchitecture principles, which are explained and outlined in relation to each of the structures.

Explanations of the methodology and technology applied through the thesis can be found in Part seven, *METHODOLOGY,* with discussion of how the socio-political sphere may shift with the onset of this new science. Part eight, “*CONCLUSIONS”* offers some insight and reflections collected throughout the process.

The Diseases of Civilization

The human will is an amazing thing. Unparalleled in its ability to set out and achieve goals, it is a foresight superpower that allows for a set, planned direction for the continuation of life. Time and time again, people have been able to identify their problems, define them, and formulate a solution. Our growth, thanks to this imaginative ability and intellect, is *astounding*. Growth is exponential. It is unstoppable. Or so we thought.

As the population on earth continues to grow, our cities are becoming more and more populated. With that population comes increased development: larger, taller buildings more numerous in quantity and a more intricate and interconnected infrastructure through which to fuel and navigate them. An amazing feat, our ability to safely contain and provide for large amounts of citizens in any given area is something unique to the human race and unprecedented in our history.

However, in recent decades, we have been noticing the trends of a potentially deleterious environment- one to which our biological selves have had difficulty adapting. These trends, becoming known as the so-called 'diseases of civilization', suggest that the way we produce and design the developed world is at odds with the natural way humans evolved over time. While the causes of these symptoms are not easily identified, it has been established that changes which occur in an organism are a byproduct of the environment to which they are attempting to adapt. It is not a stretch to assume that the environments we are designing are leaving us unable to react and adapt. This naturally influences the increases in obesity, cancer, mental depression, and suicide.

"In our consumerist society, often dominated by shallow and prejudiced rationality and a reliance on the empirical, measurable and demonstrable, the embodied, sensory and mental dimensions of human existence continue to be suppressed."[1]

It is the position of this thesis that architects and planners should begin to step up as designers of this environment to prioritize the mental and physical wellbeing of the population they serve. While a good deal of this world's

[1] Pallasmaa, *Towards a Neuroscience of Architecture*. 8

problems exist in bringing basic needs to all of its inhabitants, if the path that development leads to is one of disease and disability, it may be time to rethink its trajectory. In this vein, it is my goal to facilitate the advance of a Neuroscience-based approach to architecture and planning to improve the human condition.

Why Now, Why Neuroscience?

"Neuroscience has reached a degree of understanding about the brain and how it is influenced by the environment such that we might be of help to architects in designing environments that would assist us in our ability to function within those environments."[2]

The study of the human brain and anatomy is not necessarily a new thing, especially for architects (Figure 1). In fact, the very act of creation architects partake in depends on the ability of the human brain to perceive and respond, so that the message we wish to communicate can be passed on. For millennia, architects, artists, and designers have been using an intuitive understanding of neuroscience in order to share their thoughts and express meaning.

[2] Fred Gage, *Lecture at the AIA 2003 National Convention & Expo*. May 8, 2003.

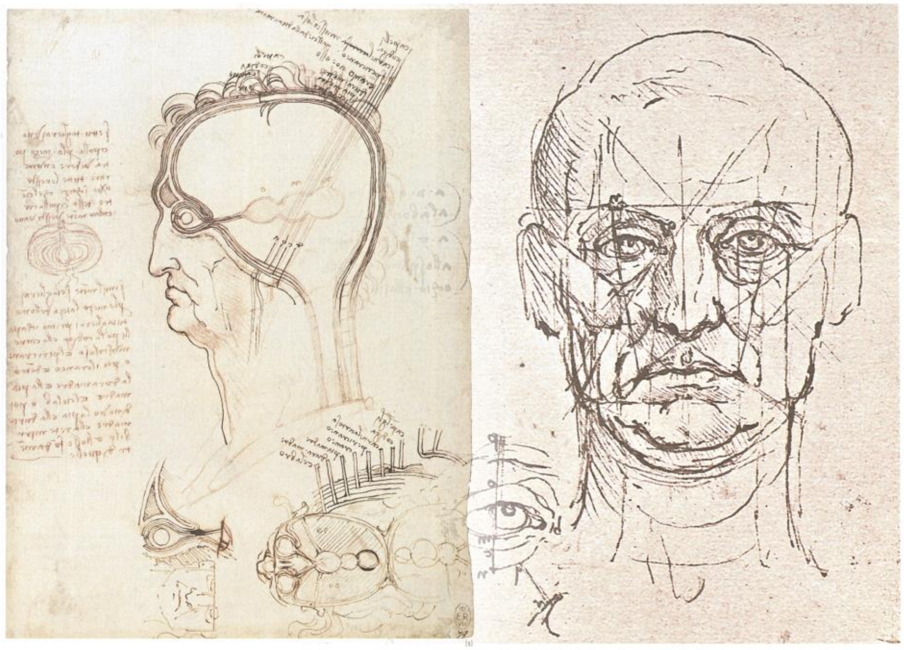

Figure 1: Leonardo da Vinci; Ponderings.
Da Vinci likened man's head to an onion, with layers to be peeled away to unearth its deeper inner workings. Composite image created from records in *Leonardo's Notebooks* by author, 2014.

Now, a deeper understanding of *why* and *how* humans interact with the creations around them, driven by neuroscientific research, is starting to prove valuable for a plethora of reasons. With the onset of advanced mapping and visualization technologies, what modern neuroscience allows us now is the ability to *see* the effects of the things around us which until now we have relied on describing subjectively. And seeing is believing. Some researchers even believe that "we have probably learned more about the biological workings of our human organisms over the past quarter-century than we have throughout all of human history."[3] Even the idea of beauty is teetering its way back into the realm of objective conversations and discourse. Semir Zeki's

[3] Mallgrave, *Should Architects Care About Neuroscience?* 25

Neuroaesthetics finds its mission statement in attempting to quantify the neural response to artistic expressions like painting and art, and is succeeding in its efforts. Architect Juhani Pallasmaa relates with Zeki's impetus, stating that he believes "neuroscience can give support to the mental objectives of design and arts, which are in danger of being disregarded because of their "uselessness" and apparent subjectivity."[4] Zeki's theory is based on the visual apparatus of the brain and its task in allowing for survival, highlighting the fact that "the brain is only interested in obtaining knowledge about those permanent, essential, or characteristic properties of objects and surfaces that allow it to categorize them."[5] Some wish to push this ocularcentric understanding through neuroscience, though, suggesting that "concentrating on visual images alone like falling in love with the photograph of a person without ever meeting him or her"?[6]

[4] Pallasmaa, *Towards a Neuroscience of Architecture, 8*
[5] Semir Zeki, *Inner Vision*, 77.
[6] John Eberhard, *Brain Landscape*. 78

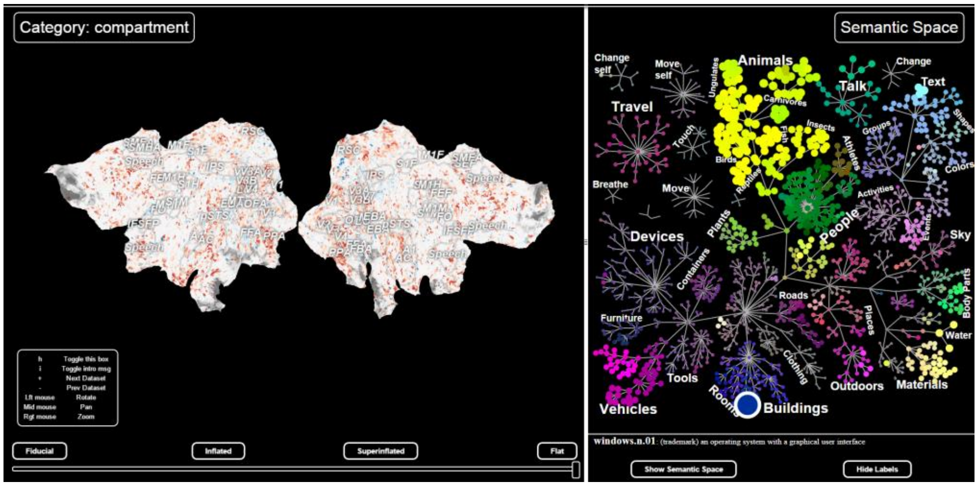

Figure 2: UC Berkeley's Gallant Lab brain viewer.
A representation of the open-source virtual online brain data mapper, compiling thousands of results from research on human neocortex. Selecting a component in the "Semantic Space" viewport highlights the regions of the cortex which react and relate. http://gallantlab.org/semanticmovies/

However, with all of its findings and visual discoveries, *"Neuroscience has returned to the necessary and unimpeachable business of amassing findings, and has largely given up the attempt to make sense of the findings, once amassed, in any larger context."*[7] While this is due mostly to the popular embrace of lateralization (neuroscience's first big claim, that the brain's left and right hemispheres are split between logic and emotion), neuroscientists have given up on speculation and generalization because common understandings of lateralization are beginning to shift.[8] If not them, though, to make sense of the findings, then who? Surely, the neurosciences are exploding at such an exponential rate that no realm of academic or occupational research is safe from being uprooted from its traditional understandings. No experts are

[7] Iain McGilchrist, *The Master and his Emissary*, p. 2
[8] V.S. Ramachandran, *Phantoms in the Brain*, p. 279

safe from being scrutinized. But how can we ensure that without a larger context and understanding of what it is neuroscience is discovering piecemeal, that the increasingly interconnected world of information sharing *won't* dismantle the process? How can we keep our "Emissaries" at bay? [9] With the speed and rapidity at which our world moves, there exists a need for checks and balances on the consilience between neuroscience and architecture. What are the goals, limits, and potential pitfalls of such a powerful science being unleashed? It is my feeling that without first designing a conceptual framework for the specific findings of neuroscience, information and ideas may become lost, confused, abused and ultimately, discredited.

1.2 Neuroethical Architecture

I am calling a proposal for this framework *Neuroethical Architecture*, which is based on premises of *neuroethics*. While neuroscience may reveal thousands of discoveries in how we process environments, Neuroethical Architecture maintains a level of **commitment to only those endeavors which seek to genuinely improve the quality of human life by advancing our ability to be happy, healthy, and generative**. Because architecture is so deeply rooted in the core of human evolutionary existence, it serves as model for how the neurosciences can reconnect us to the "archaic, bio-cultural dimensions of the

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[9] the left hemisphere, as termed by McGilchrist.

human psyche".[10] The basic concept is that we should not only deal ethically in the act of researching the brain in such detail, but we should *design* ethical places for people to live according to what neuroscience reveals.

In this sense, it is important to see past our learned perceptions to see the hardwired reactions we all share. It is those hardwired reactions which we can see, prove, agree upon, and be united by. A key text to be introduced to the realm of neuroscience and architecture, Anne Sussman and Justin Hollander's *Cognitive Architecture,* addresses clearly some of the key points at hand, suggesting that "at the end of the day, we cannot be healthy, think well, and flourish by abandoning or ignoring our primal context"[11] and questioning what the architects or planner should "know about the human as a generic client."[12] This notion of the generic client may indeed "confirm that our experiences of architecture are grounded in the deep and unconscious layers of the human mental life."[13]

Neuroethical Architecture may be understood as part of the larger story of building. The first part of that story, pragmatics of function and economy of means, can remain the same. The building should perform and not impede its own use and the uses of its adjacent context, but should also allow for a

[10] Juhani Pallasmaa, as referenced by multiple sources
[11] Susmman & Hollander, *Cognitive Architecture*. 151
[12] Susmman & Hollander, *Cognitive Architecture*. 2
[13] Pallasmaa, *Towards a Neuroscience of Architecture, 16*

biologically sensitive inhabitation. This occurs outside of the cognitive effects of the environment once it is built.

Where Neuroethical Architecture finds its home is in the realization, spatializing, materiality, embodiment, and empathy an inhabitant actually, physically experiences. While this experience does include the embodied creative intentions of the designer, which may complicate the matter, other issues of function and pragmatics which occur outside the realm of actual analysis (one cannot literally experience an underground foundation or the responsible sourcing of materials), occur outside the realm of neuro-analysis.

It should remain clear that neuroscience, indeterminate in and of itself, only really pertains to the experiential aspects of a place. The tricky part is defining how much we are really capable of experiencing and perceiving. This thesis asks of neuroscience not to help us determine what *to* do, but rather, through identifying and referencing the common core of human perception, what *not* to do.

We should treat this process of digging into the brain as we would digging an archaeological site. We know our story is there, beneath the dirt, but we don't indulge because we *know* that with our current tools, our current understanding, we cannot do so responsibly. We do not have the resources available or the planning of pieces in place to successfully reveal this important information about ourselves. "Ultimately our aim must be to find out how the same fundamental neural principles determine all behavior."[14]

On Empiricism

"One of the arguments against the whole idea of imposing empiricism on architectural design has been that this empirical approach, or the scientific approach, might challenge the intuitive and creative sensibilities of architecture. I argue strongly with that. What we are suggesting is that factual knowledge about how design changes our brain can be 'an arrow in the quiver of the architect'. Rather than stifling creativity, I believe that this added knowledge will actually broaden that creativity."[15]

In the face of doubt and complexity, architects have searched for formulaic solutions and determining constraints. Intuitive shared principles like "order", "edge", and "sustainability" come down from the heavens to help us mystically infer what to do in any given design problem. We search for this guidance because architecture is incredibly hard. In fact, the way we wish it to be is near impossible in a place like New York City. Architect and mathematician Christopher Alexander is most well-known for his battle with empiricism, illustrating one such ideal design calculation in Notes on the

[14] D.O. Hebb, *The Organization of Behavior: A Neuropscyhological Theory,* p. 166
[15] Fred Gage, *Lecture at the AIA 2003 National Convention & Expo*. May 8, 2003.

Synthesis of Form, after preaching of a potential “unselfconscious equilibrium” or “stability”[16] in design thinking. And he wasn’t the first.

René Descartes and his theory of “Cartesian doubt” ushered in what would become the French response to an otherwise emotive Italian baroque movement, one fueled by the Counter-Reformation of the church in the early 16th Century. Descartes, known as the father of the mechanized view of the world, insisted that we not believe only “what we can clearly and evidently intuit or deduce with certainty”.[17] Architect and scholar Claude Perrault and others took this to heart, developing theories on the eye, and its inherent ability to judge proportion only because of a resonant knowledge found within the intellect. Perrault goes so far as to distinguish between “Positive Beauty” and “Arbitrary Beauty” much in the way Descartes would separate body (res extensa) from consciousness (res cognitans). Perrault would draw on his extensive empirical knowledge of anatomy to undermine the Humanist notion of beauty, opening it to the volatility of the fluctuating fashions of human culture. The architect’s inner struggle between body and mind, logic and emotion, began here and has continued through nearly every sway of architectural style we now identify. Today, in *Should Architects Care About Neuroscience*, architect and author Harry Francis Mallgrave reflects on this pattern, and is even concerned with his own personal history among determinism in a Post-Modern practice. In reflecting, however he feels

[16] Christopher Alexander, *Notes on the Synthesis of Form*
[17] René Descartes, *Regulae ad directionem ingenii*

confident that the "new inter-disciplinary theories of whom we are as human beings will never tell us to paint all our walls green, and the architect should therefore be relieved." [18]

If that is the case then, and the findings of neuroscience are and will be inconclusive for some time until we unravel them, where do we go from here? Let us map out the remaining pieces to the proposal.

"It is not the rationalization itself that was wrong in the first place and now *past period of modern architecture. The wrongness lies in the fact that the rationalization has not gone deep enough. Instead of fighting rational mentality, the newest phase of Modern architecture tries to project rational methods from the technical field out to human and psychological fields…Technical Functionalism is correct only if enlarged to cover even the psychophysical field. That is the only way to humanize architecture."*[19]

1.3 The Academy of Neuroscience *for* Architecture (ANFA)

"It is obvious that the neurological investigation of architectural experiences and meanings has to be based on a deep dialogue between scientists and the makers of architecture."[20]

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[18] Mallgrave, *Should Architects Care About Neuroscience?* 26
[19] Aalto, *Rationalism and Man*. 102
[20] Pallasmaa, *Towards a Neuroscience of Architecture*. 20

In light of a framework for which to control and mitigate the specific findings of neuroscience in the context of architecture, one group is leading the effort in developing the communication between the two disciplines. The Academy of Neuroscience for Architecture (ANFA), based in La Jolla California, was founded in the early 2000s across several meetings. John Eberhard, former head of the AIA, led the movement and founded the organization. He has since then stepped down to the position of board member, of which there are several. ANFA hosts annual conferences at the Salk Institute, out of which they are based, and have pushed the convergence of its two disciplines since its founding.

However, a primary concern of this thesis is that the conversations between architects and neuroscientists is lacking. What's more, no concrete, physical space currently exists for neuroscientists and architects to work alongside one another, which, according to their own research, is a key method in what Eberhard has termed "consilience". Furthermore, the language and syntax of the two groups is disparate. Architects rely mainly on intuition and imagery to describe their creative process, while neuroscientists rely on data and the experiments which arrive at that data. In the section titled "Lidar" of this document, a new methodology for neuroscientists and architects to work together is proposed.

More importantly, it seems as if the relationship between neuroscience and architecture as it exists is not inherently mutual. Architects continually speak of “mining” neuroscience for clues and data in order to arm them for better design. In fact, the very name of the Academy hints at this, calling itself an Academy of Neuroscience *for* Architecture (AN > FA). By proposing a Neuroarchitecture Incubator with the available technological resources at hand, this thesis might suggest something more like an Academy of Neuroscience *and* architecture (AN <&> A).

1.4 New York City Applied Sciences

While the diseases of civilization we have come to know in society may seem daunting, there are movements which may begin to allow a deeper understanding and process of resolving them in large urban areas. One such initiative, New York City’s “Applied Sciences”, is a program dedicated to bringing New York City to a position of innovation and research importance. The goals of the program are to not only bring large technology-based companies into the city, but to introduce new ones. The program has been initiated with state funding, but is set to pay itself off as new jobs and institutions arrive in the coming decades.

With the Academy of Neuroscience for Architecture and New York City both pulling for the same cause, the proposal seeks to converge the efforts of the two groups into a single research institution, ANFA NYC.

2 THE HUMAN BRAIN

The following section will put forth a series of short essays on understanding the brain as an anatomical organ. It then contains preliminary research in focusing on the three phases of our brain's development and the structures that came along with those phases. The structure and anatomy of the brain are important for architects to delve deeply into, because the interrelationships and function of the structures found within it give clues as to why we perceive architecture the way we do.

Brain as Forest

In gazing out onto the universe for answers, we've begun to realize the answers we may possibly be looking for are not right under our nose, but rather, behind it. Neuroscience is beginning to reveal to us why we are the way we are. It sounds strange, but, in all reality and obviousness, what else is there to know? Every perception and motivation we could ever possibly have must be passed through the mysterious filtering machine which we call a brain. Nothing which we know, do or experience can bypass its processing. It does not make sense to attempt to make sense of what we are doing without a thorough understanding of the brain and how it works. This *is* exactly brain surgery, after all.

Essentially, we can see the brain is a forest. At birth, it uses the genetically infused laws of energy and nature in order to grow and develop. Once growth reaches its extents through adolescence, we wander within it, haphazardly tearing through its density using instinct and nurture as a guide. We don't know our way around and can hardly remember where we were in it the day before- an amnesia of sorts. We pick up tricks here and there from others we find along the way like using the sun as a compass or what to eat. As we grow, the more familiar the trees we continually pass become, and so we form habits. We learn paths that can get us from field to field most efficiently. The fields are our synapses, and our comfortable routes between them the synaptic paths. Once we learn them, we like to use them. They remind us of things. We remember them.

Like nature, a forest can never reproduce itself identically, and even if it could, no two individuals would ever come to know it identically. Despite the forces of science, it would be foolish to think we could ever understand the properties of natural growth in order to recreate it artificially. While each day we get closer and closer to understanding how the human brain works, what its spatial structure is, and what that has to do with the way we behave. However, the task of mapping the brain is unimaginably daunting. With its one hundred billion neurons, each with 7,000 bridges to other neurons, the brain's *continually changing* infrastructure of 500 trillion bridges, roads, and tunnels begs the question: is it even possible?

"The brain is constantly changing. Its raw material is information from the sense- vision, hearing, smell, touch, taste, and proprioception. From this information the brain creates a perception of what lies outside. However,

these ideas are not truly useful until they are invested with meaning. The meanings we attach to perceptions transform mere patterns of light into buildings we can use, people we can love, or music we can enjoy.” [21]

In attempting to simplify the discussion, we may look to two of the primary drivers for how we developed a shared experience of the environment: evolution and survival. The following are a pair of brief preliminary essays discussing the two topics. The important point is first calling attention to them, and understanding that evolution and survival are too far engrained in human life to consider them part of the past. In other words, we are still fighting to survive (regardless of environmental and social development), and we are still evolving.

Evolution

“Evolution brings to the present what worked out in the past.”[22]

We are all the same. We always have been. Our basic motivations and behaviors have varied so slightly over the course of civilizations and geography, but their manifestations in our environments have varied immensely based on those factors otherwise filed under ‘regionalism’. A series of case studies can show this to be true. If we can read and relate to the

[21] John Paul Eberhard, *Brain Landscape*. 84
[22] Sussman & Hollander, *Cognitive Architecture*. 61

thoughts and works of Henry Thoreau, Marcus Aurelius, Socrates, Immanuel Kant, how is it that we cannot relate to one another? Our buildings, our works, and our writing outlive us. In outliving us they build bridges that span across human limitations like life, death, and immobility. They can transfer a message: "We are and always have been the same, remember yourself by remembering us."

"Science cannot in any way make theory when it comes to architectural design. What science can do, however, is offer us an ever more revealing portrait of who we are, where have come from, and where we might be going in an evolutionary sense."[23]

Historically, evolution implies progress. By evolving, an entity is shedding its inferior qualities to make way for the implementation of superior ones. Randomly occurring genetic mutations that grant survival advantages remain, are sought after, and reproduce themselves naturally thereafter. Unfortunately, we've allowed the understanding of this theory to apply itself to civilization. The theory has driven things like African-American slavery, Nazism, and the negative segregation tidal wave that has flooded our psyches for centuries. These movements exploited the concept of environmentally driven progress and development in order to assert its believers over the rest of humanity. While it was a maladaptation of the theory, it should be noted as true, but not in the framework as used for slavery and genocide.

[23] Mallgrave, *Should Architects Care About Neuroscience?* 26

Logically, and scientifically, it cannot be argued that we as humans are a physiological, biological result of adaptations to our environment over the millennia of our existence. Traditionally, for an evolutionary glacier to slide, it takes as much time. What we truly must contemplate is that as we shape our environment to an extent unfathomable less than a century ago, are we creating one in which we would like ourselves and our offspring to adapt to? Attention disorders born from flashing advertisements, depression from neglect and a separation from happiness, mental illness, eating disorders, are very simply put how a human being adapts and regenerates in an environment built with the wrong intentions. “We shape our buildings, and afterwards our buildings shape us.”[24]

Our brain is a map of this evolution, and, in a way, has been built upon and on top of. The notion of the brain as a unitary lump of gray matter with random neural firings is being demystified through mapping efforts, revealing the brain as a “complex of different components that have built upon one another during the lengthy period of evolutionary development.”[25]

Survival

The human species has existed on this planet in some form or another for 13.8 billion years. That is when our evolutionary process from single cell organism (*evolution*) began. Since that moment, we have begun developing and filtering

[24] Winston Churchill, from a meeting at the House of Commons, 28 October 1943
[25] Rossi, *Architecture of the City.* 87

our anatomical traits in order to better maintain life. The basic ‘need’ was, in fact, a need: survival. There were so many natural threats and so very few defenses that it took some 13.799999 billion years to win, if one wishes to claim victory at this point in the year 2014. Of course, notwithstanding newly introduced manmade threats, we essentially have won the battle against our natural predators and climatic challenges in developed countries. In a way, “our perceptual systems are designed to register aspects of the external world that were important to our survival…”[26]

Our reading and evaluating of the environment can directly be linked to our instincts to survive. It has become commonplace understanding in neuroscience that our reactivity to the environment is one of filtration and evaluation. When we digest a form, a contour, or object, we instinctually assess it in terms of its ability to do harm. Discomfort, ugliness, irritation, and beauty are all the reactions of our endless thirst for survival and procreation. Not only have we not evolved beyond this instinct in the short amount of time since we became self-aware, but parts of the world are still very directly involved in the struggle to simply survive.

[26] Steven Pinker, *The Blank Slate: The Modern Denial of Human Nature*. 2003. 199

Return to Anatomy

Architects are creatures of synthesis and systems thinking. The ultimate natural system is the anatomy of the human body. In re-focusing architecture on the human, there is no question that a thorough understanding of anatomy, in this case of the human brain, is essential. It is a mission of understanding *why* we operate the way we do, and of mapping connections and correlations between the way we are and the way we wish to be. In a way, Neuroethical Architecture is a sort of contemporary humanism.

Humanism

In Italy, in the early fifteenth century saw the onset of *humanism*, the multi-dimensional artistic appreciation for the human body through a classical lens. Christianity and the medieval past required reconciling, offering a viewpoint that the human being "by virtue of his divine creation, occupies a privileged place within the cosmos."[27]

Of the most famous of the period's architects was Leon Battista Alberti, who put forth a treatise in the early 1450s depicting the metaphoric relationships between architecture and the human body. Through his treatises *De pictura* (On painting), *De Statua* (On sculpture), and finally *De re aedificatoria* (On architecture), Alberti mathematically correlates geometry with the humanization of space. His notion of *Historia* depicts the artist's ability to,

[27] Harry Francis Mallgrave, *The Architect's Brain,* p. 9

through the proper representation of people in works of art as free-willed, beautifully proportioned, and emotive. It is this emotion which stirs our empathy "as to hold the eye of the spectator for a long while with a certain sense of pleasure and emotion."[28] The theme carries through his rhetoric on sculpture and architecture, ultimately claiming the corporeal relationship between building and Nature, with anatomical analogies abound; buildings possess bones, muscles, ligaments, skin, limbs, and even bosom.[29]

Through his ten books, Alberti comes attempt a definition of architectural beauty to separate himself from his contemporary, Vitruvius, with the concept of *concinnitas*. *Concinnitas* allows for the "sympathy and consonance of the parts within a body" and therefore its ability to be beautiful.[30] He continues on "for about the appearance and configuration of a building there is a natural excellence and perfection that stimulates the mind; it is immediately recognized if present, but if absent is even more desired. The eyes are by their nature greedy for beauty and concinnitas, and are particularly fastidious and critical in this matter."[31]

Alberti's contemporaries would go on to advance his theories of the humanist metaphor, including Leonardo Da Vinci, Michelangelo, Filarete, and Francesco di Giorgio. The theories would spiral into proportional debates and

[28] Leon Battista Alberti, *On Painting and On Sculpture,* as translated in Grayson, p.95
[29] Alberti, *On the Art of Building*
[30] Ibid, Bk. 9:5, p. 302
[31] Ibid. Bk. 9:8, p. 312

encircle themselves in logic, eventually losing sight of the more psychologically human notions of Alberti's *Historia*. Humanism, in a way, became more of an obsession with the brain's ease of proportional digestion than its ability to empathize. In a way, the pendulum began to sway back toward a rationalized society.

Similar to Leon Battista Alberti's humanist inclination to understand the connection between body and building, we must once again return to this metaphor, except slightly altered. If we consider the body as a walking brain, with all its neural tendons reacting to and transmitting stimuli through the senses, then we should more directly focus on the anatomy of the brain. If the anatomy-obsessed humanists of the 16th C. were alive today, there is no doubt they would be looking into the neurological understanding available to architects today.

In understanding the anatomical brain, we must first clarify the distinct systems within which the many components of the brain are found. This understanding is most easily dissected in a hierarchical view. I will refer to those larger systems of the brain in terms of their evolutionary appearance, as is the underlying theme of this thesis. The oldest part of the brain, the brainstem and cerebellum, will be referred to as the "primitive brain". Next, the limbic region, or "early brain", with its parallel set of hemispheric components, is largely our brain's "powerhouse".[32] Finally the cerebral

[32] Rita Carter, *Mapping the Mind,* p. 54

cortex, or “modern brain”, which is the most quickly referenced view of the brain, comprised of the outer mantle of neurons and its four primary lobes.

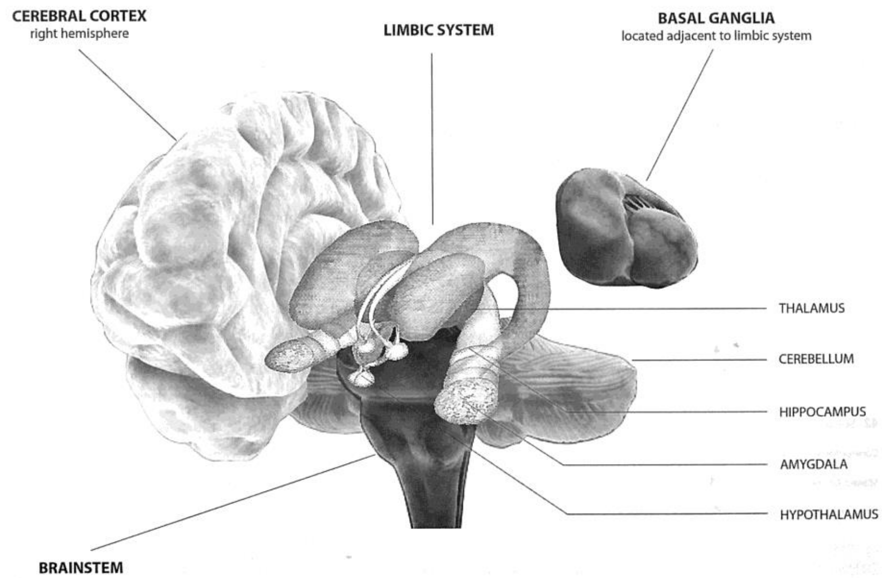

Figure 3: Exploded Axon view showing the primary brain systems.
Abby Bristow and Michael Mastriano, as printed in Mallgrave, *The Architect's Brain*.

2.1 The Primitive Brain

“In order to discover something new, we must study what is oldest.”[33] Not surprisingly, the oldest part of the brain is turning out to be the most biologically complex.

Cerebellum

The cerebellum was, at one point, the primary brain, most readily identified as helping control coordination, precision, and timing. Closest to the superhighway for neural input (the spinal cord), it’s clear why our early

[33] Professor Aulis Blomstedt, Finnish architect and Professor at Helsinki University of Technology

ancestors would need these skills for basic survival; how quickly and how well we could evade environmental risks triggered by stimuli as well as capture prey were critical in our existence from the earliest stages of man's development.

Pons

Sometimes referred to as the *pons Varoli*, or "bridge of Varoli" after the Italian surgeon Costanzo Varolio (1543-1575), the Pons is just that: a bridge between the spinal cord, cerebellum, and the rest of the brain, transmitting messages up the evolutionary chain. Not only does the Pons bridge our primitive brain to our more recent components, but acts as the threshold to the dream world. Its other primary function is that of controlling sleep and other regulatory cycles.

Medulla

The medulla is unique in that its functions are involuntary, without conscious thought. The medulla regulates some of the most basic corporeal functions like the regulation of blood pressure, swallowing, heart rate, and breathing.

2.2 The Early Brain

Amygdala

Emotion barometer, recognizes threat potential and promotes the emotional response to react. Bar and Neta (2006) discovered that slightly curvilinear contours in the environment are preferred among individuals, because angular contours pose more of a threat, as noted by the amygdala response. How does this pan out architecturally? How does it affect our wayfinding ability, and balance itself out with the otherwise understood spatial order of architecture? By looking at the environment in different scales, perhaps we can appropriately apply curvilinear design? For example, is it more beneficial for the exterior of a building to be angular? Or the interior? Or maybe just those details which we interact directly with at a small scale, like handrails and doorknobs?

Results were repeated in Michael O'Boyle of the Salk Institute's study *An fMRI-based Exploration of Neural Correlates*. The study expanded out to interior, exterior, object, and landscape, and produced interesting contrast to Bar and Neta's results. When examining interior or exterior (i.e. built) environments, the amygdala actually detected threat when viewing curvilinear contours. When we consider Wayfinding, you *need* "unambiguous directionality" to avoid "meandering anxiety" in spaces concerning utility. The experiment was based on analyzing healthcare settings, where wayfinding is essential.

Hippocampus

Part of the Limbic system and Latin for "seahorse", the hippocampus primarily controls the functions of memory (both short- and long-term) and its storage. Its attention today is mainly in helping to understand Alzheimer's disease, and how a malfunctioning within the hippocampus may be responsible for it.

Architecturally, the hippocampus therefore allows for the mapping of space and our ability to remember and navigate environments. London taxi drivers, for example, have enlarged hippocampi.[34]

Thalamus

Known to be the gateway to the cerebral cortex, or the bridge between the new and old brains, the thalamus rests within the seahorse curve of the hippocampi. The thalami, egg-shaped and at the very center of the brain, (one in each hemisphere), are subdivided into about 20 smaller regions, each corresponding with a very particular part of the cerebral cortex. Because of its omnipresence in nearly all brain functions, the thalamus can be viewed generally as the control center of the brain. The *hypo*thalamus is specifically responsible for sensations of thirst and hunger, as well as maintaining a comfortable body temperature in varying environments.

2.4 The Modern Brain

Cerebral Cortex

The most commonly understood areas of the brain, as well as its left | right lateralization (that the brain has two hemispheres, one for logic and one for emotion) falls within the realm of the cerebral cortex, or the outer skin of

[34] Mallgrave, *The Architect's Brain*, p. 131.

fibrous neurons that connect all parts of the brain. Because of its rapid growth within an otherwise limited cranium size, the cerebral cortex has folded over upon itself time and time again, creating fissures and canyons known as *culcii* (*culcus*, singular).

The well-known lobes of the cerebral cortex, the *frontal, parietal, occipital, and temporal* lobes, each are neatly divided and control certain higher level functions.

The frontal lobe, the most recent introduction to the brain's evolution and in an individual life, helps us plan and reason. Individuals with violent tendencies often don't have very active frontal lobes, and our teenage years are typically when we make poor decisions.

The parietal lobe, located along the top-rear of the brain's outer mantle, is of particular interest for the architect concerned with emotion and embodiment. Working closely with the occipital (visual) cortex of the brain, the parietal lobe (more specifically the *somatosensory cortex*) focuses on allowing us to touch and move. This relationship will be important later in understanding *empathy*. By working with the visual cortex, the somatosensory cortex can process visual stimuli and evaluate them using several types of *receptor cells*, each pertaining to different types of stimuli ranging from temperature changes to chemical presence. The lower, periphery *temporal* lobes of the brain, near the ears, focus mainly on language and sound recognition and spatial visualization. [35]

While the hemispheric understanding of the brain has grown less tidy than the previously accepted notion, each still does focus its efforts on certain functions; the left hemisphere specializes in language and analytic skills, while the right is more capable of seeing the big picture, and the processing of spatial relationships and feelings. Many processes happen on both sides.

Corpus Collosum

Although each hemisphere of the brain has its own cortex and limbic components, it shares several in common, including the *corpus collosum*. The bridge between both hemispheres of the brain, the corpus collosum has been the target of studies and procedures aimed at understanding and preventing autism and seizures; usually, its severance allows for confused trans-hemispheric neural activity to cease.

[35] Mallgrave, *The Architect's Brain*, p. 133

3 SITE DESCRIPTION

While the initial interest in the site for the locating of ANFA NYC came from that of the Smallpox Hospital Ruin (a predominant curiosity early on in the process) analysis expanded the scope of the site and led to a much deeper understanding and embracing of the ruin's context. In the process, it became evident that the site offered a vast multitude of environmental conditions, making it an ideal place to bring researchers interested in the effects of environment on the human brain. The following is a list and description of the various environmental conditions in the vicinity of the ruin and a description of how they might serve the research agenda on site.

3.1 Blackwell (Roosevelt) Island

To place the site in context, a brief general description of Roosevelt Island is helpful. The island is located on the east-west centerline of the Hudson River of New York City, between the boroughs of Manhattan and Queens. Initially settled by and named after the Blackwell family, the island's primary purpose was agricultural. Over time, land was partitioned off and developed for various different uses ranging from religious to residential. Eventually, the island was realized as an ideal setting for quarantine. New York City's sick or unlawful would be brought to the island and rehabilitated in one of a variety of campuses ranging from hospitals to nursing schools to penitentiaries. These structures that served these past institutions have come and gone in various phases of development and as societal needs shifted over time, but some remain as historical remnants.

Currently, the island hosts a large population of residents, high rise developments, religious institutions, and is connected to Manhattan by a well-known aerial tram and hosts its own subway stop along the F line. The Ed Koch Queensboro Bridge extends over the island, but does not connect it to either Queen or Manhattan, leaving the only vehicular access to the island via Queens. In an effort to generate revenue, New York City, which technically owns Roosevelt Island, has leased the island to New York State on a 99-year contract. This leaves a strange conglomeration of decision-making when it comes to making changes.

Two primary organizations involved in the more intimate inner workings of the island include the Roosevelt Island Operating Commission (RIOC) and the Roosevelt Island Historic Society (RIHS). While some of the structures on the island have been taken in by the New York City Landmarks Preservation Commission (LPC), both RIOC and RIHS hold direct control of the primary records and operations of the island. Both were contacted and worked closely with in the development of the thesis proposal.

3.2 South Point Park

Figure 4: The approach to South Point Park along the East River
Facing Manhattan. L. Petrocelli, November 2014

The largest area of development and institutional change over time has occurred at the southern end of Roosevelt Island, in an area now developed as a multi-acre park landscape: South Point Park, which still hosts its own set of historic structures. These include the ruin of James Renwick's Smallpox Hospital, and the Strecker Memorial Laboratory

Figure 5: The Ruin in its 'landscape'
The image shows a more interesting vantage point from the nearby hilltop in South Point Park, highlighting the then and now. This may be a more interesting approach to the Ruin than the existing one along the East side. L.Petrocelli, 2014

3.3 Blackwell Island Smallpox Hospital

Latitude:	*40.751589*
Longitude:	*-73.959597*
Country:	United States of America
State, City:	New York, New York; Roosevelt Island
Initiative:	1850
Constructed:	1854 – 1856
Opened:	18 December 1856

Reason for Being

In the mid-19th Century, industry was a burgeoning cultural explosion- a new lifestyle. Cities were expanding with the onset of technological, mechanical invention and innovation, production was compounding, and *'progress'* saw no bounds. The excitement of electric lights and economies of rail and port had cities bursting at the seams. New York City wasn't an exception, but rather, the rule.

Building legislation was obliviously non-existent for some time during the growing pains of the industrial revolution, leaving room for poverty, crime, and disease. Smallpox struck. Immigrating populations played a large role in spreading the disease, so New York City saw large outbreaks even though vaccinations were available. While its primary function was quarantine, the move to the island wasn't necessarily pulling people apart. Its grandiose design was predominantly a measure to appeal to citizens on both ends of the class spectrum.

The original 1856 commission was simply termed the Blackwell Island Smallpox Hospital. It was designed by Renwick, Aspinwall, & Owen as a Neo-Gothic, 100 bed hospital. The building later became known as the Maternity and Chapel Hospital Training facility, when two smaller adjacent structures were added in an effort to keep birthing clinics sanitary; birth fatalities were at an undesirable rate because doctors were spreading disease from other patients to birthing mothers.

Figure 6: A view looking South toward the existing structure, 1870
Image borrowed from RIHS, author unknown.

Shortly after its birth in 1875, the hospital closed, leaving the structure to be reused as a nursing training facility for nearby City Hospital, known later on as Charity Hospital. In 1903, the original James Renwick, Jr. hospital block invited two co-pilots: a pair of sympathetic wings on either side designed by York & Sawyer and known as the Home for the Nurses, eventually becoming the Maternity and Charity Hospital Training School. A growing academic interest in the field begged for more square footage. The renaming of Blackwell Island to Welfare Island in 1921 had a large impact on the structures of the island, and it was at this time that most became obsolete and fell to disrepair.

Figure 7: The Ruin; existing conditions of the SW corner
Cavaglieri's steel endoskeleton acts as a framework for a steel pipe exoskeleton bolstering window openings. Photo by author, September 2014

Figure 8: The Ruin; existing North elevation looking NorthEast
The ruin has been lit for viewing from Manhattan and the East River since the early 2000's in an effort to raise funds for its preservation. L. Petrocelli, 2014

Figure 9: The Ruin, at the S.East corner of the North wing
Now the home of graffiti hinting at the building's haunted past. Windows on the ground floor are outfitted with security chainlink. L. Petrocelli, September 2014.

Figure 10: The existing Ruin's North façade
Now mostly gone due to a collapse less than a decade ago. The Cavaglieri steel-framed portions remain moreso intact. L. Petrocelli, Septmeber 2014.

Figure 11: The view North along the East side of the Ruin.
An access road currently runs North South, with temporary trailers set up along it. The access road is locked by a metal gate at its North end, leaving visitors to enter along the West side of the structure. L. Petrocelli, September, 2014.

After a century of use, the hospital was closed, leaving its maintenance in the hands of the elements. The preexisting uses of the building were moved to Queens in the 1950s. In 1972, the National Register of Historic Places adopted the ruin. It became a landmark of the city in 1978, making it the only ruinous landmark with preservation status. 1973 saw the renaming of the island once again, this time after United States President Franklin Delano Roosevelt.

The Roosevelt Island Operating Commission (RIOC) has been working to raise funds for stabilizing the structure since 1995, simply by illuminating it at night to draw attention. Despite preservation efforts, the North wall of the structure collapsed the day after Christmas in 2007. On May 28, 2009, a park system encompassing the south end of the island incorporated plans for stabilizing the structure and creating a visitor center, as well as Louis Kahn's Four Freedoms Park and 14 acres of public land. The stabilization project continues, but has stalled in light of lacking funds and scope of work. In a way, we have given up on the old man.

Figure 12: The existing conditions of the East face of the 'Renwick Ruin'.
The fallen stones of the North wall collapse are maintained in pallettes on site, in the existing "courtyard" area of the building. L. Petrocelli, September 2014.

"The Smallpox Hospital could easily become the American equivalent of the great Gothic ruins of England, such as the late 13th century Tintern Abbey in Monmouthshire, which has been admired and cherished since the

18th century as a romantic ruin," and described the building as "a picturesque ruin, one that could readily serve as the setting for a 19th century Gothic romance."[36]

Architectural Description

When completed, it was a three-story, nine-bay U-shaped structure faced in granite veneer in a random ashlar pattern over load-bearing rubble masonry. The central block has a hipped roof, with corbeled crenelated parapets on the projecting sections, with a simple cornice on the non-projecting sections. Crenelated polygonal chimneys rise from the southeast side of the main block. The two wings, which project from the ends of the northwest (front) facade, had mansard roofs.

At the center of the front facade is the main entrance. It has a porch open on three sides, oriel window above and projecting corbeled feature above the roofline. A wide pointed arch holds the main entrance. Though designed in the Gothic Revival style, all of the windows on the third floor have pointed arches rather than curves, unusual for that architectural style.

"[A]n expression of an eerie romantic mood ... a palpable documentation of a period in the past ... something which recalls a specific concept of architectural space and proportion."[37]

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[36] New York City Landmarks Preservation Committee, *Smallpox Hospital Designation Report*, 1976.
[37] Paul Zucker. as quoted in *Smallpox Hospital Designation Report*. 1976.

James, Jr.

Why did James Renwick, Jr. apply neo-Gothicism? Why evoke the spirits of the 12th Century Catholics to house the sick and dying on a quarantined island? Options abound, why bring back the dead? The decision was not an unlikely one. Similar to the acclaimed St. Patrick's Cathedral, the realization of which book- and tail-ended that of the smallpox hospital (the Cathedral was constructed between 1853 and 1858), Renwick revived the eerie ghost of Gothicism. A survey of his most notably celebrated works makes it obvious that Renwick had a passion for the styles of the past, but why? An excavation of the architect and his time might provide insight.

The apple didn't fall far from the tree. James Renwick, Jr. was, as titled, the offspring of James Renwick, architect, structural engineer, and professor of natural philosophy at Columbia College. His mother, Margaret Brevoort, was a wealthy New York socialite. One can speculate that James Renwick held a great paternal influence; he trained all three of his sons in the art of engineering. While all three were successful, the precocious James, Jr. would go on to become one of the most acclaimed professionals of his time. After completing studies at Columbia in structural engineering and then architecture at a very young age, James Jr. focused shortly on canals and railroads before he realized an urge for buildings. By entering and winning a competition in 1843 for Grace Church, an episcopal New York City beacon, and three years later doing the same for the Romanesque Smithsonian Institution Building, James Jr. stepped into the spotlight of an industrializing port coast. He brought with him the revived architectural styles of the past.

The Gothic Revival

While James Jr. sometimes breached and spanned subtly related architectural styles, he became most known for sparking the Gothic Revival. It makes sense from a logical standpoint that James Jr. would fall most susceptible to the point in history when architects were most interested in the liberation of architectural form granted by a structural understanding. “One can define Gothic buildings by their spatial characteristics, which tend to emphasize the vertical, consist of articulated but unified cells of space, and have a sense of openness afforded by the construction system.”[38] While most cannot define exactly what constitutes the architectural “style” of Gothic architecture, it is usually identified by its common forms in cathedral construction: the pointed arch, the ribbed vault, and the flying buttress. Theoretically, the Gothic was not so much a style as it was an anti-style.

While these common forms may narrate the architecture of the religious, they were not necessary in the modesty of secular construction. This is perhaps because the spirit of what we typically term Gothic architecture was *driven* by the religious dependence context of the 12^{th} Century Medieval world. It was a religious architecture. It was an architecture obsessed with connecting man to the heavens in a time of doubt. Amongst psycho-social chaos, we yearned and

[38] Moffett, et. al, *Buildings Across Time* p.229

stretched and grasped for the sky in an effort to uplift our psychological conditions. We find this obsession with the vertical to be true on a neurologic level, and reminiscent of Vischer's *Einfuhlung*.

The connection between Renwick's reason-based background and the structurally-founded Gothic might be self-evident, but a deeper speculation might offer insight as to how he, and in turn American society, so strongly grasped it. In a way, architectural styles have always been a mirror for those things which we as a society lack. "Gothic" architecture is one of the more telling points in our design history of the relationship between man's brain and the socially constructed environment. An artist or architect may initiate any particular style or neo-style, but it grows roots only if it appeals or provides an "aesthetic experience" for the masses.

While most forms of religious architecture hold true in their attempts to deliver earth dwellers to the heavens in "houses of God", the Gothic took on a slightly different character than that of its predecessors. The titling of the particular religious architecture of 12th century France as "Gothic" was a reflective afterthought, as is usually the case. (A style couldn't' possibly be named until we notice it as a trend). The word was applied to architecture through the Italian *gotico*, quite literally meaning "barbaric and rough". Surely, any stylistic form against the grain of ancient Rome was that of an aggressive outsider seeking to dismantle the Empire.

At the Abbey Church of St. Denis in the Ile-de-France, we find the birthplace, (not conception) of Gothic architecture. Amongst a collection of the period's most energetic, informed, and innovative patrons of the arts, Abbot Suger commissioned the church in 1137 based on a new model; the institution of the church in France was in a state of financial and religious reform, and the Abbot saw fit to derive a new image to reflect the change of its inner workings.[39] In starting with a blank slate, Suger, like most institutional patrons, sought to create an image of God better, grander, and more spectacular than its predecessors. To do so, he sought the origins of divine architecture in the Bible by referencing the Temple of Solomon, a design said to have been specified by God himself. Paired with writings he thought to be those of St. Denis suggesting the metaphysical, mystical ability for the human (or God's) spirit to be visually manifest in images, Abbot Suger initiated the Gothic foundations of the time.[40] In a way, the Gothic style itself was born in an understanding that humans emotionally embody their environments- an early neuroscientific approach. One might guess that its virility spoke to the success of Gothic architecture's ability to appeal to a common, neural core in humans regardless of culture or place, or even time. Claude Perrault would later pull from Gothic precedents, citing not their typically non-agreeable barbaric forms, but its structural ingenuity.[41] This meaning of the term has carried through in a peculiar fashion in our society.

[39] Moffett, et. al, *Buildings Across Time* p.230
[40] Moffett, et. al, *Buildings Across Time* p.230
[41] Claude Perrault, *Voyage a Bordeaux*

3.4 Strecker Memorial Laboratory

Figure 13: Strecker Memorial Lab Elevation Composite.
From top to bottom, views of the East-facing, North-facing, and South-facing elevations of the existing Strecker Memorial Lab. The Lab was the first center for pathologic medicine in the United States. Images created from Lidar imagery recorded on site, post-processed and extracted using FARO Scene Orthophoto application. L. Petrocelli, September 2014

3.5 Four Freedoms Park

Designed by Louis I. Kahn and constructed after his death, Four Freedoms Park provides a unique architectural experience for furthering the research agenda on site. It is described below through a series of images.

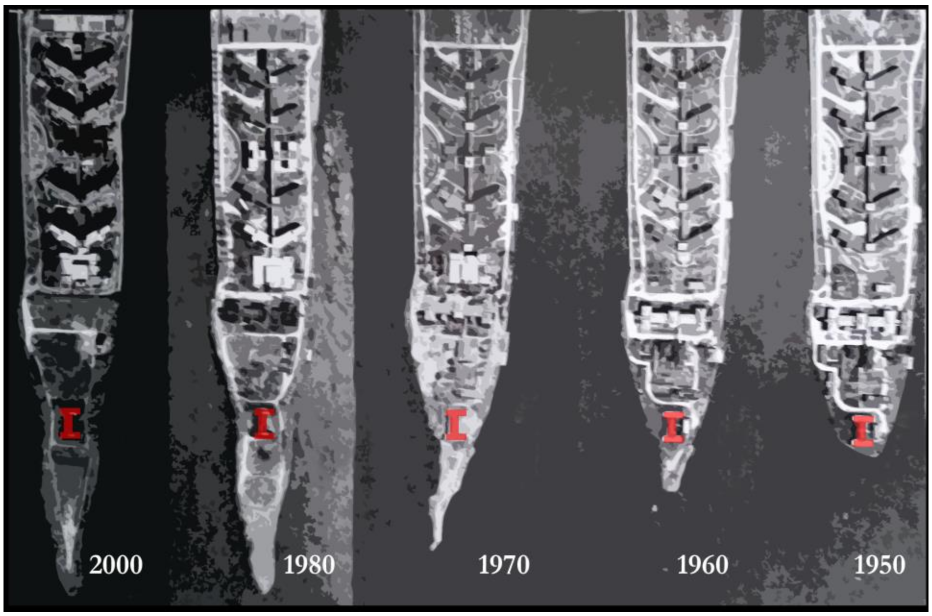

Figure 14: Four Freedoms Park Site Phasing Diagram
Conditions at the south end of Roosevelt island since 1950. Most notable is the view from c. 1950, showing the Ruin in its original context- one very close to the water's edge. Imagery courtesy of RIHS**,** Diagrammed by author.

Figure 15: The entry groundcover at Four Freedoms Park
1" gray gravel mingling with slightly larger scale canopy shade. Footsteps are made audible prior to entering the hardscape, closest to the Ruin. L. Petrocelli, September 2014.

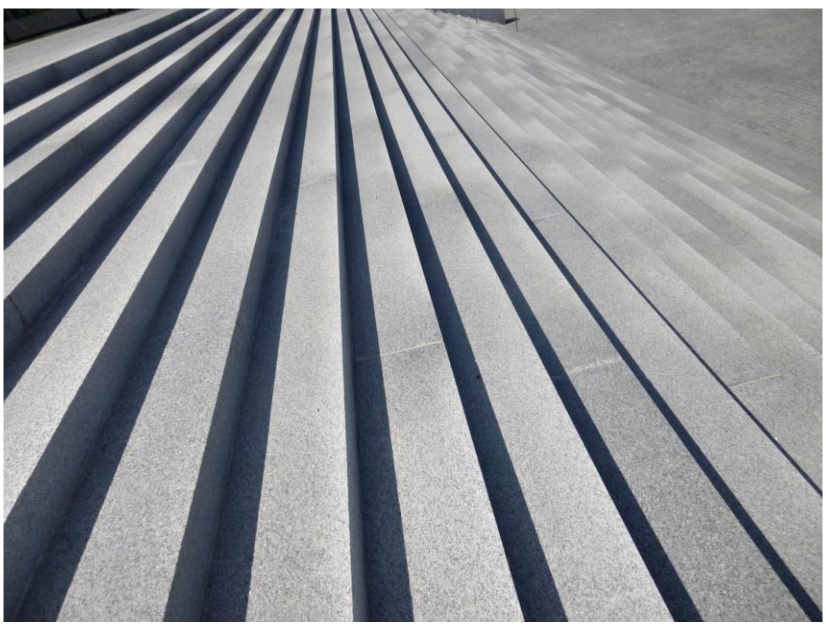

Figure 16: The monumental stair at Four Freedoms Park
Existing means for navigating the grade change up to the main lawn. L. Petrocelli, September 2014.

Figure 17: South Point Park Lawn
A comparison of the views North (top) and South (bottom) from the midpoint of Four Freedoms Park. The Park reportedly was meant to "frame" both the Ruin and the Ed Koch Queensboro Bridge behind. L. Petrocelli, September 2014.

Figure 18: The reverse of the Franklin Delano Roosvelt Monument
The stone display serves as a screen from the Ruin when inhabiting Kahn's terminal "room", looking North. L. Petrocelli, September 2014.

"IN THE FUTURE DAYS WHICH WE SEEK TO MAKE SECURE, WE LOOK FORWARD TO A WORLD FOUNDED UPON FOUR ESSENTIAL HUMAN FREEDOMS. THE FIRST IS FREEDOM **OF SPEECH AND EXPRESSION** – EVERYTHWERE IN THE WORLD. THE SECOND IS FREEDOM FOR EVERY PERSON **TO WORSHIP GOD IN HIS OWN WAY** – EVERYWHERE IN THE WORLD. THE THIRD IS FREEDOM **FROM WANT**…EVERYWHERE IN THE WORLD. THE FOURTH IS FREEDOM **FROM FEAR**…ANYWHERE IN THE WORLD. THAT IS NO VISION OF A DISTANT MILLENIUM. IT IS A DEFINITE BASIS FOR A KIND OF WORLD ATTAINABLE IN OUR OWN TIME AND GENERATION." [42]

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[42] Franklin Delano Roosevelt, *Annual Message to Congress*, 1941

3.6 Cornell NYC Tech

The Cornell NYC Campus is the largest planned development of the Applied Sciences program to date, and finds its home on nearly a mile of soon-to-be cleared Roosevelt Island real estate. Designed by SOM, the master plan features iconic buildings from the likes of Morphosis and also Manfredi Architects. The proposal first called for the demolition of Goldwater Memorial Hospital, the removal of which is now reaching completion at the time of this thesis. Cornell NYC Tech, as the new campus is to be called, is “the first graduate research institution where someone is trying to design it from the ground up in the information age,” and, according to the school’s dean, Daniel P. Huttenlocher, “that is a very abstract goal”. [43]

Figure 19: Aerial rendering of Cornell tech’s campus
Phase II development rendering, south of the Ed Koch Queensboro Bridge. The Ruin is buried in the treecover south of the Campus plan. SOM & Cornell University.

[43] Sarah Maslin Nir, *In Bedroom Community…* (www.nytimes.com)

Figure 20: Master Plan of Cornell Tech on Roosevelt Island
The park landscape to the south of the master plan have been revised to include larger residential and academic buildings. North here is to the right of the page. Image property of SOM Architects and Cornell University.

Figure 21: Existing Goldwater Memorial Hospital
The building development is slowly being demolished to make way for Cornell Tech's campus buildings and lawns. L. Petrocelli, September 2014

Figure 22: Proposed renderings of the incoming Cornell Tech Campus
The spectacle arrives on the coattails of Thom Mayne and Manfredi. Image property of SOM & Cornell University.

3.7 *Site Analysis and Design Reactions*

So then, in designing a new Neuroarchitecture research incubator, how do we begin to balance all of the existing conditions and incoming resources at play? First, an analysis of Cornell Tech's proposal and impact on not just Roosevelt Island, but its new neighbor, South Point Park, specifically. While the resources supplied by this campus are immense and hugely beneficial, there are certain concerns of residents on the island that the amount of infrastructure will be too difficult to manage.

The primary feature of the campus (the Tech Walk) is a north-south pedestrian access way through the spine of the campus, delegating vehicular traffic to the outer loop along the waterfront. This loop was an existing roadway, and works efficiently in terms of moving vehicles safely around the site. A major downfall to the master plan designed by SOM rests in the termination of the TechWalk at the southern end of campus. Currently, the proposal remains opened to South Point Park, but does not address a connection to it.

Before approaching the siting and massing of the new structures for South Point Park, certain modifications to the site at a larger urban scale were developed. Cornell Tech's campus plan features a central pedestrian circulation spine, deemed the "TechWalk". As proposed, the TechWalk terminates awkwardly between a pair of larger buildings at the South end of the campus, and does not address the northern face of South Point Park. Existing entries to South Point Park and service vehicle access to Four Freedoms Park are coupled, mixing vehicular and pedestrian access ways. What's more, entrances to South Point Park are not clearly navigable from visitors traveling from the TechWalk due to issues of vicinity and topographic changes.

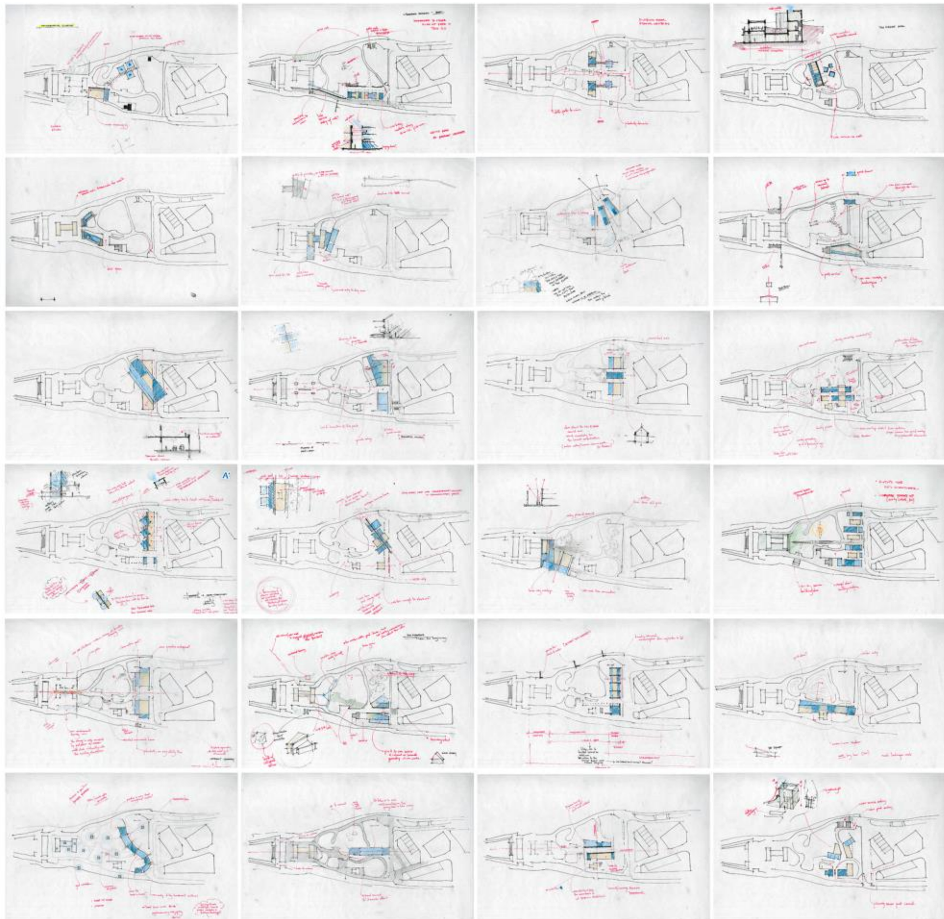

Figure 23: ANFA NYC; Schematic Design Composite.
A composite board of site plan diagrams in an exploration of how to most effectively and responsibly locate the new programmatic elements. In each, dark blue signifies common work area, light blue signifies private work area, and tan represents area for more intensive lab space. Sketches by author, 2015.

Other changes to the site include topographic modifications such as flattening of the northernmost portion of South Point Park, allowing its use as a recreational or sport field (see *Neurogenesis* & *Chronobiology),* and the fusing of the two lower mounds to the north of the Smallpox Hospital. Park walls typically replace iron fencing in an effort to alleviate view obstruction and focus cognitive processing. A new park path system directs visitors from the new entrance through a direct pathway through the ruin and out on axis with Four Freedoms Park.

For the most part, landscape on site was left unchanged for a multitude of reasons. Primarily, resource and energy conservation achieved by limited footprint of new construction is accomplished. By only altering a small portion of the site, very little site preparation and foundational work is necessary, which is typically the most resource-heavy phase of construction. Furthermore, most of the site hosts very mature tree growth, especially just north of the Smallpox Hospital ruin. A good majority of the proposed construction seeks to avoid areas of mature tree growth, and seeks to relocate younger trees when the design interferes with them.

Otherwise, maintaining the general character and topography of the site offers an interesting position on the idea of cognitive memory, especially when considering existing residents of the island. If memory functions through a combined degree of familiarity and novelty, the proposal suggests that maintaining a certain level of familiarity with a given site is important to those residents and visitors who have already cognitively mapped the site, or who may have formed important memories through repeated visits to the site. Perhaps a slowly changing environment provides a sense of cognitive stability and mental ease over time, a problem that may certainly exist in any populated metropolitan region, especially one as rapidly developing and changing as New York City.

Figure 24: ANFA NYC; Proposed Master Plan
A composite image of Lidar data taken by author, 3Dimensional modeling, and AutoCAD topographic alterations. Circular highlights signify density of scan location information. Image by author, 2015.

The ANFA NYC proposal suggests re-developing the entries to South Point Park, adding a new access point directly in line with the termination of Cornell Tech's TechWalk and designating the eastern entrance to the park for service vehicles only. Other changes include a more clearly navigable east-west pedestrian access walk along the north end of South Point Park, so that walkers, joggers, or cyclists can successfully and safely wrap the southern end of the campus without entering either South Point Park or Cornell Tech's campus. This in essence connects the Manhattan-view waterfront to the Queens-view waterfront.

As seen in Fig 24, new structures or changes to the site are indicated in white & gray rendered areas, with all existing park and site conditions remaining color-rendered. From north to south, as seen in the plan drawing, is the exit sequence from Cornell Tech's proposal, South Point Park (including new structures), the Smallpox Hospital ruin, and finally Four Freedoms Park. Four Freedoms Park was not fully scanned as it did not pertain to the intervention of the site, resulting in the faded image replaced by linework drawn with basic measurements.

Figure 25: Site Plan Circulation: South Point Park & Cornell Tech
The existing (top) & proposed (bottom) circulation and access conditions between South Point Park and the Cornell Tech Proposal. Blue corresponds with pedestrian paths and access points, red corresponds with vehicular. Diagram by author, 2015.

Figure 26: ANFA NYC | New Park Entry
A rendered character vignette showing the new entry to South Point Park at the termination of Cornell tech's TechWalk. This could also be a new location for the proposed FDR Hope Memorial. NeuroArchitecture Incubator rendered on left, with Blackwell tower in distance on mound, contrasting lower Manhattan Skyline.

4 NEUROARCHITECTURE INCUBATOR

"The spirit of the start is the most marvelous moment at any time for anything. Because in the start lies the seed for all things that must follow. A thing is unable to start unless it can contain all that ever came from it. That is the characteristic of a beginning, otherwise it is no beginning – it is a false beginning." [44]

"The environments we live, work, and play in are changing our brains and our behavior all the time. I believe it's time that we begin figuring out how they do that, and we can work together on this. I can imagine a time when architectural design will be a subject of study in the clinical sciences and will be used to promote health and to prevent disease by virtue of the knowledge that you can contribute about the structures that you build. I think it's time that we begin, and I look forward to working together with you."[45]

Fred Gage wants neuroscientists and architects to work together, but I feel that they need a *place* to work together. You cannot truly learn much about what a person does, or how they do it, or what they're all about, until you work with and alongside them. That is the purpose for this research incubator.

Described in this section is the primary structure brought about by this proposal. The structure is being called the ANFA NYC Neuroarchitecture Incubator. It is served by an additional programmatic venue, Blackwell Tower, defined in Part five. The design of both of these buildings seeks to promote research of their effects on inhabitants as well as the effects of the nearby Smallpox Hospital ruin, defined in Part six.

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[44] As quoted in Bachelard, *The Poetics of Space*, p. 91
[45] Fred Gage, *Lecture at the AIA 2003 National Convention & Expo*. May 8, 2003.

4.1 Programmatic Drivers

First and foremost, the design of the Neuroarchitecture Incubator building is intended to meet a set of basic programmatic and functional needs based on the analysis of appropriate precedents. These included both Neuroscience research facilities and various contemporary co-working spaces. The settled upon list of programmatic needs is as follows:

Research Incubator Space

The incubator, or co-working typology is an increasingly common one in major cities. The concept behind co-working or collaboration spaces is simple: bring like-minded individuals who lack resources to a common place so they can share ideas, thoughts, and build professional networks. Typically, this typology helps smaller start-up companies grow and develop to become larger, more successful groups. In the case of the Neuroarchitecture Incubator, the shared resource includes rentable scheduled workspace, common conference and presentation areas, digital and print media resources, bath & fitness facilities, and secure access to Blackwell Tower (described in Part 5). Most importantly and relevant to the study of neuroscience, researchers renting space at the Neuroarchitecture incubator have access to a full suite of brain-imaging technologies, located in the retrofitted Strecker Memorial Lab. These spaces are described hereafter.

Social Breakroom

Located on either end of the incubator spaces, the social breakrooms foster neurogenic and chronobiological development of the researchers.

Forum

A common presentation area hosted on the second floor, with outlooks to the Queens skyline and Hudson River. The forum is an open-access presentation circle allowing researchers to informally share and discuss their findings.

Fitness Center

Located in the cellar of the Incubator building, the fitness center promotes exercise, a key factor in both Neurogenesis and Chronobiology.

Neuroimaging Facilities

All located within the repurposed Strecker Memorial Laboratory, new neuroimaging facilities feature an innovation on virtual cave environments, named at this time as the *scanCAVE*. The scanCAVE is a round virtual reality chamber with rear projection screens, movable interchangeable flooring, access to natural climate and light when desired, and most importantly emphasizing the use of Lidar imaging techniques as grounds for simulation.

Most researchers readily agree that simulated environments are not the ideal means of testing. However, rather than rejecting simulation out of hand, we can look at it more maturely through understanding that our brain is constantly simulating its environment as a means of survival. It is, in a way, a more natural process than it appears to be through virtual reality and augmented reality.

We recreate and simulate out of reach environments around us in order to imagine their potential threat to our survival. We need to manipulate and exploit this mechanism ethically, carefully, and responsibly. Other Neuroscience facilities include an fMRI suite and MEG room, located in the cellar and 2nd floors of the existing Lab building.

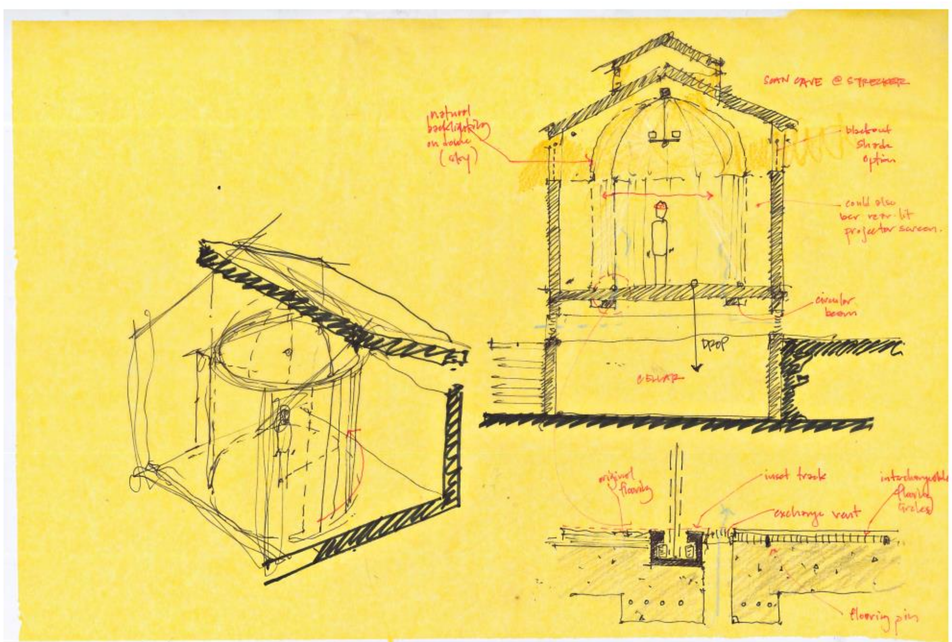

Figure 27: NeuroArch Incubator | scanCAVE Sketch
An early sketch representation of the described scanCAVE. Seen on left in isometric, top in sectional view, and bottom in concept detail. Sketch by author, 2015.

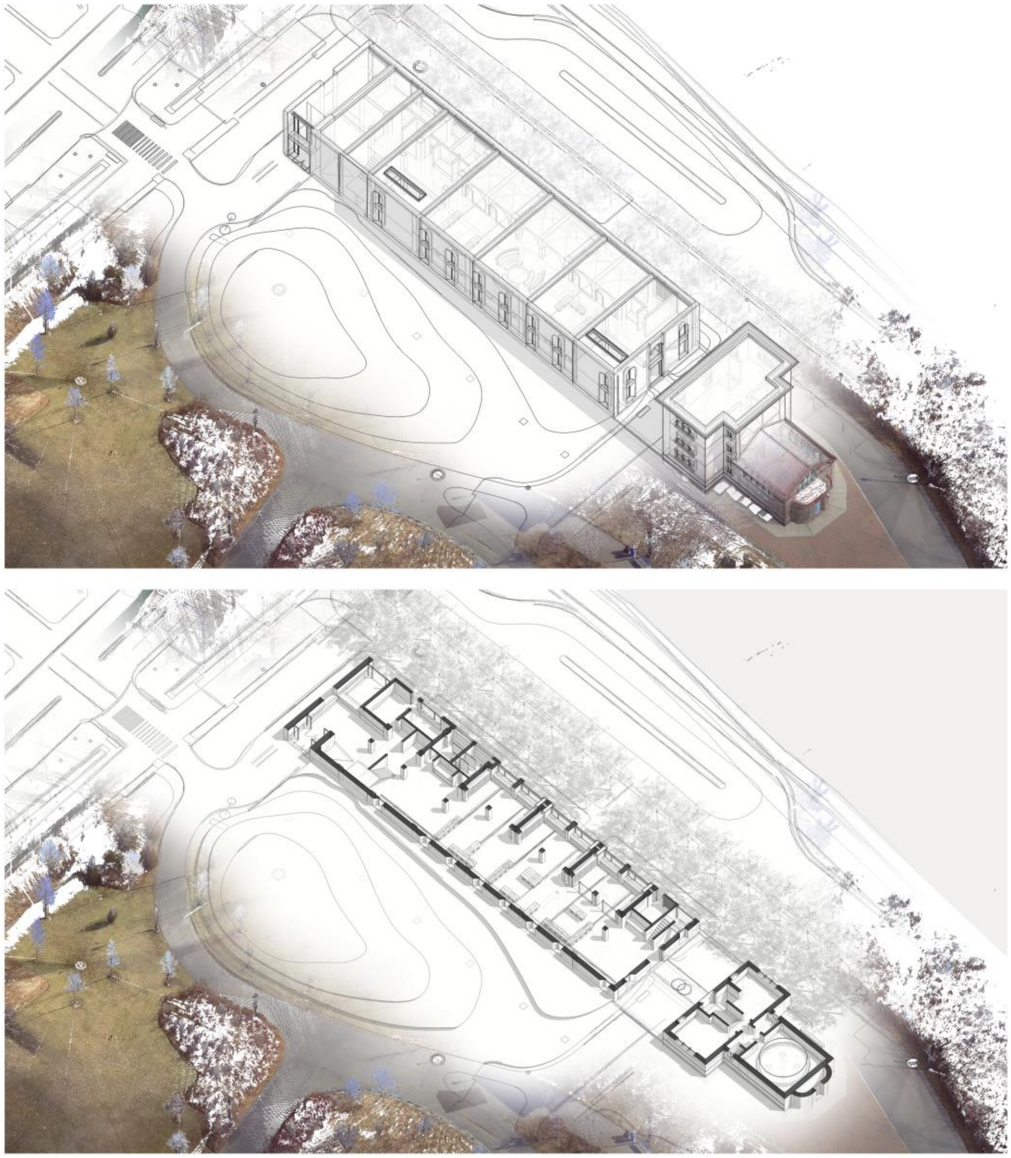

Figure 28: NeuroArch Incubator | Axonemtric Composite
Aerial views of the proposed NeuroArchitecture Incubator building, shown cut at ground floor in lower portion of image. Of note are topographic grading changes for drainage purposes and east-facing deciduous trees for summer shading. The logo set into the paving between the incubator and Strecker Memorial Lab acts as a means of priming. Drawings by author, 2015.

Figure 29: NeuroArch Incubator | East-facing Elevation
The East-facing elevation view demonstrates the semi-circular arched openings which signify the location of work-pods. For Neuroethical significance of the semi-circular arch. Rendering by author, 2015.

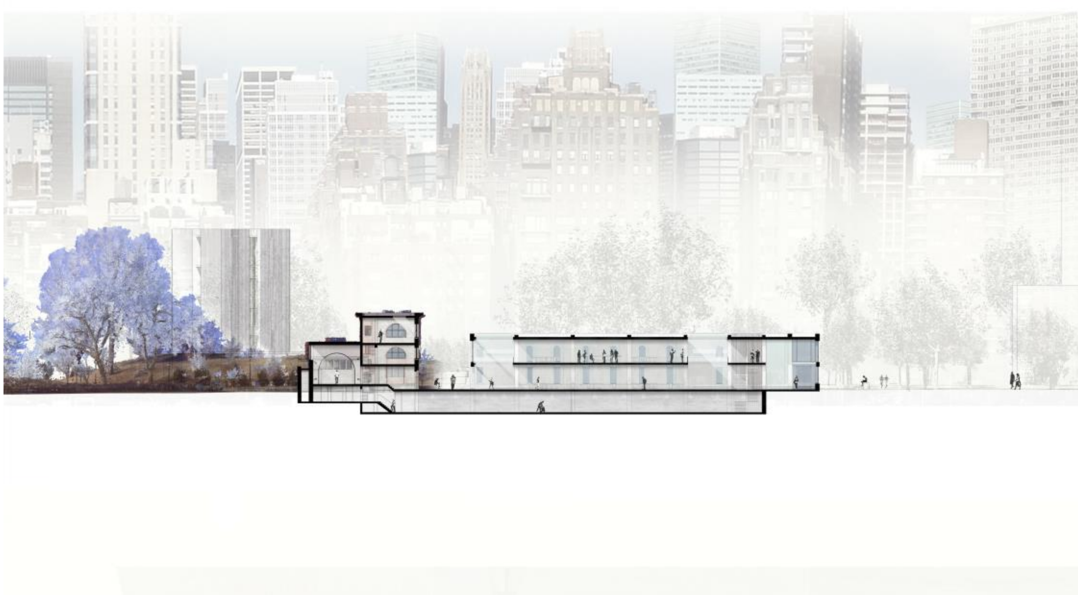

Figure 30: NeuroArch Incubator | NS Section view west
The sectional view of the building calls attention to not only the sub-grade cellar connection to Strecker Memorial Lab, but also the double height Social Breakroom spaces and their increased levels of natural lighting in an effort to compound Chronobiological benefits. Drawing by author, 2015.

4.2 PRINCIPLE: Neurogenesis

Neurogenesis is a term describing the process by which the birth of new neurons occurs. The process takes place via *stem cells,* which are a type of primitive cell that remain and persist throughout life, acting as a source (i.e. 'stem') for the authentic production of new cells. Once born, a new neuron extends its connectivity throughout the appropriate parts of the brain within about a month of a child's birth. It follows its blueprints (DNA) for integration. Previously, this process was thought to only occur during the years in which a mammal was still developing (thought to slow around a person's mid-twenties). Neurogenesis has now been found to occur throughout life depending on several factors, one of which is the physical conditions of the environment in which a person exists. Of particular interest to architects is the way in which the environment can foster the growth of new neurons. Neurogenesis allows an individual to maintain longevity, learning, and growth.

Plasticity

Neurogenesis is served by the umbrella term *Neuroplasticity*, which defines the process by which "neural pathways and synapses" change "due to changes in behavior, environment, neural processes, emotions, and/or bodily injury."[46] Neuroplasticity talks about the brain's ability to change, adapt, and reorganize within its existing structure; research in Neuro*genesis* seeks to understand

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[46] Pascual-Leone, A. et al. *Characterizing brain cortical plasticity and network dynamics across the age-span in health and dieases with TMS-EEG and TMS-fMri.* 2011.

how *new* structures can be integrated into the existing. In a way, the two work together and form a kind of metaphor. Think of the brain as a high rise tower, with its mechanical and circulation core as the *stem cells*. The core of the tower remains constant- it allows for the extension of slabs and plates, and can be brought up in height over time. In this metaphor, Neurogenesis would be the act of adding an additional floor plate or dividing one of those floor plates into rooms and offices. Neuroplasticity, on the other hand, is the process of moving the tenants on the 12th floor to the 4th, or changing the circulation corridor on the 6th, or building a stair between the 8th and 9th. It's more a process of reorganization and connectivity as the required conditions change for how the tower is to be used.

But a question arises with this metaphor. "If neurons were able to divide, how would the newly created cells with their new dendrites, axons, and synapses, functionally integrate into the brain without disrupting existing circuits?"[47] In other words, how many times could we possibly subdivide the tower, build it higher, and create new rooms inside it before its collapses in on itself? This remains one of the bigger questions within the study of Neurogenesis. Somehow, unlike a gravity-stricken tower, the brain *can* continue to allow for new structures, without impeding its context or collapsing to failure. The question still remains, however, exactly *what* this underlying construction method is that can allow for unlimited differentiation. Neuroscientists have

[47] Fred Gage, *Neurogenesis in the Adult Brain*.

yet to find "the function that underlies this residual structural plasticity". [48] They have, however, discovered some of its anatomical underpinnings and what helps it occur.

Neurogenesis: Anatomical Context

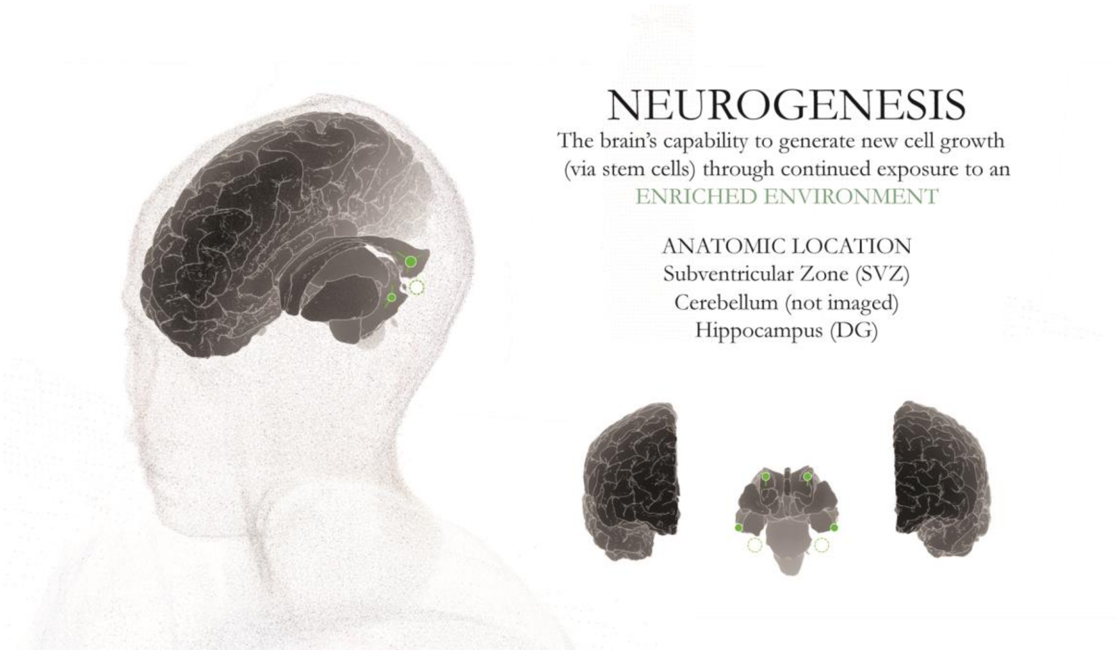

Figure 31: Overview of related neuroscience principle applied: Neurogenesis.
Diagram composite using point cloud model of human skull (subject: Gina Fernandes, F, age 23), generated by author, with graphically inserted image of 3Dimensional Brain model via Bentley Rhinoceros modeling software. Diagrams by author, 2015.

Anatomically speaking, neurogenesis has been found to occur in three specific parts of the brain: the cerebellum, the *dentate gyrus* of the hippocampus, and a system connecting the subventricular zone (SVZ) of the cortex to the olfactory bulb.[49]

[48] Fred Gage, *Neurogenesis in the Adult Brain*.
[49] Fred Gage, *Neurogenesis in the Adult Brain*.

DENTATE GYRUS:

The dentate gyrus is part of the hippocampal formation, is thought to contribute to the formation of new episodic memories, and may have a functional role in moderating stress and depression. Neurogenesis has been found to increase along with medication of antidepressants, and stress has shown significant inverse relationships with rates of neurogenesis in primates. [50] [51]

SPATIAL BEHAVIOR:

In studies where nearly 90% of the dentate gyrus in rats was destroyed, there was extreme difficulty in learning a maze after repeated attempts. Rats were unable to shift the learned information about the maze into their working memory. In a way, the lack of a functioning dentate gyrus resulted in a sort of spatial amnesia. In studying this failure, we see that the role of this part of the brain in learning and remembering place, a point critical to the experience of architecture over time. For these reasons, Neurogenesis seems especially important to enhancing the quality of life for individuals in the environment.

[50] Gould, et al. "Proliferation of granule cell precursors in the dentage gyrus of adult monkeys is diminished by stress." 1998

[51] Marlberg, et al. "Chronic antidepressant treatment increases neurogenesis in adult rat hippocampus." 2000

Neurogenesis: Enriched Environment

So then, what does this anatomical explanation mean for architects? If we agree that mental fitness and learning are of importance, how then does the design of the environment allow for Neurogenesis? Researchers studying Neurogenesis have concluded that an “enriched environment” is the single most important catalyst for the differentiation and creation of new neurons. “The standard definition of an enriched environment is a ‘combination of complex inanimate and social stimulation’”.[52] Primarily, as with most neuroscientific studies, research is carried out on rodents within a lab environment. In these experiments, “enriching” the environment varies, but usually calls for a plethora of colored toys, bedding and circulation objects, periodically changing in their configuration to produce novelty. This enriched environment also usually contains a running wheel. Rodents living with EE showed a significant increase in the number of hippocampal granule cells and markedly higher ability to learn the Morris water maze (MWM) than mice in standard housing conditions.[53] The Neurogenesis which occurs as a result of EE helps our ability to learn and navigate new spaces. It’s a sort of mapping calisthenics.

[52] van Praag, et al. “Neural Consequences of Environmental Enrichment”.
[53] G. Kempermann et al, *More hippocampal neurons in adult mice living in an enriched environment.* 1997

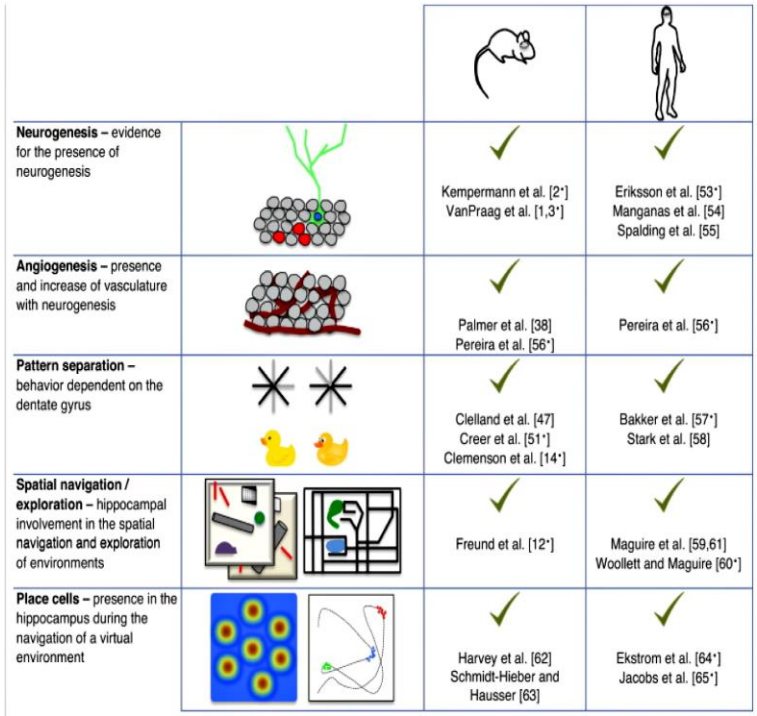

Figure 32: Environmental Enrichment; Animals & Humans
Similarities between animal and human studies in regard to environmental enrichment and neurogenesis. Clemenson et. al.

When considering the hippocampus more generally, “the exploration and navigation of real and virtual environments correlate with increases in hippocampal volume”.[54] One study of London taxi cab drivers showed a significant increase in hippocampal gray matter. This isn’t surprising considering the intrinsically rich and variegated network of roads they are required to mentally map.

It is my speculation, however, that this is a circumstantial and misleading result. While London taxi cab drivers are required to learn the networks of London, and have increased hippocampal matter and spatial navigation

[54] Clemenson, et al. “Environmental enrichment and neurogenesis: from mice to humans”. 4

abilities because of it, it does not make London an inherently good place for people to live. In other words, even if a place is positive in terms of its potential neural development, the point alone does not mean it is an intrinsically good or enjoyable place to live. It does, however, re-emphasize the correlation between parts of the brain which are both prone to Neurogenesis and deal with spatial memory and learning. It highlights the connection between environmental conditions and brain development.

While enriched environments for lab rodents may seem obvious, the transition to defining enriched environments for humans is “highly ambitious”.[55] In fact, the comparison seems quite obviously disparate when considering a lab rodent’s typical environment of a small cage, compared to the highly stimulating cities, stores, and malls humans have come to inhabit. Furthermore, it is increasingly difficult at this time to measure this sort of process in a human brain when compared to a rodent brain. However, similarities do exist between the two, as summarized in Fig 13, a table by Clemenson et. al. in “Environmental enrichment and neurogenesis: from mice to humans”.

So what then, is a responsible definition for an ‘enriched’ human environment? If we take the definition of EE directly from experimentation on lab rodents, the obvious solution seems to provide visually stimulating places

[55] Clemenson, et al. “Environmental enrichment and neurogenesis: from mice to humans”. 4

to live, work and play. Architects have learned this lesson, most clearly seen in Muthesius and his analysis of the English House.

Take for example Times Square in New York City. Surely we can agree this is one of the most visually and socially stimulating locations in human history. In fact, this standard of stimulation has been built *directly* into the zoning resolution.

But if the role of an urban environment is to provide genuine living conditions for its inhabitants, is Times Square necessarily a place where any given individual wishes to live, work or even play? Nearly all of the inhabitants of Times Square are visiting for a day or weekend, and wish to *see* what the buzz is all about. Leave them there for a day, or 40 days as the case with most lab rodent experiments in EE, and you will find yourself a very troubled, exhausted individual. Clearly, stimulation can, and does go too far in the human urban environment.

It is the stance of this thesis that there are more valuable and responsible components to the definition of an ‘enriched environment’. Those components are titled “PEOPLE”, “NOVELTY”, and “FITNESS”. These three items have been shown to be directly correlated with preexisting definitions of EE and the resulting neurogenic outcomes.

Figure 33: NeuroArch Incubator | Cellar
An axonometric diagram of the NeuroArch Incubator cellar highlighting the new subgrade connection between Strecker Memorial Lab and the new building. In orange is the described fitness center, in gray is a bath and shower suite, and in blue (at Strcker Memorial Lab) is a new Magnetoencephalogram (MEG) suite with magnetic-proof lining. To the Southeast is the crawlspace to the ScanCAVE. In the linkage between the two structures are the pump room and storage areas. Diagram by author, 2015.

Figure 34: NeuroArch Incubator | 2nd Floor
An axonometric diagram of the NeuroArch Incubator 2nd Floor highlighting the programmatic assignments to each area. Orange is shared public space, in this case the "Forum" presentation area in the central bay. Smaller kitchenette areas on either end are easily accessible by two additional incubator bays, highlighted in green. On the 2nd level in Strecker Memorial Lab is a new fMRI suite, shown in blue. The double height social spaces (near kitchenettes) below can be seen in the diagram as well. Diagram by author, 2015.

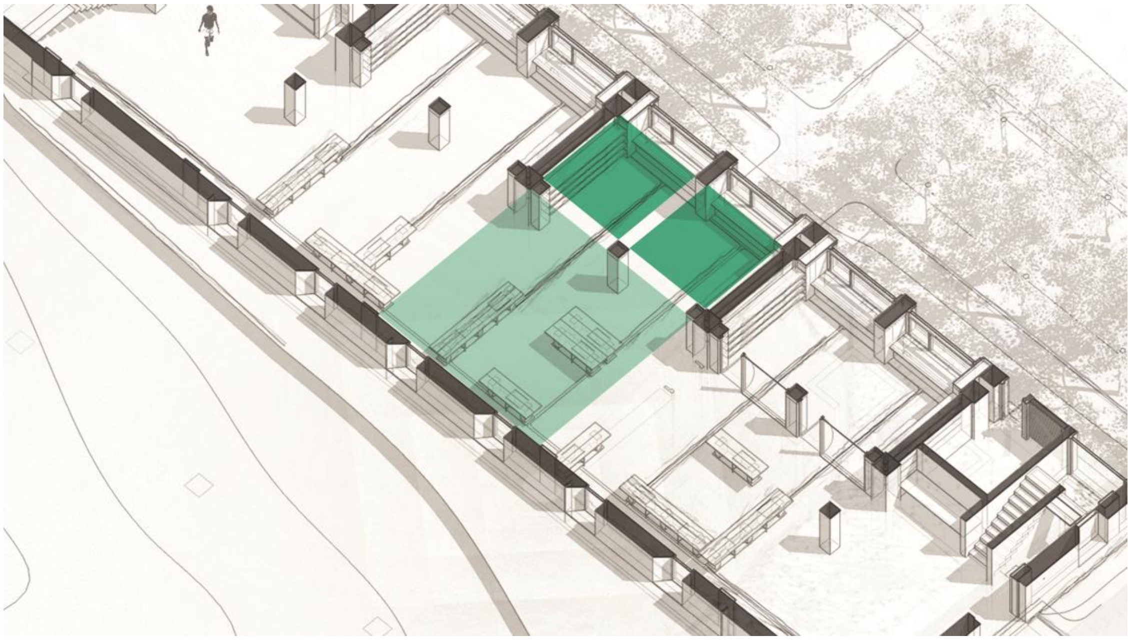

Figure 35: NeuroArch Incubator | Incubator Bay Diagram
An axonometric diagram of the NeuroArch Incubator Ground Floor, zooming in on one of the incubator bays. Light green indicates the larger open co-working space, whild darker green represents the more concentrated work pods assigned to each bay with full lab benches, library resources, and open space for architectural model fabrication or ad hoc use. These pods are optionally partitioned for conferencing, and sometimes separated by glass enclosures to be used as ANFA Board offices. Drawing by author, 2015.

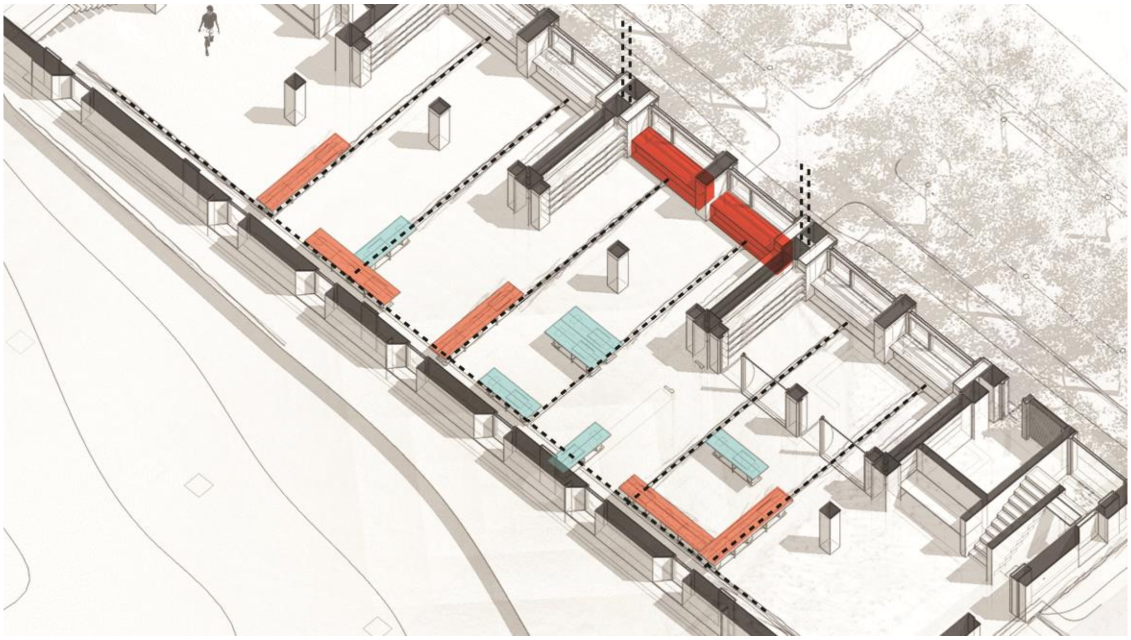

Figure 36: NeuroArch Incubator | Incubator Function Diagram.
An axonometric diagram of the NeuroArch Incubator Ground Floor, zooming in on one of the incubator bays. The LithIo Lab Bench system is seen in light red and blue, with black dashed lines indicating layout of in-floor contact charging strips. Desks can be configured in any plethora of ways based on daily needs or group sizes. In dark red are the more traditional dry-lab bench areas. Diagram by author, 2015.

Figure 37: NeuroArch Incubator | Ground Floor Diagram
An axonometric diagram of the NeuroArch Incubator Ground Floor, highlighting programmatic areas. Yellow indicates the entry and reception area at the north end of the building, orange indicates social breakout space, and green represents the three incubator bays in the center of the building. At Strecker Memorial Lab, additional entry and reception areas are allowed for for clinical purposes, and a square pre-existing autopsy room is converted to feature the described scanCAVE. Diagram by author, 2015.

EE: People

Figure 38: ANFA NYC | Interior Space
A rendered character vignette showing the interior of the NeuroArch Incubator, standing in one of the new social breakout spaces. The long unimpeded space and LithIo Lab Bench system provides for increased variety of spatial layouts.

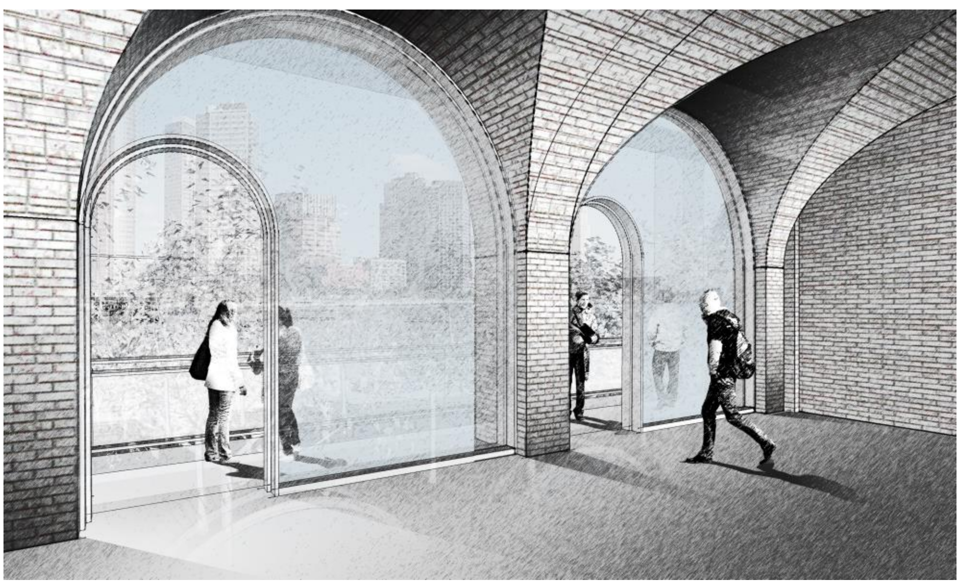

Figure 39: ANFA NYC | Second Level Balcony Approach
A rendered character vignette showing the interior of the NeuroArch Incubator, standing in one of the new social breakout spaces. The long unimpeded space and LithIo Lab Bench system provides for increased variety of spatial layouts.

Jan Gehl once said “Man is man’s greatest pleasure.” This is an excellent notion. Think about a place you either worked, lived, or played for an extended period of time in your own life. Somewhere in your mind just now there was an image of a person you affiliate with that place or time. *Over time, it is my understanding that what maintains and continues the enrichment of a space is the people who you share it with, and what you learn from them.*

In its very DNA, an incubator or “co-working” location fosters just this kind of exchange. Because spaces and offices are not assigned, and there are more tenants than there are rooms, the interchange and variability of meeting someone new is increased. For this reason, co-working spaces are reproducing at high rates all over the world, especially in New York City. I had the pleasure of working on the design and construction of one such incubator space in Brooklyn, New York at the abandoned Pfizer manufacturing plant. It wasn’t technically conceived as an incubator, but it surely fits the definition. Since Pfizer left (and took jobs with it), the building remained vacant until Acumen Capital Partners and Bromley Caldari Architects purchased the site and redeveloped it as a Food Start-up co-working space. The building *came alive*. Not because we intervened more stimulating spaces or a new front elevation, but because of the *people* which brought their stories together inside it. All I helped to do was provide a framework, and it remains one of the projects I am most proud of.

At the Neuroarchitecture Incubator, the same mentality applies. Spaces remain open, unassigned, and flexible. The overall composition is spatial, but modest enough so as to allow minimal places to hide. The mixture of both neuroscientists and architects within this space not only allows for the collaboration of the two to increase, but for the positive neural development of its users. One way to look at this theory is through John Eberhard's hypothesis on lab design. He hypothesizes that "The proximity of laboratories occupied by different disciplines contributes to the collaboration because the brain, by seeking novelty, is more attentive to puzzles generated by another discipline."[56]

EE: Variety

Variety, and more so novelty, is a sticky subject in architecture. Arthur Koestler in *The Act of Creation* emphasizes the importance of "the aesthetic experience" in which a given work elicits response by providing a break from a more constant context. It's an important idea, and is what allows great buildings to be great. There cannot exist a background architecture without a foreground architecture.

We currently exist within a building culture which allows for almost anything to be physically constructed. More and more we are finding the object building vying for stimulating effect. In a series titled *The Secret Life of*

[56] John Paul Eberhard, *Brain Landscape.* 131

Buildings, Zaha Hadid reflects on her work and expresses a quest for novelty, stating that architecture is simply about giving humans an experience or vision they have never had before. But how long will this, can this, last? Consider the Bilbao Museum in Spain. A popular case study, the museum has been either loved or hated by the critics of the world. Let's look at it under the auspice of neural 'novelty'.

Consider the viewpoint of an employee at Bilbao. Is the place really 'novel' to such an individual? Is not 'novelty' then, clearly, an adjective tied to relativity? Is it not a fleeting trait when considering the formal qualities of a work of architecture? The question should always be "novel *compared to what?*" In this sense, architects need to embrace the fact that a building is, by nature, a *static* thing. "Structure" and "kinetic" are not exactly synonymous. Considering a conception of structure which continually moves or physically changes, which is surely plausible in such a building culture, does not seem like a rational solution. How could you possibly convince a tenant to rent a certain square footage with a "plus or minus" in front of it? How could you promise them a "sometimes" skyline view in their "occasional" penthouse? More importantly, and in light of our ability to find our way and cognitively map (see navigation) place, a continually changing framework for place would be threatening, confusing, and amnesic (at least at such a straightforward definition of the concept).

Imagine that the shape of your bedroom changed each time you entered it. How could it ever provide the comfort of familiarity? Imagine the Mona

Lisa's background changed every Tuesday, just to maintain a sense of novelty for the museum employees. To say that the things *within* a space provide familiarity is to say that space is a non-factor in the environment. Even the natural settings which our brains evolved within had some sense of permanence. It's not as if a cluster of trees rotates or reconfigures or caves or mountains reshape in any noticeable temporal interval. How then, can we provide continual novelty in an environment in an effective but responsible way?

The thesis has hypothesized on a few of these ways to achieve novelty and applied them to the design of the Neuroarchitecture Incubator.

EE: Fitness

Exercise is critical. Results skyrocket when subjects have voluntary access to running wheels. This is why I haven't included a parking lot with my building (makes you walk, *and* walk through a buzzing campus), why the Strecker Tower is separate and uphill, and why there's a gym downstairs and a bike-rack outside. Drop-off and limited parking still available, though.

Exercise has proven to be a key component in the continual growth of neural networks. First and foremost, we need to go outside. Exercise out of doors not only provides the physical, neurogenic activity we require, but does so in our natural setting. *Biophilia* is a common term applied to our thirst for natural environments. For that reason, I’ve left one of the largest, flattest lawns on the island intact in the siting of the new structures. This lawn remains open to both the public of the University and the users of the Neuroarchitecture Incubator. The design even goes so far as to enhance this by supplying an area for grilling, eating, and sharing. The path redevelopment seeks to wrap the South end of Cornell Tech, now allowing for a seamless lap for island joggers, of which there are many throughout the year. These numbers will only increase. A parking lot has not been introduced, but a small bike rack has been supplied. But unless you’re like my friend, Sarah Stein, you don’t have the gall to get out there in the middle of February for a brisk jog or a quick game of Frisbee. In an effort to keep inhabitants physically active in the winter months, I’ve provided for a conditioned fitness center in the cellar of the Neuroarchitecture Incubator designed to promote social interaction.

If you think of your traditional fitness center, it may or may not promote social interaction at the same time, if so this usually occurs as a byproduct of being in the same place, and when the amount of equipment is appropriate. What is really more important: that you exercise in isolation as efficiently as possible and leave, or that you help the next person with that last rep, or wait while they finish a set, coordinating your time with them between exercises? By supplying a smaller-than-usual fitness center for users of the building, the Neuroarchitecture Incubator not only allows for voluntary fitness development in the winter months, but does so in a way that is intended to heighten interaction and coordination among members.

The aspect of EE which I believe aids in Neurogenesis most and can manifest at a relative scale (in other words, enriched <u>compared to what</u> again) is the idea of novelty and variation in the environment. By providing a place in which the two disciplines of architecture and neuroscience can work in close proximity in and of itself defines an enriched environment. Furthermore, an open floor plan, like that at the Salk Institute, with a movable, changeable furniture system, provides a basis for novelty. This novelty should be balanced with our need for spatial clarity and learning. In other words, if we push novelty *too* far, we will start to impede on the needs set out by principles like Wayfinding and Memory for the everyday inhabitant.

With that definition of ‘environment’ in mind, this Neuroarchitecture incubator, like most other incubators, with its intermittently changing, mixed tenants, provides for what I would define as an enriched environment. Furthermore, closed, framed views of the landscape within a changing, unassigned floor plan offer novel views of the environment, changing throughout the day and during the seasons as well. A skylight and tall slender windows bring light into the space, leaving the structure unchanged and navigable but at the same time varying.

With the benefits of physical activity in mind, the placement of a fitness center in the cellar floor is an added incentive for tenants and stresses the importance of physical activity in an otherwise very competitive real estate viewpoint.

A CLARIFICATION

Studies have been conducted which conclude that the behavioral affects (like reduced stress and increased ability to habituate a novel environment) are *not* dependent on the process of Neurogenesis, and that an enriched environment alone will provide for these positive outcomes. The experiments in these studies inhibit the production of new brain cells in rodents while maintaining EE, and show the same results with or without Neurogenesis occurring. The latter is not reliant on the former, then. It is not a relevant piece of research to the stance of this thesis, however, which seeks to outline *all* of the positively related processes involved in EE, including Neurogenesis.[57]

4.3 **PRINCIPLE: Ancient Biology**

So we can agree that being surrounded by an enriched environment is beneficial for the cognitive development of users, but there's more to the story. Another realm of neural research, *Chronobiology*, underlines the importance of some of the stimuli involved in enriched environments, but tells

[57] Meshi, et al. "Hippocampal neurogenesis is not required for behavioral effects of environmental enrichment." 2006.

us something about *when* and *how* our exposure to them should be (i.e. “Chrono”) The Neuroarchitecture Incubator design tries to promote the understanding of environmental stimuli that research in Chronobiology has shed light on.

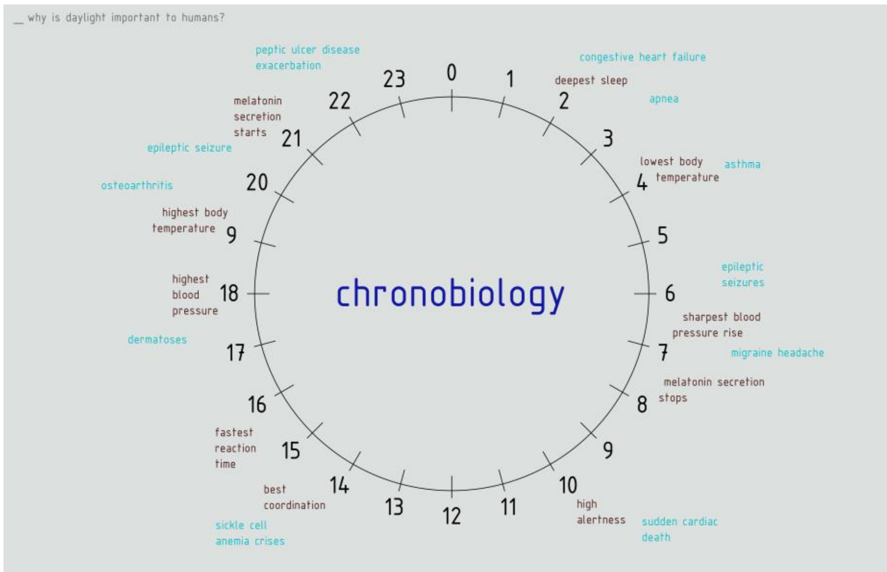

Figure 40: Diagram highlighting common daily rhythms
Throughout the day, the average human is prone to certain biological changes, both mental and physical (in red). These times of day correspond to when a “chronodeficient” or out of sync individual will most likely suffer health failure or experience an episode for specific diseases (in blue). Diagram by author, 2014.

The great majority of the diseases of civilization are onset by our lifestyle habits once we overcome basic survival needs. I would suffice to say the reason for this is what I’d like to call *Chronodeficiency*, or a desynchronous relationship to the stimuli which control our internal biological cycles. The ability to put pleasure over things like sleep, extend night hours, consume empty but neurologically deceptive foods, and replace medication with exercise has allowed the sneaking in of unfortunate ailments. The study of this phenomenon is known as *Chronobiology*, and I believe that in returning architecture to its simplest aims, is a critical foundation for any architectural or urban design process.

Zeitgebers

The field of chronobiology deals directly with the cyclical, internal biological and chemical processes any one individual (plant or human) undergoes in a 24-hour period. These processes are synced up each day via environmental cues (called *zeitgebers*), the two most important of which are the cycles of light and dark based on solar rhythms and eating/drinking patterns, respectively. The coordination of these chemical processes is dictated by our age and genetics (*chronotype*), and directly correlates to a person's physical health and mental well-being. Architecture and building development has a huge role in allowing a framework for successful, maintained contact with the zeitgebers that control our internal biological clock, also known as the *suprachiasmatic nucleus* (SCN).

Figure 41: The various "zeitgebers", and their relative importance.
Diagram by author, 2014

The most critical zeitgeber is the cycle of light and dark based on solar rhythms on (Fig x). Within the last decade, science has detected the existence of a third type of photo-sensitive receptor in the human eye: *ganglion cells*. Like cones (color detection) and rods (low light + contrast), ganglion cells take in external information and process it through the retina, informing the body of its environmental conditions. A ganglion cell's role is to pick up on the cycles of light and dark throughout a typical day. However, unlike rods and cones, these cells do not communicate with the visual center of the brain, but rather send information directly to the SCN. From there, light/dark information instructs systems of the body what to do and when.

Chronotype

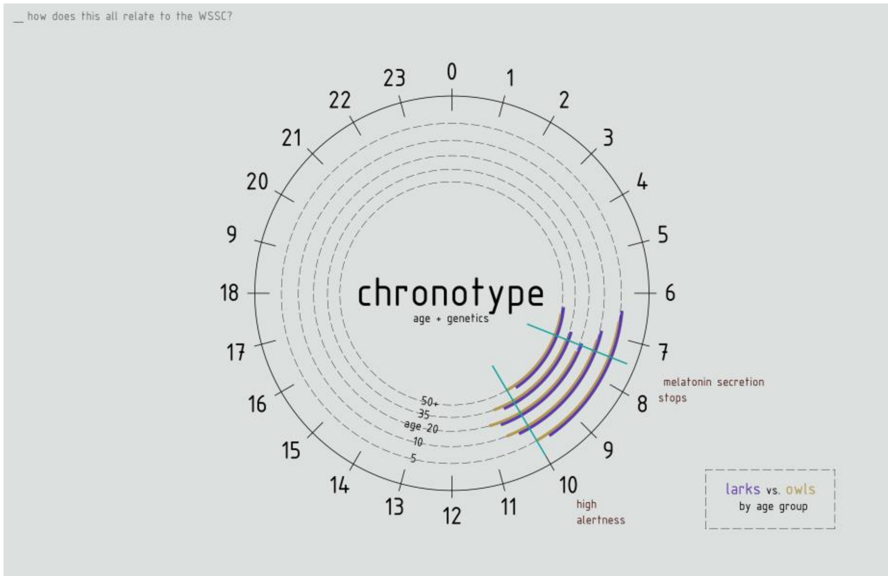

Figure 42: Diagram of chronotype sway
An interesting way of graphically representing the idea of chronotype, and how the average time slot for one daily rhythm, that of peak alertness, slides among age groups. This is important in considering different users of a given space, as in a school setting. Diagram by author, 2014.

Our current lifestyle of external clock-based scheduling ("the 9 to 5") and extended exposure to late-night artificial activities and light sources force us to operate outside of our internal clock. This directly effects our moods, metabolism, and sleep patterns. The result is not only a lessened quality of life, but unfortunately an increased onset of various diseases with cancer and obesity being the most prevalent.

In the case of the rigid educational model used in the United States and most of Europe, these negative results are compounded by decreased student attention and performance, which peaks at various times based on the individual's chronotype. The school schedule and subsequently the traditional age-based class system clearly needs to be adjusted in light of this science.

Through research, we have established that a coordinated exposure to the natural light and dark cycles is essential to health and performance. We have also established that the time of the solar day in which an individual should be exposed to that cycle varies from individual to individual (i.e. late-riser/learner v. early-riser/learner).

Chronobiology: Anatomical Context

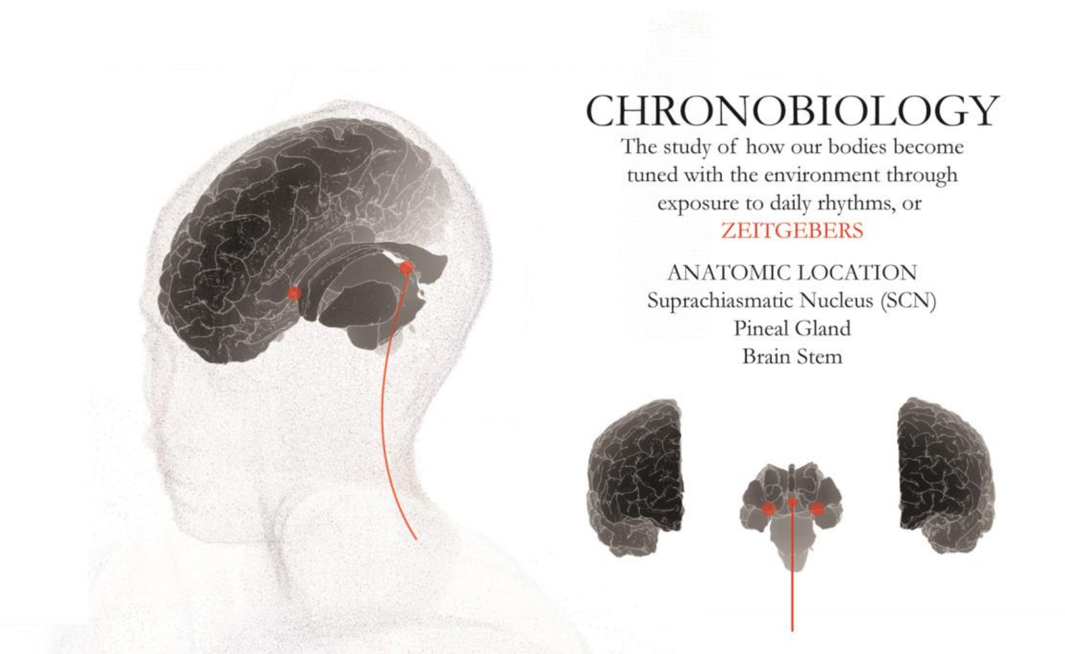

Figure 43: Overview of related neuroscience principle applied: Chronobiology
Diagram composite using point cloud model of human skull (subject: Gina Fernandes, F, age 23), generated by author, with graphically inserted image of 3Dimensional Brain model via Bentley Rhinoceros modeling software. Diagrams by author, 2015.

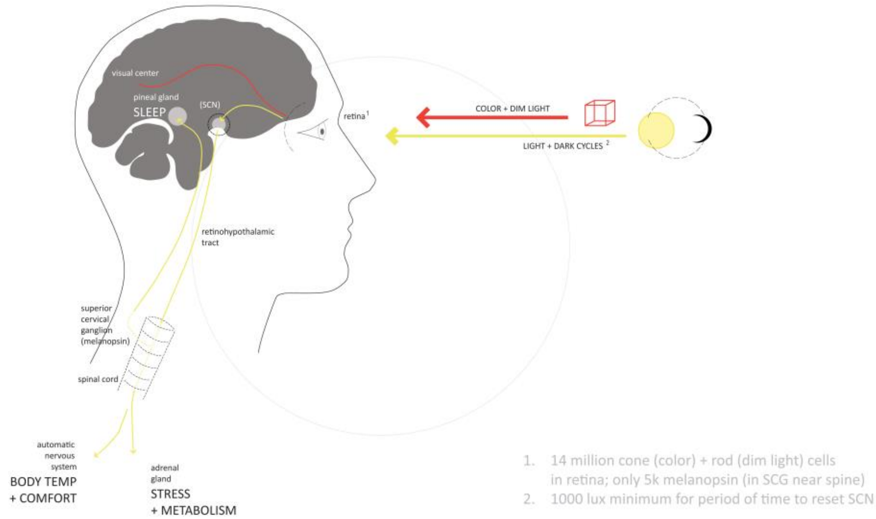

Figure 44: Diagram of how a human processes light and dark cycles
The Visual center remains uninvolved. The SCN is one gateway to our more primitive systems. Diagram by author, 2014.

Architectural Applications of Chronobiology

Social spaces on either end make you interact *before* you get to your work space, and also have the highest levels of daylighting. These are also the areas where food is stored and shared.

The fitness room lights only come on during certain hours. A narrow floor plate allows for relatively short distances to natural lighting, but remains controlled in respect to solar exposure building efficiency. The building orientation and layout acts as a sort of light clock, exposing different areas at different times. Artificial lights do not come on after sundown.

The separation between the Strecker Lab and the Neuroarchitecture Incubator provides the necessary isolation between more and less sensitive programmatic areas, but also gently forces the occupant’s exposure to the external temperature (albeit for a brief time), another factor in chronobiological rhythm therapy. One way to do this would also be natural ventilation, but this compromises the working conditions of the space and thermal efficiency. The separation also maintains the historic landmark. If more sensitive transitions are required between the two labs, the cellars have been attached by a subgrade pass and the idea of programmatic separation.

5 BLACKWELL TOWER

5.1 **A Place for Private Study**

Figure 45: Blackwell Tower: Axonometric Rendering
An aerial view of the proposed Blackwell tower, demonstrating the ADA accessible ramp allowing visitors and researchers to reach the top of the existing mound. Topographic representation taken from on site Lidar scans and re-developed by author, 2015. Image composite of raw site data and 3Dimensional modeling. Rendering by author, 2015.

> *"How are we going to collect this new information that we can all use to live in an even better, more beautiful, and more effective environment?* ***Well, one way that might be helpful is to develop a kind of empirical architecture,*** *an experimental architecture based on some of the premises that we use in science. When we design an experiment, the first and foremost important step is to develop a hypothesis."*[58]

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[58] Fred Gage, *Lecture at the AIA 2003 National Convention & Expo*. May 8, 2003.

At a lecture given to the AIA in 2003, Dr. Fred Gage began to suggest a framework for the way in which architects may practice to help advance the understanding of how the brain is affected by the environments we design. Using intuition and research findings as a guide, Gage believes that architects are in an ideal circumstance to begin responsibly forming and testing hypotheses. Blackwell Tower, the next part of this proposal, seeks to allow for the successful development of a necessary programmatic element of ANFA NYC while at the same time studying its inhabitants as a means of testing a series of hypotheses on how we navigate cities.

While most of the direct programmatic needs take place in the Neuroarchitecture incubator, the proposed design takes one piece of that program and isolates it for multiple reasons. The need for an area of private, quiet study and meditation is one that is fairly common in both Neuroscience facilities (namely the Salk Institute and Sanford Consortium) and places of architectural practice. Typically, this piece of the program looks to occur in relative isolation so that users may be afforded a quiet, controlled space free of cognitive distraction. In the case of ANFA NYC, this part of the program is served by what is called Blackwell Tower: a new 6 story study tower located on the existing mound in South Point Park and within walking distance of the more intensive and public Incubator building.

By completely isolating the act of private study from the social nature of the Incubator, researchers can be guaranteed a distraction free place to contemplate and study on an individual basis. Its location on the mound activates and emphasizes one of the unique conditions of the site. A new ADA accessible ramp wraps the mound's topography, granting access to the physically disabled. What's more, the siting of Blackwell Tower takes advantage of the Park's most resilient (in terms of sea level rise) locations. While a good majority of the site may be subject to sea level rise, the base of the tower is well above common sea level projections.

Figure 46; ANFA NYC: View North from South Point Park
A rendered character vignette showing the new landscape of South Point Park as proposed. To the left is a new ramped entry for access to Blackwell Tower. In the distance is a massing sketch of Cornell Tech's southernmost residential building. Along the right is Strecker Memorial Lab.

The extended time of transition between public and private study gives researchers the ability to separate, unwind, and clear their minds, allowing them to more purposefully seek out private study. What's more, exposure to the external conditions of the environment, namely the temperature and sun, is a key factor to good, chronobiological design; being exposed to these things intermittently re-syncs our internal rhythms.

Finally, by isolating the program of the tower from the Incubator and designing as I have, it is intended to act as a means for testing and further researching a very important finding between neuroscience and architecture: the way in which we map, learn, and remember place.

5.2 PRINCIPLE: Wayfinding

The first of two closely related principles involved in the proposal for Blackwell Tower, deals with our ability to spatially navigate and remember place.

Have you ever wondered how you were able to travel from one place to another without being aware of your surroundings, and somehow still manage to find your way? Maybe you've questioned how you could remember the layout of your childhood home even after years of being absent from it. In the past few decades, neuroscientists have discovered a series of cell types that serve as an explanation as to how this is possible, and the results are quite astounding. They may play a part in how we continue to design human environments.

A field of research called *Wayfinding* describes the biological process by which we navigate place. The process first came to light in 1971, when John O'Keefe discovered what is known as the *place cell*, a very specific type of neuron which gets assigned to a particular geographic place in the environment. Over time, we essentially leave bread crumbs in the places we inhabit, permanently fixing them to the place they are dropped, and assigning a neuron (in this case in the hippocampus) to each one. That place cell's sole purpose in life is to let your brain know when the body has passed over the bread crumb it has been assigned. In 1960, architect and planner Kevin Lynch coined the term "Wayfinding" in his seminal text, *The Image of the City*, in which he sought a definition based on our use of sensory perception of cues in the external environment. The text is a critical one for those interested in Wayfinding.

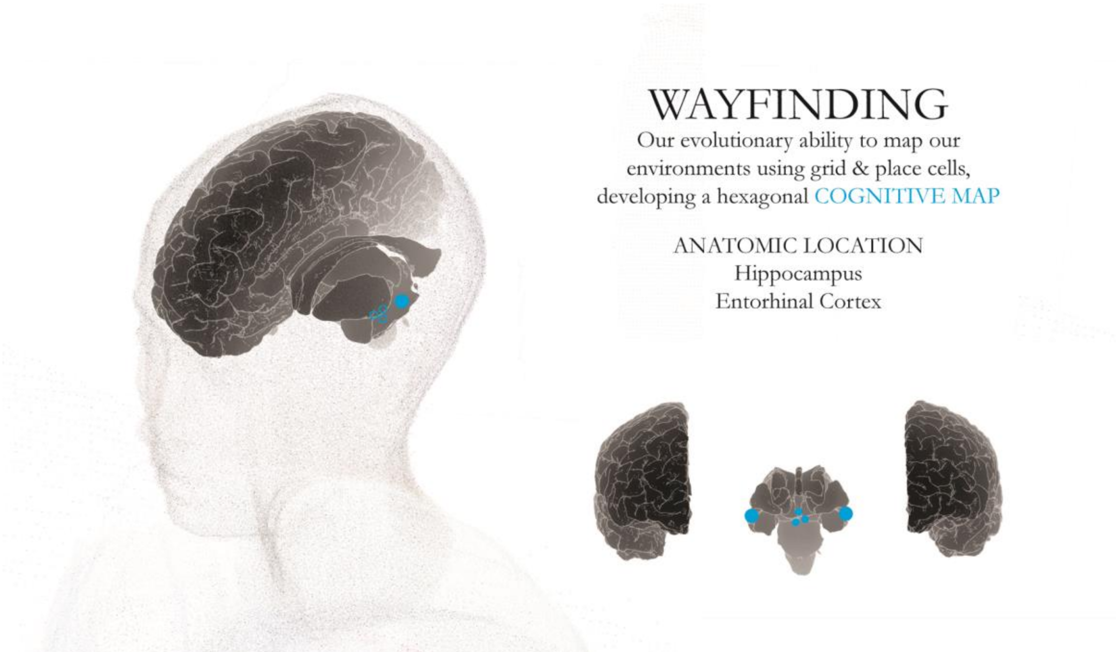

Figure 47: Overview of related neuroscience principle at play in Blackwell Tower: Wayfinding
Diagram composite using point cloud model of human skull (subject: Gina Fernandes, F, age 23), generated by author, with graphically inserted image of 3Dimensional Brain model via Bentley Rhinoceros modeling software. Diagrams by author, 2015.

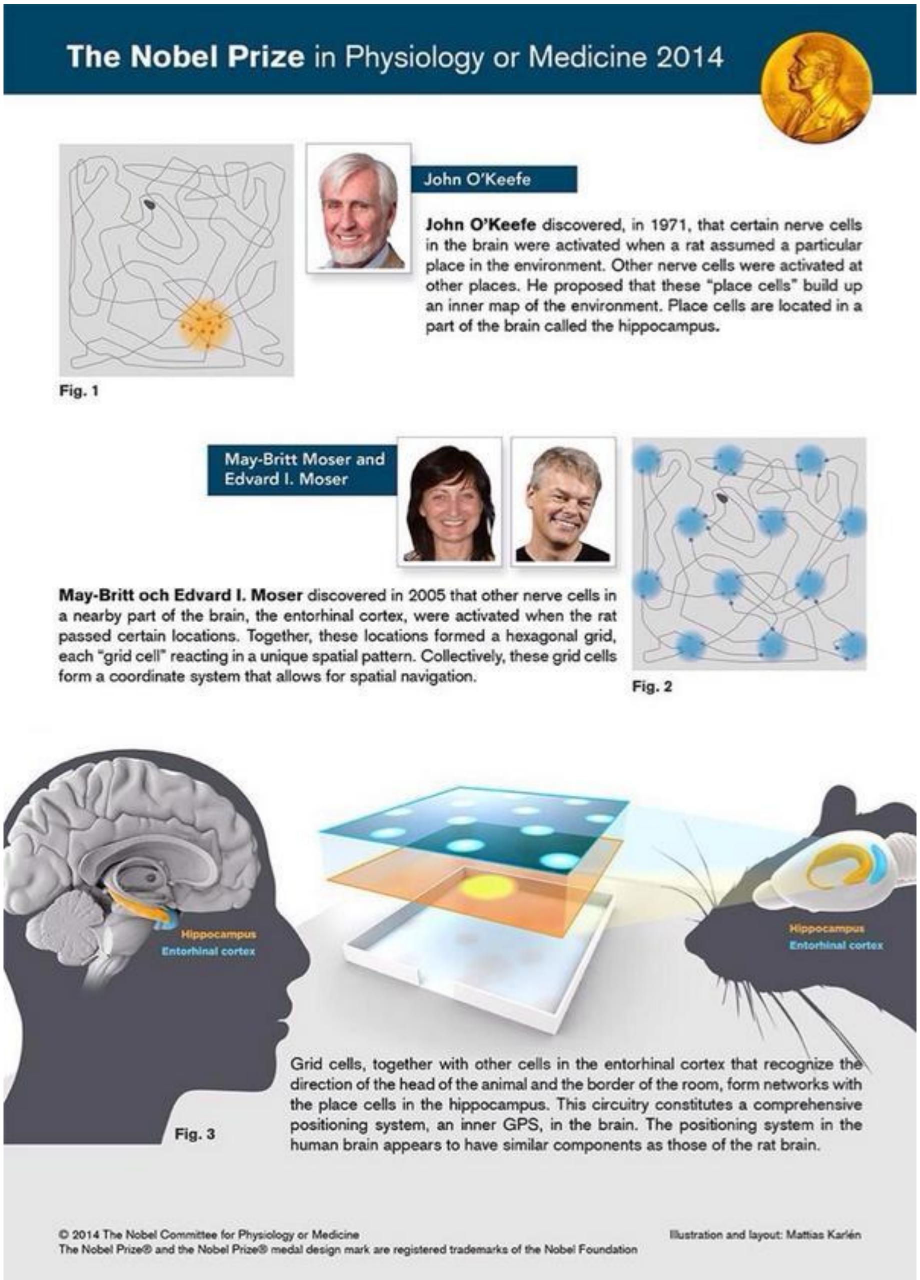

Figure 48: Wayfinding; Nobel Prize Poster, 2014
An informational slide illustrating the history of research done in Wayfinding, found worthy of a Nobel Prize in Physiology of Medicine in 2014. As referenced.

Over thirty years later in 2005, May-Britt and Edvard Moser pushed this research to identify a second type of cell, which they deemed the *grid cell*, found in the nearby entorhinal cortex. Amazingly, these grid cells orchestrate and organize the establishment of place cells and as a result form a coordinate system for the environment. What's more interesting, however, is that they do so in a hexagonal grid. In short, we are learning the places we live, work and play by creating triangulated cognitive maps of them, assigning neurons to fire in sync and let us know where we are. With this internal biological GPS, "we can define a navigational strategy and the route we need to take in order to move accurately and effectively to a desired location."[59]

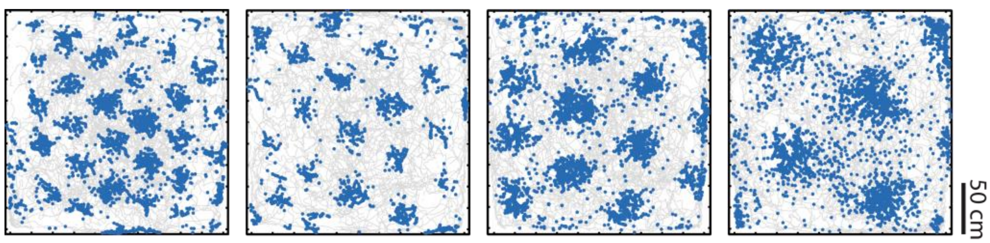

Figure 49: Grid cells at work
The image represents a rat's recorded movements (in gray) through a 2.2mx2.2m box. Each sample, from left to right, is the recording of a different grid cell, with instrumentation set at varying resolutions. Image courtesy of The Norwegian University of Science and Technology, www.ntnu.edu. As published in *The many maps of the brain* online article, 2012.

Two other cell types, *border cells* and *head direction* cells add to this biological wayfinding system. As one might assume, border cells focus on maintaining a clear understanding to the edge of a given space, while head direction cells let the brain know the disparity between orientation of the head and body as we move through space.

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[59] Eduardo Macagno, *Direct Relevance of the 2014 Nobel Prize...* 1

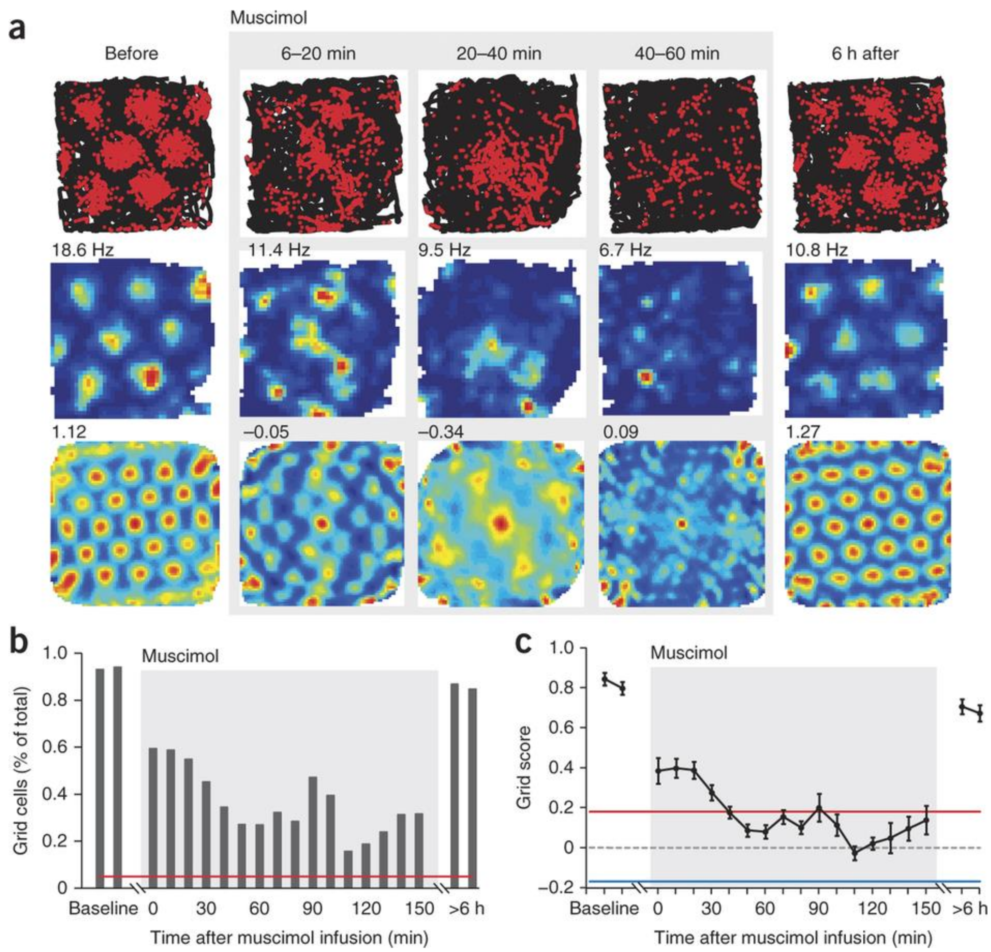

Figure 50: Disruption of entorhinal grid structure after inactivation of the hippocampus
A series of visualizations showing the results of various chemical injections to neural Wayfinding structures to determine the correlation between the hippocampus and grid cell system. The slide highlights in various ways the presence of the hexagonal grid cell firing fields. Image courtesy of Tora Bonnevie, B. Dunn et al. in *Grid cells require excitatory drive from the hippocampus.* Accessed via http://www.nature.com/neuro/journal/v16/n3/full/nn.3311.html

Neuroethically speaking, architects and planners should be "designing spaces that are straightforward for the user to navigate, by considering geometry and the location of cues and landmarks."[60]

[60] Eduardo Macagno, *Direct Relevance of the 2014 Nobel Prize...* 2

Hypotheses on Navigation

In light of the discoveries in Wayfinding and navigation, the proposal has formed several hypotheses that address some intuitive questions that fall into two larger categories: How the design of the environment can be sensitive to or reinforce navigational Wayfinding, and how we navigate a multi-tiered 3Dimensional environment like New York City. If architects can better understand how this biological mapping occurs in 3Dimensions, and what the role of architectural design is in light of Wayfinding, we can create more easily navigable, clearly mapped buildings.

Methods for testing these hypotheses involved attempting to isolate and control the variables involved. In this vein, the design provides for a very closely repetitive floor plate with consistent extents and floor to floor height, direct cardinal orientation with the largest openings and vertical circulation facing those cardinal directions, and consistently sized wall thicknesses and openings. Materials are to remain neutral; poured in place concrete and wood boards of consistent size allow for these things to fall to the bottom of the cognitive chain. Interestingly, these factors which allow the experiment to be controlled also make it an ideal place of private study and meditation. Non-distracting materials, stability, consistency, sound-proofing, and navigability make inhabitants free to focus on their work and leave the architecture in the background.

The floor plan for the tower is a 36’ x 36’ square, with four smaller squares segmented off within it in each corner. Its primary circulation occurs in a cruciform, and creates this segmentation. Two egress stairs which open out on the east and west exterior walls provide safe and clear vertical navigation, and an elevator aligned with the southern opening provides handicap accessibility to the floors above. As users continue to return to the tower and its unassigned rooms, they in effect cognitively map the structure over time, allowing researchers to understand better the way in which we navigate. A shifting, underlying hexagonal system is inset within the floor plates of the tower, allowing for two hypotheses to play out.

The first hypothesis, which questions how place cells become assigned to particular locations, calls for the locating of architecturally significant moments directly on the points of this hexagonal system. Can the environment dictate or reinforce where we decide to leave these Wayfinding ‘bread crumbs?’ Thresholds, window and door openings, light wells, and placement of a specifically designed bed/desk combination all find their way onto the points of this grid, setting up a means for researching whether they correspond with the inhabitant’s place and grid cells.

The second hypothesis deals with the way in which this cognitive map pans out in 3Dimensions. If our cities are becoming increasingly multi-tiered, we should deepen our understanding of how we in fact remember and navigate multi-story buildings. As the floor plates stack and repeat, the hexagonal system either repeats vertically, rotates, or vanishes altogether. The plurality of familiarity and controlled novelty from level to level will over time act as a means of researching the variables at play. The plan drawings and diagrams below illustrate and define the experiment.

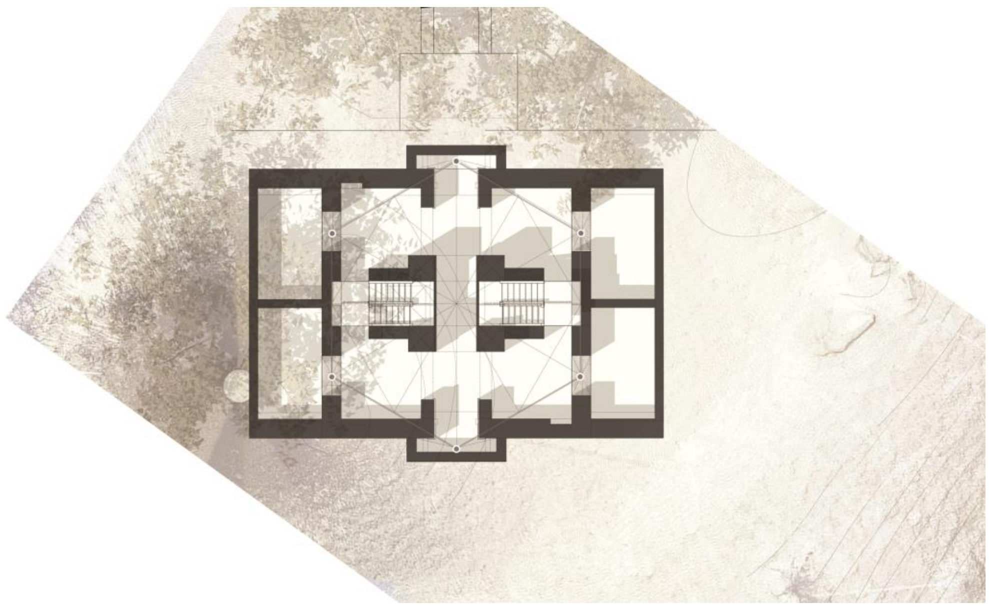

Figure 51: Blackwell Tower: Subgrade Level Floor Plan
The layout of the tower is centered around four large structural piers, hosts two egress stairs on its east and west for both code requirements and additional navigational experimentation, and four private study rooms, unassigned until requested. Orientation is true north. The subgrade level features four additional chambers for testing various "Ground Space Phenomena" (Thiis-Evensen, *Archetypes in Architecture*) and lightwells centered on the north and south walls to host wayfinding cues. Drawing by author, 2015.

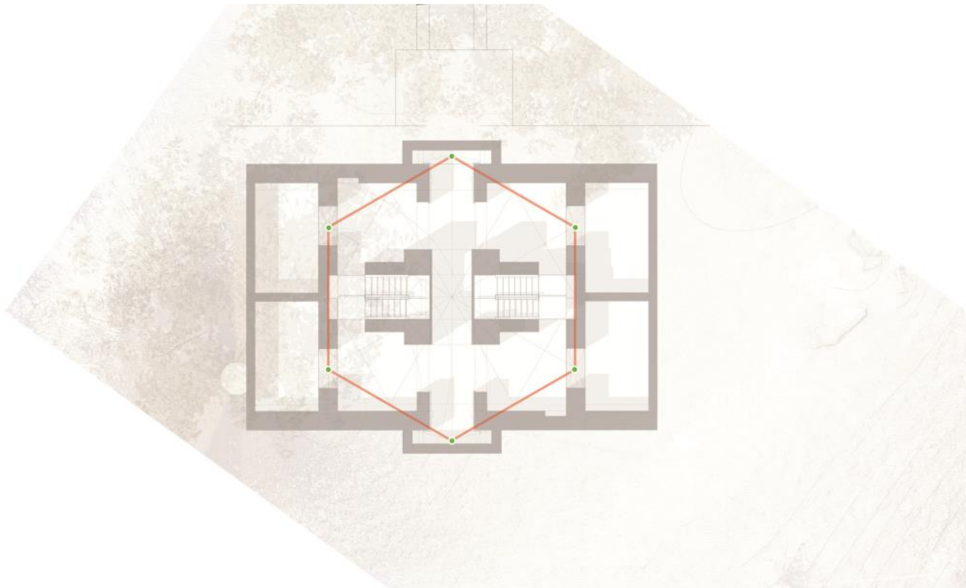

Figure 52: Blackwell Tower: Subgrade Level Floor Plan Diagram
The same plan drawing, but highlighting the underlying hexagonal layout. Thresholds and lightwells provide the architectural cues at the subgrade level. Orientation is true north. A pinhole lightwell invites users to stand in the small coves on the north and south walls, potentially resulting in the assigning of a place cell. Drawing by author, 2015.

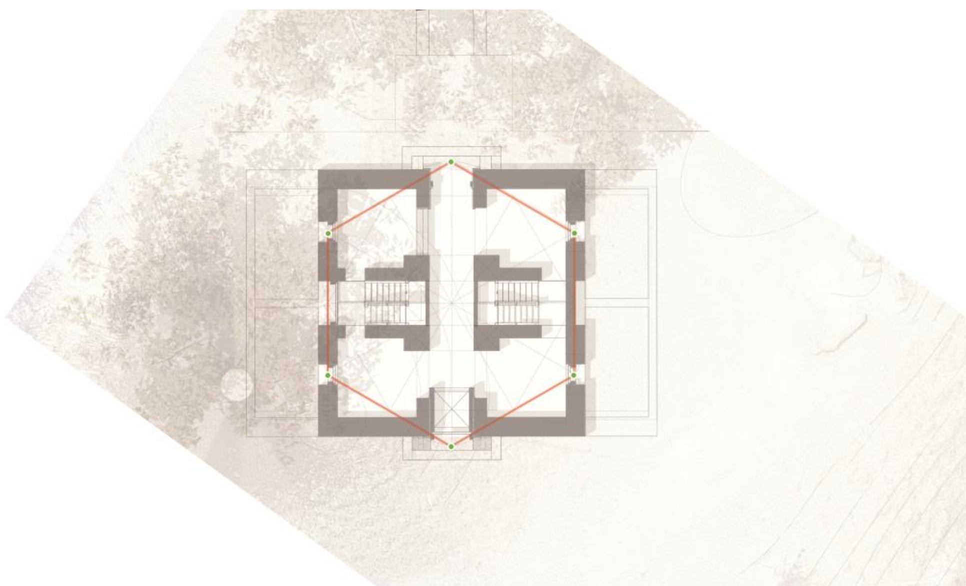

Figure 53: Blackwell Tower: First Floor Plan Diagram
At the ground level, the layout of architectural cues is repeated on an identical hexagonal layout as the subgrade level beneath it. Here, cues are entry and window openings. Orientation is true north. Drawing by author, 2015.

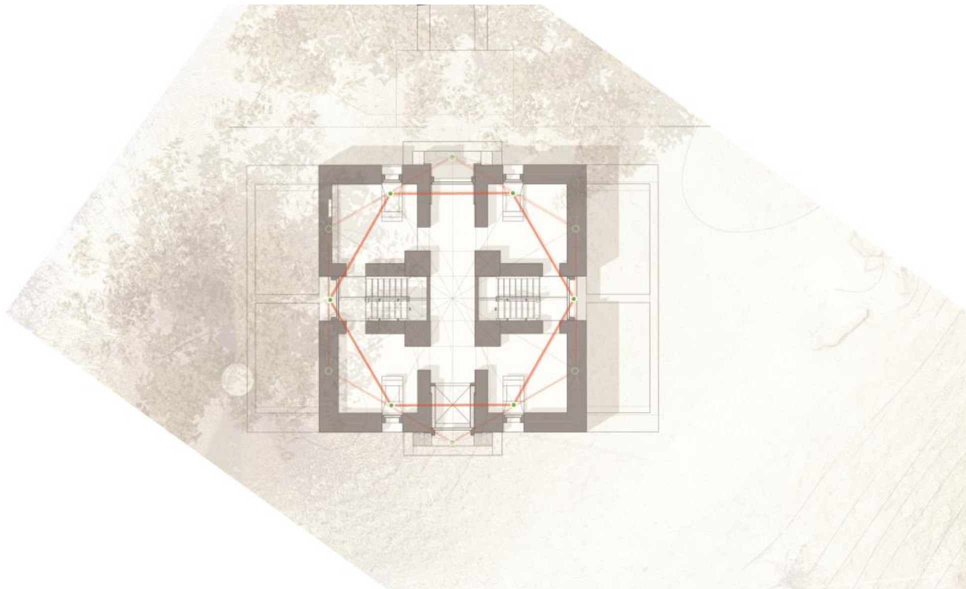

Figure 54: Blackwell Tower: Second Floor Plan Diagram
On the second floor, the underlying hexagonal organization is rotated from that of the one on the first floor, with cues aligned where users habitate (headrest of desk/bed furniture below window opening) and views out to the city at shared egress stairs. Orientation is true north. Drawing by author, 2015.

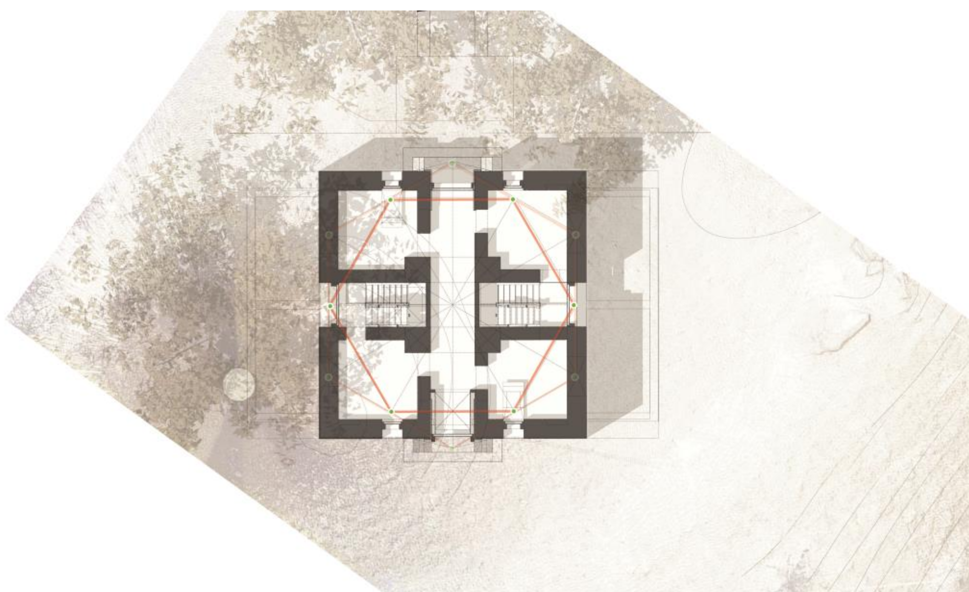

Figure 55: Blackwell Tower: Third Floor Plan Diagram
The hexagonal layout is repeated from the Second Floor, but the interior layout becomes slightly less navigable and uses in the Northwest and Southeast corners becomes unassigned. Orientation is true north. Drawing by author, 2015

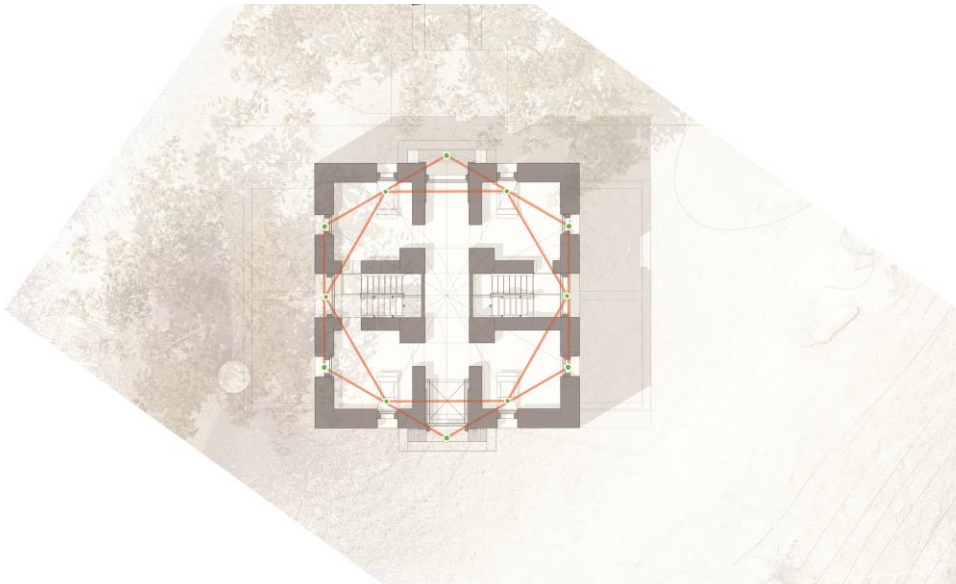

Figure 56: Blackwell Tower: Fourth Floor Plan Diagram
Both preexisting layouts of architectural cues are overlaid on the fourth floor in an effort to determine which takes precedent. Orientation is true north. Drawing by author, 2015.

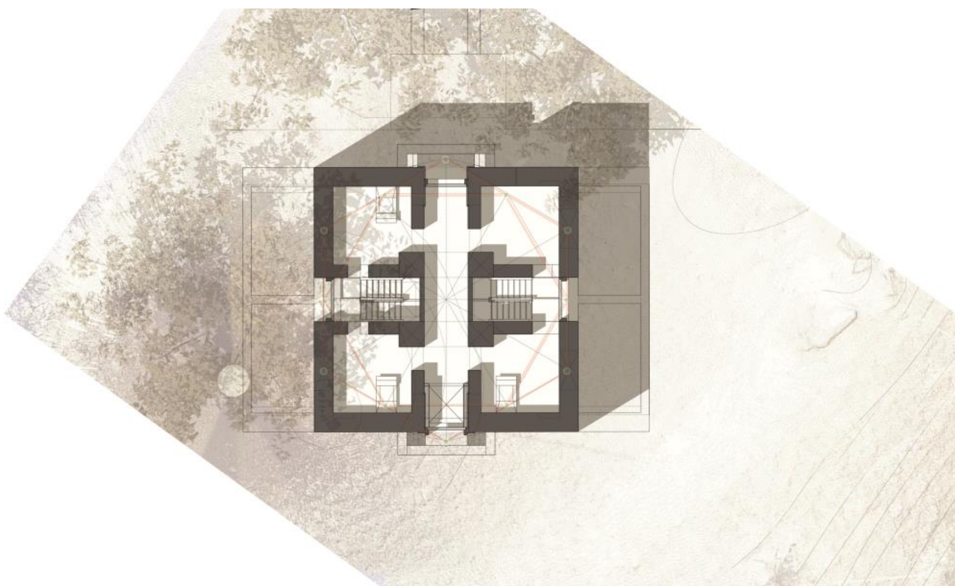

Figure 57: Blackwell Tower: Fifth Floor Plan Diagram
On the uppermost floor, the predetermined hexagonal layouts are non-existent in plan, with natural lighting being provided for by skylights sbove. Orientation is true north. Drawing by author, 2015.

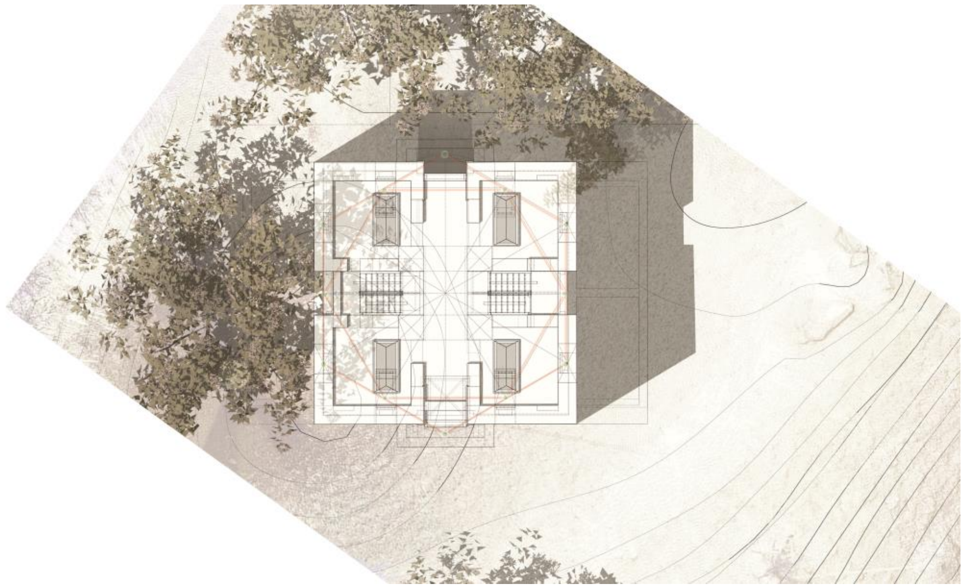

Figure 58: Blackwell Tower: Roof Level Plan
An aerial view of the tower showing roof layout, hidden lines below, and the skylights lighting the fifth floor. Orientation is true north. Drawing by author, 2015.

Other questions for future development and hypotheses might include:

i. First and foremost, is there anything unique about the human grid cell and how it behaves that makes it different from the one found in rodents?

ii. If architecture can reinforce the assignment of place cells, what is our tolerance for picking up on these cues? Is there a certain level of contrast or significance which must be obtained in order to establish a noticeable cue?

iii. If architecture can reinforce the assignment of place cells, does physical contact with an environmental cue increase its effectiveness?

iv. In light of our ability to see ourselves in external environments (see *Embodied Simulation*), do we necessarily need to physically inhabit a location in order for a place cell to be established, or can we in a way cast these place cells out like a fisherman would his lure?

v. How readily or quickly do our cognitive maps adapt to change in the environment? Do place cells shift with temporary things like furniture or other objects?

vi. Does the process of cognitive mapping vary in individuals who lack one or more senses, particularly vision?

vii. What is the resolution at which grid cells organize themselves? In other words, what determines the distance between place cells, and does that distance adapt to a smaller or larger context?

5.3 **PRINCIPLE: Memory & Attention**

We can see that Wayfinding is an essential tool for designing Neuroethical environments, but it stands very close to another concept architects have wrestled with both poetically and literally over time: *memory*. In fact, the two principles occur anatomically in the same part of the brain. As with most neural research, discoveries and understanding are done through analyzing individuals with deficient or diseased cognitive abilities. A look at aging individuals highlights the closeness between Wayfinding and memory.

Our ability to cognitively map and remember environments becomes increasingly important as the human population ages. Unfortunately, as we age, our spatial cognitive abilities decrease, due in part to the deterioration of the memory system. In research conducted on Alzheimer's disease, a closer look at the neural structures of patients diagnosed shows that the "hippocampus and associated structures, such as the *entorhinal cortex*, are the earliest to show a severe volume decrement."[61] As discovered through research in Wayfinding, these are the structures of the brain which help us remember our place. It becomes evident, then why individuals with damage or deterioration to these parts of their brain demonstrate a loss of their sense of place, but increased memory deficits as well. Spatial navigation and memory are too inextricably tied to consider one and not the other.

There are many applications of this thing we call memory. Because it resides in both the physical and metaphysical realm it becomes a difficult thing to define. Essentially, memory is just a retracing of the synaptic paths previously formed in our brains. Stimuli enter our brain, initiating an instant launch sequence of neurons which know the way to processing completion. You smell musty air in an unfamiliar house, and suddenly you think of your grandfather's basement where you'd spend summer days when you were unknowingly dredging paths in the sponge of your subconscious. Tying together spaces and material configurations allows you to move about your own house with ease, and leaves you lost in a new set or subset of spaces.

[61] Eduardo Macagno, *Direct Relevance of the 2014 Nobel Prize...* 2

Playing chopsticks on the piano was the first and last thing your brain ever had to process on a keyboard, so it’s like riding a bike- you don’t forget how.

Then there is the embodied memory which lives on in our inanimate configurations of matter. A tombstone, for example, maintains a physical presence for a person no longer walking among us. It allows us to learn a good deal of history and our ability to tell narrative through their inscribed clues may give us a sense of how life really was at times in the past. The same can be said of a building. However, while a tombstone serves no other user than its owner and his loved ones, a building may typically serve many over the course of its lifetime, and will undoubtedly serve as a memoriam of the decisions which those users made among it.

Memory: Anatomical Context

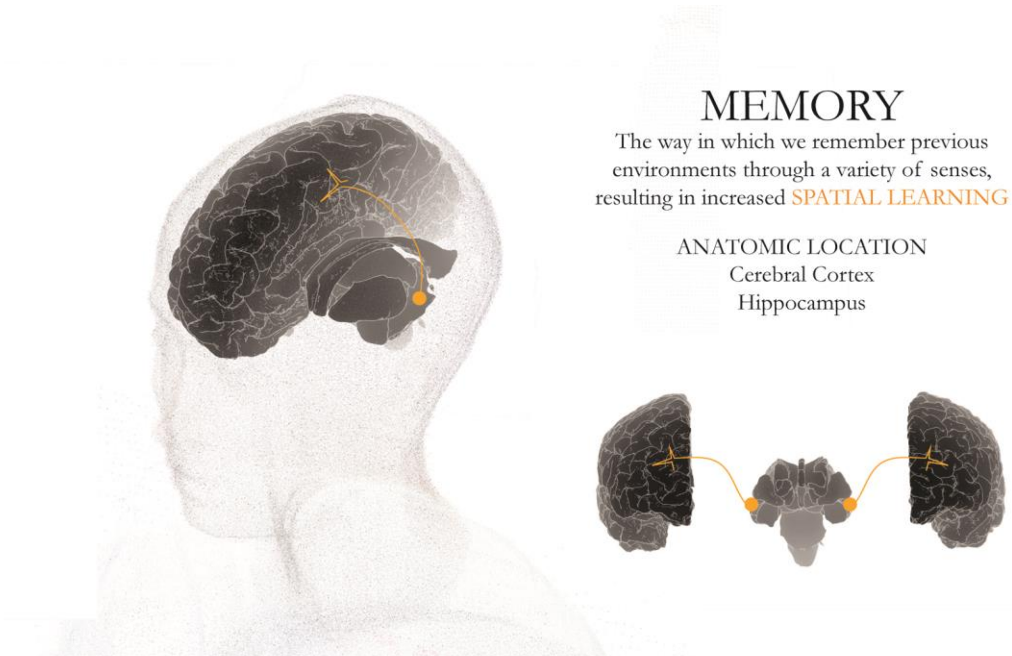

Figure 59: Overview of related neuroscience principle at play in Blackwell Tower: Memory
Diagram composite using point cloud model of human skull (subject: Gina Fernandes, F, age 23), generated by author, with graphically inserted image of 3Dimensional Brain model via Bentley Rhinoceros modeling software. **NOTE TO READER: while the above diagram highlights the role of memory development in the cortex, other subcortical regions also undergo memory formation.*
Diagrams by author, 2015.

Functional memory allows us to progress through our lives. Embodied memory allows us to reflect on them. In these terms, we must understand the obligation of our prerogative to create and change the environment, in that our buildings may live on beyond us and leave a mark of who and what we were. It is only through shared social, embodied memory that our species perpetuates itself.

How, then, do we come to understand the lure of architectural ruins? Finding a neo-revival, the ruins of our built past, now more contemporary than the ones left by our stone-setting ancients, are and will always be a point of interest. It is a thing that I have wondered about for several years now, but know that it has something to do with the realms of empathy, embodied memory, as well as the stripping of intention.

Navigating Urban Spaces Demands Attention

Studies have been conducted correlating the role of cognitive attention in both Wayfinding and our memory of them. In essence, if we are not focused and paying attention, we sacrifice our ability to identify the cues which help us remember place. A study titled "Navigating Urban Spaces Demands Attention: Evidence from physiological indices of arousal and visual attention" highlights the importance of attention and memory in place. The study was conducted by Kevin R. Barton and Colin Ellard of the University of Waterloo, and used Bill Hillier's *Space Syntax* as a guide. Readers interested in the study should consider Hillier's text.

In this particular study, attention was measured by recording measurements on the subject's blink rate and autonomic nervous system. In short, when we attentive, we tend to blink less, a research found to be true by studying theater-goers. Together with biological readings measuring the variability and frequency of the subject's heart rate, as well as their Galvanic skin response

(GSR), the study was able to create a metric for the subject's level of attention when virtually navigating a novel urban space. Results show a decrease in spatial memory for subjects with lower scores in attention metrics.

The importance of the study is two-fold. First, and as described, spatial navigation and memory are dependent on the attention of the user. In that sense, designers should keep in mind that regardless of successful design and planning or not, a disengaged inhabitant will not navigate efficiently. This ability to engage inhabitants may or may not be accounted for in design. Furthermore, attention naturally varies among age groups. In environments or buildings with a known mix of age groups, i.e. a school, special care should be taken in accounting for various attention levels in different programmatic areas.

6 THE SMALLPOX HOSPITAL

Figure 60: Lidar Axonometric view of Smallpox Hospital in context
On site recording of raw data, image edited by author, 2015.

> *"The quiet ruin reveals again the spirit out of which it once stood as a proud structure. Now it is free of its bonds.*
>
> *To of this spirit is a building being built now more wonderful than when it will be completed. Its spirit is young and anxious to become itself. It too is free and need not answer.*
>
> *The building standing complete has its spaces locked in unbending structure. Its bonds are the duties of use. The spirit is engaged and must answer.*
>
> *The quiet ruin now freed from use welcomes wild growth to play joyously around it and is like a father who delights in the little one tugging at its clothes.*
>
> *The ancient building still vigorous in use has the light of eternity."* [62]

---

[62] Reproduced, by permission, from Louis I. Kahn, Letter to Harriet Pattison, September 15, 1964 as printed in Tyng, *Beginnings...*

Figure 61: Smallpox Hospital | Southerern Wing Xray
An early study using Lidar imaging to create composite sectional drawings. Drawing by author, 2015.

6.1 A Place for Research & Worship

The program outlined for this thesis project is that of a research facility geared toward understanding the emotional, neural reactions that humans display to specific environments. Rather than be a place of simulated reality, it can, in its brief remaining lifespan, be used *as* a reality. Rather than try to authenticate representations of the past and conjured atmospheres, the Ruin can, in its current unaltered state, be a testing ground for mapping our brain's reaction to architectural ruin.

While most of the ruin may remain intact, those parts which must be reinforced can take on a new, alternate life in form and materiality. One which will question and tease out those things about the environment that we can readily identify as authentic, and how inauthenticity makes us feel.

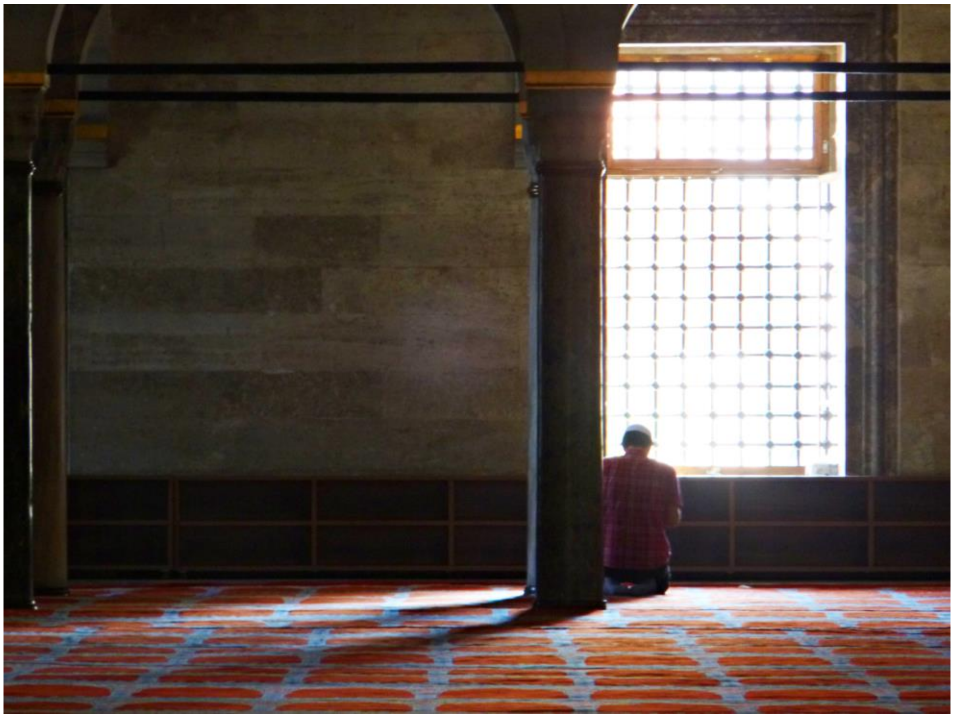

Figure 62: Süleymaniye Camii; A lone worshiper is drawn to a daylit location
L. Petrocelli, 2014.

We have learned through our mapping of the human brain that empathy and mirror neurons empower us to connect with others and also identify ourselves. Traditionally, this has occurred through ritual, and through religion. Places of worship have served one primary purpose, to regularly remind us that we are part of something bigger than ourselves, and reinforce that perspective with their architectural forms (see *The Gothic Revival*). They serve to humble us so that we may in turn understand, connect, and relate. With such a deep history in human mortality and our common fight for survival, the Ruin presents itself as an ideal place to amplify our connectivity, not just through place, but through time. Rather than hold a memorial to honor its fallen, it *is* a memorial in and of itself.

"Death comes even to the monumental stones and the names inscribed thereon." [63]

6.2 The Lure of the Ruins

"I think we're drawn to ruins because we feel. We see something in them that we need at a very deep, base psychological level, which is placing ourselves in time- we need that, we need a place. And that's what ruins do. And the few times people, or myself in particular, get anything out of seeing ruins is when that is understood. When it is realized.

So it's about using science to really understand what we really need, why we're drawn to certain things, in order to allow those things to really happen. What this analysis can do is educate people on how to find what they may need, so they can get more out of life. And that is all we should ever use science for. We should only ever use it to connect us to that deeper need, so that we can be truly and deeply fulfilled in our experiences." [64]

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[63] Decimus Magnus Ausonius, *Epitaphia*. (AD 130)

[64] *[By author, from conversation with S. Stein, 11 Nov 2014]*

Figure 63: Religious Piligrimage to Andriake, Turkey
Photo by author, 2013.

Figure 64: Visitors Posing with Ancient Sculptures
Photo by author, 2013.

Figure 65: Visitors at Stone Henge
Image edited by author, 2015.

6.3 PRINCIPLE: Emotion

Writers and architects throughout time have wondered the origin of emotional response in art and architecture. More recent theories on emotion suggest laterilazation, but neuroscience is slowly debunking this theory, leaving us to re-think the separation between emotion and logic. How does simplicity in form and materials, and a coalition between the two evoke emotional response? Juhani Pallasmaa wonders, "Why does the stair hall of Michelangelo's Laurentian Library, built of mere *pietra serena*, make me weep?"[65]

[65] Juhani Pallasmaa, *Towards a Neuroscience of Architecture*, 6.

My experience with ruin has left me asking the same question: how do ruins elicit an emotional response?

Emotion: Anatomical Context

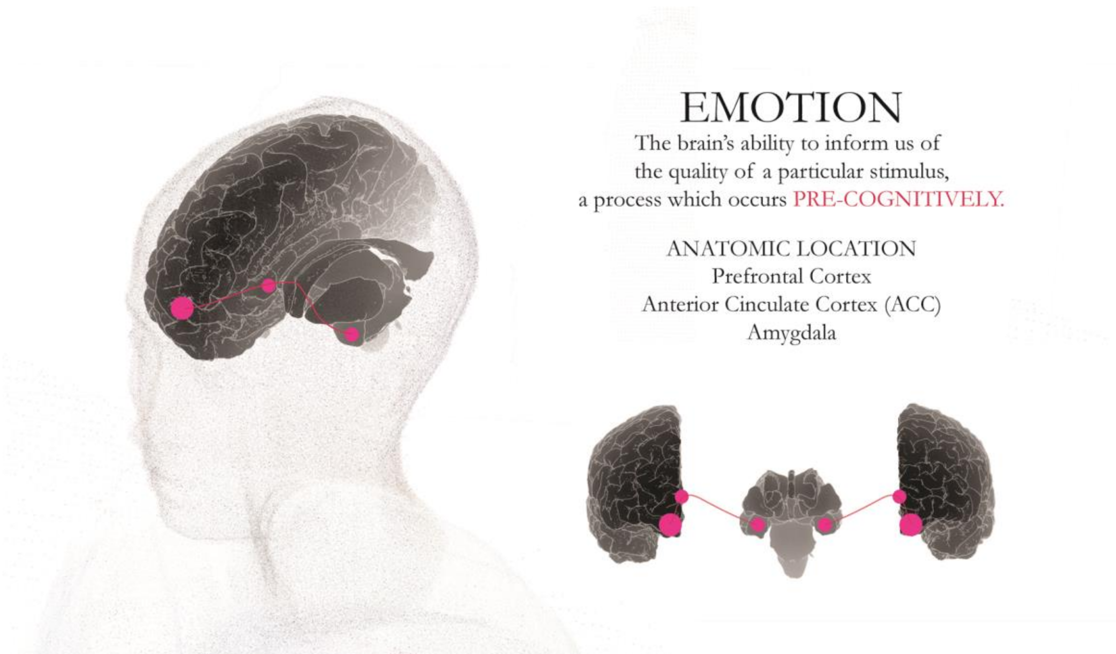

Figure 66: Overview of related neuroscience principle at play in the Smallpox Hospital: Emotion Diagram composite using point cloud model of human skull (subject: Gina Fernandes, F, age 23), generated with permission by author; graphically inserted image of 3Dimensional Brain model via Bentley Rhinoceros modeling software. Diagrams by author, 2015.

It turns out that "the built environment is initially perceived emotionally- that is, prior to our conscious reflection on its many details."[66] Essentially, stimuli produce a "core effect" which is routed in two neurological pathways (systems) in the OFC. One, the sensory, gives preliminary value and effects on homeostasis. The second, the

[66] Lisa Barrett, as quoted in Mallgrave, *Should Architects Care About Neuroscience?* 28

visceromotor circuit, modulates the corporeal response to the stimulus. These things are filtered before anything else (culture, experience, etc.) comes into play. “Collectively, they produce an affective state bound to a particular situational meaning, giving us the disposition to act in a certain way.”[67]

Figure 67: ARCH600, Comprehensive Studio
Studies in light, materiality, monumentality, and emotion. ¼” scale model, cast-in-place plaster and wood framing. Completed by author in 2013.

[67] Mallgrave, *Should Architects Care About Neuroscience?* 29

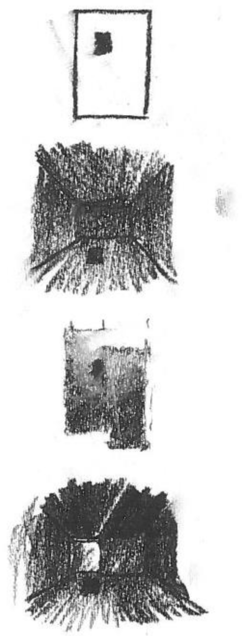

Figure 68: ARCH600, Comprehensive Studio.
Charcoal on Paper sketch. Completed by author in 2013.

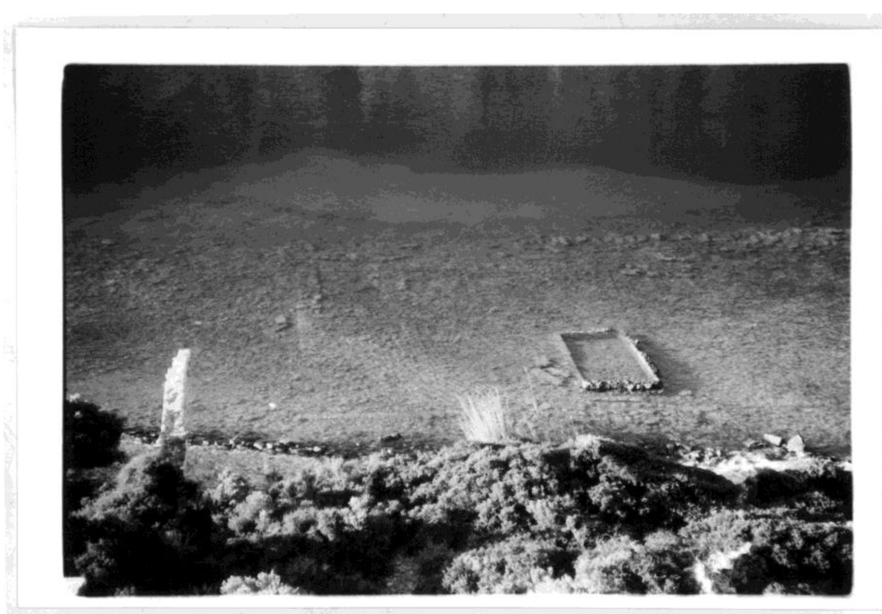

Figure 69: Submerged Harbor at Aperlae, Turkey
How do ruins elicit an emotional response? Photo by unknown author, 1996.

6.4 PRINCIPLE: Embodied Simulation (Empathy)

Mirror Neurons

Why are we empathetic as humans, and are we the only ones? In the last decade, researchers have determined a possible neurological underpinning for how and why empathy happens. Mapping this system of reflexivity in the brain can help us understand not just how we are empathetic to others, but to our environments and buildings as well. This underpinning hinges on the concept of the *mirror neuron*, first discovered in the 1980's by Italian researchers Giacomo Rizzolatti, Giuseppe Di Pellegrino, Luciano Fadiga, Leonardo Fogassi, and Vittorio Gallese. The initial study, focused on the *ventral premotor cortex* of Macaque monkeys, sought to study neurons specialized in controlling the hand and mouth of the monkey. By honing in on a single neuron over multiple activities, they discovered that activity occurred and overlapped when the monkey performed the action, as well as when it observed another perform the same action. In fact, even the sound of or hint at the action fired the neuron.

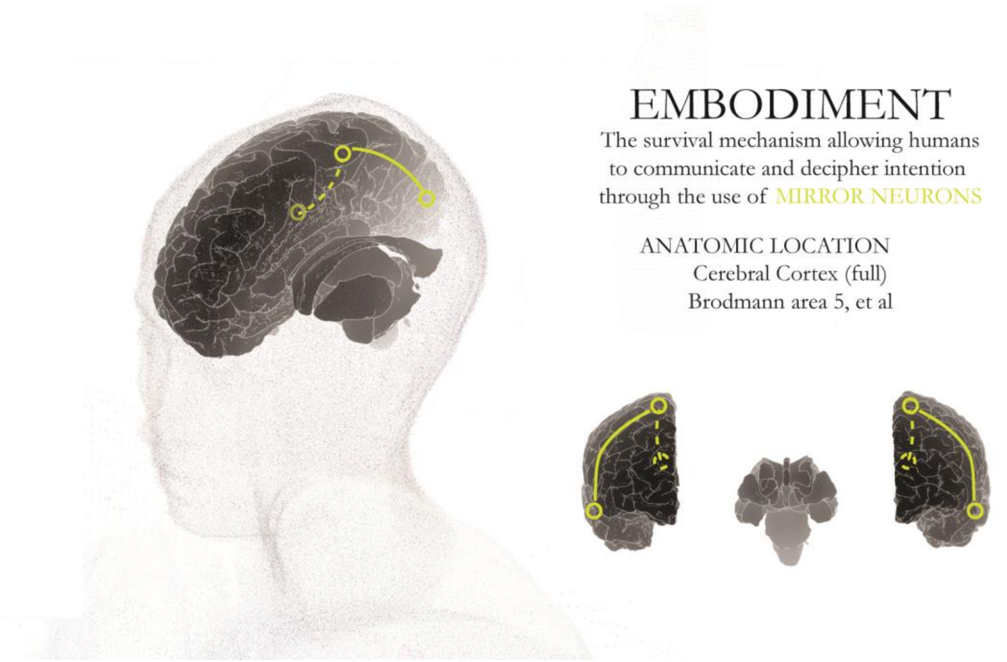

Figure 70: Overview of related neuroscience principle applied: Embodiment
Diagram composite using point cloud model of human skull (subject: Gina Fernandes, F, age 23), generated by author, with graphically inserted image of 3Dimensional Brain model via Bentley Rhinoceros modeling software. Diagrams by author, 2015.

> "... I also speculated that these neurons can not only help simulate other people's behavior but can be turned 'inward'—as it were—to create second-order representations or meta-representations of your *own* earlier brain processes. This could be the neural basis of introspection, and of the reciprocity of self-awareness and other awareness. There is obviously a chicken-or-egg question here as to which evolved first, but... The main point is that the two co-evolved, mutually enriching each other to create the mature representation of self that characterizes modern humans". [68]

[68] V.S. Ramachandran, *Self Awareness: The Last Frontier*

Mirror neurons may be subject to what researchers call *exaptation*, or the idea that any given evolutionary trait persists in our DNA, but comes to serve a different function over time and through the development of the environment. Part of what mirror neurons allow is the act of empathy.

Empathy

"How is it possible that architectural forms are able to express an emotion or mood?"[69] The question, posed in an 1886 art history dissertation by Heinrich Wolfflin, remained unanswered in the sea of "extraordinary theoretical debates of the 1880s."[70]

Professor Robert Condia of Arkansas/Kansas State University and his colleague Michael Luczak reopened Wolfflin's question in 2014 with their study *"On Mood and Aesthetic Experience in Architecture".* Relying on the veracity of the idea that "buildings are measured with the whole body" via empathetic pathways, the two researchers claim that the "intersection of architecture and neuroscience is the re-creative experience known as mood."[71] Surely, traces back to Vischer's work can be correlated with the study; the German refugee insisted that "those external phenomena that have such a particular effect on us, into which we unwittingly read our emotional moods" must certainly reflect the internal, objective condition of the subject.[72] In

[69] Heinrich Wolfflin, *"Prolegomena to a Pscyhology of Architecture"*, 1886.
[70] Mallgrave, *The Architect's Brain,* 80
[71] Condia & Luczak, *"On Mood and Aesthetic Experience in Architecture"*
[72] Friedrich Theodor Vischer, "Kritik meiner Aesthetik" (1866)

terms of this mood-like reactivity, he went so far as to suggest the spiritual implications of horizontal, vertical, and curvilinear contours in the environment. He termed this *Ineins- und Zusammenfulung*, the "animistic urge to read our emotions and ourselves in the forms of the sensuous world.[73]

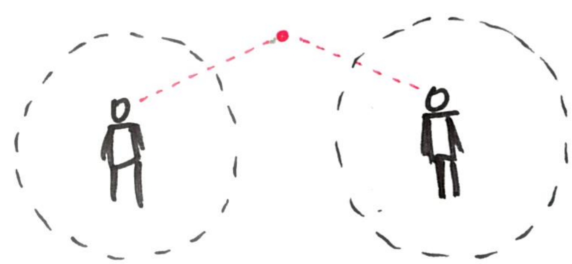

Figure 71: Empathy
Ink diagram by author.

Einfuhlung

The theory of animistic mood-recognition would continue on through Friederich Vischer's son Robert who evolved his father's work by introducing the concept of *Einfuhlung*, a word incapable of direct translation to the English language. In a way, *Einfuhlung* is a more personalized empathy, one which reflexively calls upon our own experiences as a means to read and understand those of another. This theory may more closely approach a reason for the emotional draw of ruinous architecture; we can use our own conditions as a database for reading otherwise inanimate ensembles. *Einfuhlung* drives

[73] Mallgrave, *The Architect's Brain,* p. 77

home the unconscious nature of empathetic neural processes, "the unconscious projection of 'our own bodily form – and with this also the soul – into the form of the object.'"[74] Vischer used the neural workings (nerves & muscles) of the optic system to attempt an unraveling of why this was. [75]

The 19th C. explosion of excitement in *Einfuhlung* was in a way a determinist drive. Suddenly, the notion that architectural form could evoke emotive response simply due to neurobiological synchronization and not nostalgic historicist or "representational trappings" opened the door for a scientifically justified abstraction of architectural form.

Empathy, the ability to understand and share another person's experiences and feelings, will become a critical piece in understanding the way in which we interact neurologically with the environment. It is one of those common human denominators which only few other creatures on earth can exhibit. Empathy is our way of saying "I understand", and in turn becoming self-aware. An understanding which comes from the fact that, because we have created, we have spoken.

In *Act of Creation*, Arthur Koestler defines the phenomenon as "projective empathy", in which "not only motions, but emotions too are projected from the self into lifeless objects." He suggests that we perceive the inanimate

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[74] Robert Vischer as translated in *Empathy, Form, and Space*
[75] Mallgrave, *The Architect's Brain*, p. 77

world as animate "probably as a consequence of our own unconscious eye movement" and our tendency to project life and emotion as simply "a basic feature of our psychic make-up."[76] The author references the way a church spire seems to soar upwards, or how his car tends to "groan and pant" under the effort of climbing a hill.

Intention

The other part of the empathy response is our biological ability to understand and replicate *creative intention*. Because evolution has not trained us to sympathize with the inanimate, we see ourselves in our artifactual creations and environments. We see our intentions, desires, and universal struggle against mortality and the unknown.

Our strengths and insecurities, our ego, our emotional states, the processes of the brain and their inherent learned biases, all live on within our creations. By carrying out the act of creation, we effectively mirror ourselves and encapsulate our being into animate material configurations. If there is a biological life force behind it, the creation will be animate. Inanimate configurations are machine-mass produced, not produced by the living, breathing, and masses. They are, again, a degree separated.

[76] Koestler, Arthur. *Act of Creation*. p. 296

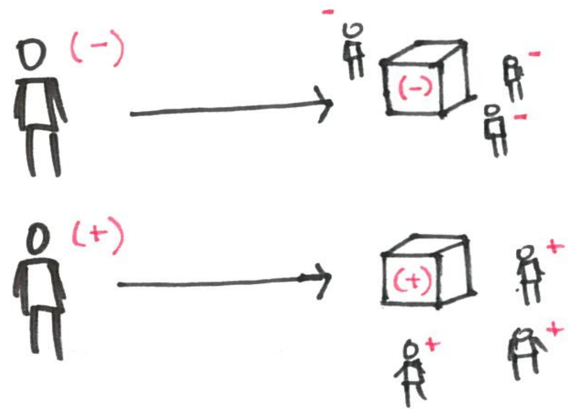

Figure 72: Intention
Ink diagram by author.

This life force can be positive or negative. Whatever polarization, it will not only be noticeable in the interpreter's experience of the artifact, but also be subsequently transported to and recreated within the interpreter's own being, ultimately leaving them impregnated with our seed of intention.

Essentially, our creations are a mirror of ourselves, and our selves are a product of a life surrounded by the creations of others, creating an exponentially self-generating importance in our responsibility as creators to reflect on our self before committing materials to the process of replicating it.

We then think the world of these things, and pour our lifeness into them. They are a manifestation of ourselves, and an eternalization of our personal conditions.

Architecture is, in a way, the ensemble of our obsession to survive held firmly in place by the slowness of evolution, and the more recent neural introduction of creativity and logic. All of these things, survival, creativity, and logic (in order of evolutionary appearance importance) are shared, and it is essentially this sharing which makes architecture universally understood. In creating, we unconsciously infuse these base drivers into our work, play with their representation, and use order in order to build them.

Digital production and mechanization forces a degree of separation from this act of creation, which starts to restrict our ability to empathize. This is, in a sense, the core of the debate on ‘craft’. When we discuss the degree of craft in a given artifact or creation, we’re speaking about our ability to empathize with its author. Whether it means observing irregularities in a handmade wooden bowl, in a way allowing us to *see* the actions of the creator, or latch onto the artful and logical struggle which endeavored its production, we seek out empathic connections.

So how do empathy and architecture overlap? What is it that alerts our ancient circuitry that we like this building or that painting? Consider art since art began, as Iain McGilchrist has in *The Master and his Emissary*. Particularly, consider the way we represent ourselves and each other. This is in a way a record of our growing ability to read and recognize subtlety in the human face, and empathize with one another. What makes this even more important is the fact that it *is not a learned behavior*. It is innate, and not of our own experience's doing.

"Our buildings are crucial extensions of ourselves, both individually and collectively."[77]

"What else could a poet or painter express than his encounter with the world?"[78]

"We are mentally and emotionally affected by works of architecture and art before we understand them."[79]

"…a profound piece of architecture invites and guides us to be better and more sensitive human beings."[80]

6.5 Relation

"If either arch or man expose themselves to their special temptations or adverse forces, outside of the voussoirs or proper and appointed armor, both will fall."[81]

Relation is the title of a theory I'd like to suggest which seeks to explain what it is about unfamiliar things from the past, like ruins, that make us so universally interested in them. Relation is the act of seeing ourselves in the

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[77] Pallasmaa, *Towards a Neuroscience of Architecture*. 9
[78] Merleau-Ponty, *Signs*. 56
[79] Pallasmaa, *Towards a Neuroscience of Architecture*. 11
[80] Pallasmaa, *Towards a Neuroscience of Architecture.* 12
[81] John Ruskin, *The Stones of Venice*

creations of others, allowing us to self-reflect and occasionally resulting in an emotional result. It is a combination of neuroscientific research done in both the fields of Emotion and Embodied Simulation. As astronomer Carl Sagan once said, “Human history can be viewed as a slowly dawning awareness that we are members of a larger group.”

In researching ruins, both academically and experientially, I’ve uncovered a few things that I’d like to share and discuss. Ruins have the ability to elicit an emotional response. This emotional response results in an act of self-awareness and reflection. Typically, this act of understanding another by referencing ourselves is called empathy.

Empathy occurs within the brain via mirror neurons. While other architecture may elicit emotional responses, that which ruin produces is unique, and for a moment, tragic. This is a good kind of tragedy. One that strengthens us by uniting us with something larger than ourselves. By reminding us of what is important in the face of an otherwise tumultuous world. By keeping us humble.

Without direct results of conquest, this is *not* an act of pleasure, as suggested by Rose Macaulay. The hedonic circuit of the brain is irrelevant in the experience I’m talking about. The sequence of recognizing the impact of time on the intentions of another human, empathizing with it, and moving on, we in essence *relate*.

Tourism is the industry built around the craving for the act of relation, but falls short in not allowing visitors to *genuinely* reflect. The things that inhibit relation are the things which clutter our reading of the ruin: signs, modern reinforcement, and merchandise. Our brains waste time processing these things, and we jump the tracks of relation. The things that aid in relation are the ability to inhabit the thing, touch it, be immersed within it, share it, see the sky through it, contrast it with modernity, become lost within it, and be centered within it.

At the Smallpox Hospital, I've tried to dig up and provide for the preservation of these things. Once the ruin collapses to stability, it can be played on, in, around, from all angles. It can be wandered within and through. Users can be lost within it or sit in its Eastern courtyard. Information and history is found elsewhere on site to those curious enough to seek it out. It is not forced or interfering with the experience of the ruin.

The primary path connecting Cornell's TechWalk to the Four Freedoms Park brings visitors through a ritual of approach, ruin, recentering within the ruin, and then disperses them on axis with the memorial.

The other obvious resolution is restoring the Smallpox Hospital to a functioning building. In fact, the current (or last) thought was to make it into a visitor's center. That's not so easy. Primarily, funds do not exist to restore it. Furthermore, upon analyzing it with point cloud data, the structure is in a greater state of disrepair than previously thought. So whatever that restoration sum is may be larger. Furthermore, what is more rare: a historic building in New York City, or a genuine, safe, inhabitable architectural ruin? Besides, look at the fate the restoration of the Strecker Laboratory suffered, being converted into an MTA substation, essentially a covering for subway transformers. Is this why we restore old buildings? Where does the line exist between genuine preservation which enhances the quality of a city and pathological preservation? I'm not so sure. If we have a unique opportunity to allow for the experience, the celebration, of ruin in a more than appropriate island park setting, why wouldn't we take it? We need to celebrate our demise as much as we celebrate our victories. In fact, our victories only exist with the presence of demise.

"I love above all the sight of vegetation resting upon old ruins; this embrace of nature, coming swiftly to bury the work of man the moment his hand is no longer there to defend it, fills me with deep and ample joy."[82]

It's interesting to attempt a definition of architectural ruin, and how to classify one as such. At what point in a building's state of disrepair does it no longer

[82] Gustave Flaubert, 1846 letter to a friend, as printed in R. Macaulay, *Pleasure of Ruins*.

become identifiable, and transition into “site”? It’s a question typically asked in philosophy, known as the *Sorite* paradox. The idea speculates on when a heap of sand, being removed a grain at a time, no longer can be called a heap? Similarly, if a musician eats a corner of a sheet of music, and then performs it as it sits on the stand, at what point does the performance become “incorrect.” “Ruin” is in some fashion a vague predicate.[83]

Karsten Harries once said that architecture is a “defense against the terror of time”. An incredibly profound statement, it in a way sums up the message architectural ruins convey: that our creations outlive us in order to send our message on to the next in line, to tell them who we were and what we valued so that they can decide who *they* are and what *they* value. If time is a terror, it is only because humans have a finite life span. Without the creative act, we would not be able to live on beyond our means. Architecture in a way defends us against this mortality.

6.6 The Architecture of Relation

What I’ve done is to try and identify the varied spatial conditions and interactions with the Smallpox Hospital as a means for understanding what exactly about those conditions amplify the experience of Relation: our ability to see ourselves through the creations of others. Ruins in particular allow us to

[83] Sorenson, Roy. *sorites arguments*. p. 565

see ourselves as humans, and mortal ones at that, allowing us to be part of something larger, alleviating the stresses of life.

This seems to occur most strongly once a user has inhabited the ruin, not simply by looking at it from a distance. As an unprecedented Neuroarchitecture research venue, the proposal calls for research to focus on what happens once inhabitants are *inside* the ruin, and how those internal, enclosing spatial conditions enhance our experience of Relation to ruin. In the process, it begs the question of what is truly worth preserving: the image of the ruin, or the experience from within it.

The ruin is collapsing, and there simply isn't enough funding to maintain it. Rather than restore it completely, the proposal hopes to identify those parts that are most important, using neuroscience as a basis. It is those parts which can be focused on, requiring less resource to maintain but still allowing the ruin to do its job as a research setting. More importantly, identifying and preserving these various spatial interactions with the ruin further adds to the richness and variety of the research agenda available on site.

The following is an explanation of the various ruin spatial types already existing within the Smallpox Hospital, which by no means cover the entire spectrum of ways and settings in which we may experience ruin. Rather, it is an introductory effort at a process by which we may observe, identify, and maximize the effects involving the experience of ruin. The identification and suppositions at play are no more than the application of my intuitive observed experience among ruin.

Entry & Embrace

Figure 73: Entry & Embrace; Basilica ruin in Turkey
Photo by author, 2013.

Of course, the context of a ruin is always important. Things like initial sighting, volumetric iconographic image, etc. are certainly among the things we remember, but usually because that's what is most shocking. Commonly located among other modern buildings or in the middle of a landscape, the sight of a ruin initially sparks our excitement for reasons of novelty in contrast to its context. This, however, does not allow for the most direct interaction and experience with ruin. Not unlike any environment or architecture, new or old, simply looking is not enough to genuinely *experience*.

Again, the primary design change I am proposing for the Smallpox Hospital on its site is to bring it from something seen as a mere spectator activity to one of direct experience. By selectively stabilizing and collapsing the ruin, it can become an open amenity and act as the primary means of access from Cornell Tech's campus and South Point Park to Four Freedoms Park. Making a passage through the ruin acts as a means of not only interacting directly with the ruin and researching the phenomenon of Ruin, but may act as a means of spiritual cleansing and preparation in a longer sequence of campus > park > ruin > reflection.

Due to site circulation and navigation practicality, as well as the northern face of the Smallpox Hospital already collapsing almost entirely, the new entry to the structure occurs near the center of the Northern wing on axis with the central corridor of its original central bay. A stone-lined wall leads visitors toward the northern wing of the ruin and in turn frames it in the distance along the way.

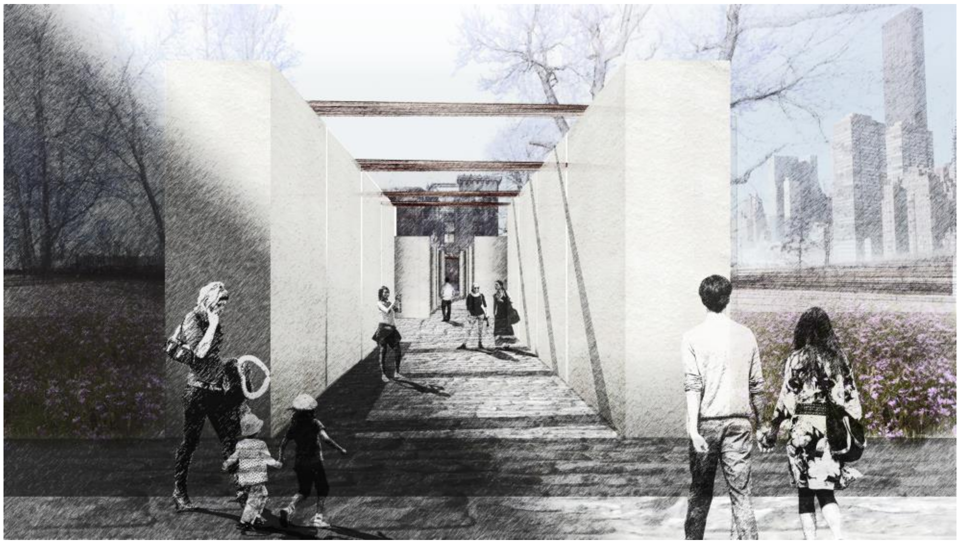

Figure 74: ANFA NYC | Ruin Pass
A rendered character vignette showing the new approach to the Smallpox Hospital Ruin. The design of the RuinPass features large stone blocks relating to those in Four Freedoms Park, rhytmically placed overhead boards to define vertical space, and intermittent resting areas once inside.

The act of architectural embrace can be traced as far back as the Renaissance movement. As a gesture to arriving inhabitants, perhaps research at the Smallpox Hospital can help us better understand how this occurs.

In an effort to further clarify this act of entry, the two existing structural towers in the northern wing will remain, but will support additional plant life in an effort to disguise their differing materials. If we embody the intervention and architectural intentions of a given work, cognitively processing multiple layers of intervention (in this case the steel work of the reinforcement towers) may detract from the essential experience of the ruin. Suddenly, we subconsciously must work to untangle the various changes and moves made by various authors, potentially confusing the primary experience.

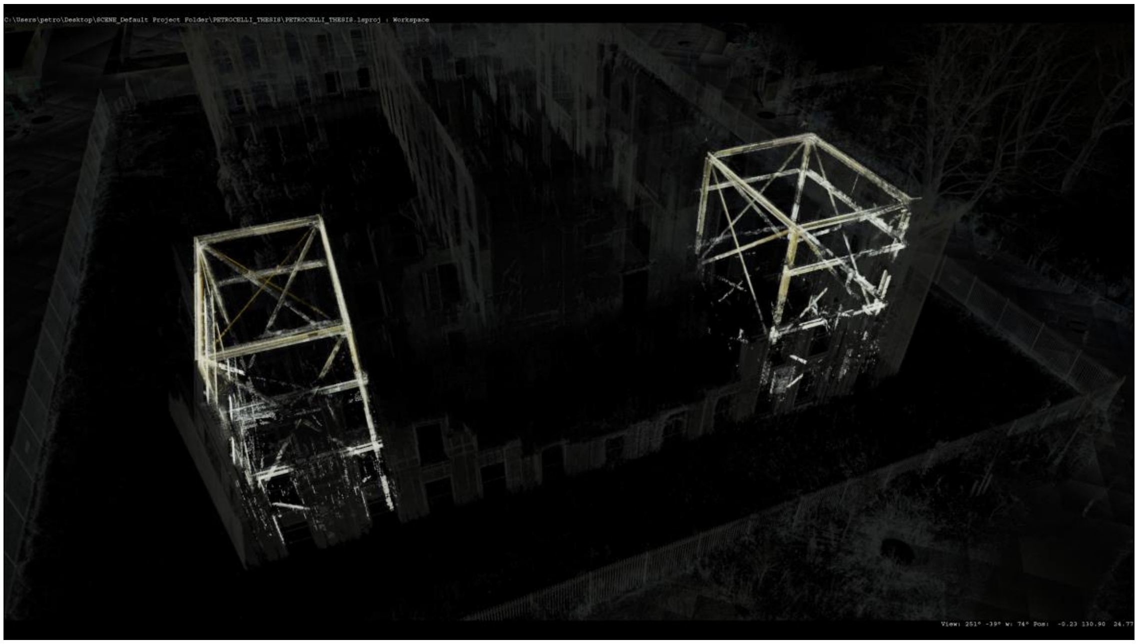

Figure 75: Entry & Embrace; Smallpox Hospital Xray
Drawing by author, 2015.

Dark Enclosure

Figure 76: Theater accessway, Sagalassos, Turkey
Photo by author, 2012.

Once inside the northern open-air wing of the Smallpox Hospital, inhabitants are faced with a tall red brick wall, this was once the bath and kitchen facilities for the nursing school. This chamber provides a unique experience: that of being more enclosed in a dark, intimate space. In an effort to preserve this unique moment for research purposes, a light-gauge steel frame is extended from the existing towers through the interior of the brick chamber. This connects both towers and holds up the chamber. By setting the frame within the chamber, readings by inhabitants in their approach is not cluttered.

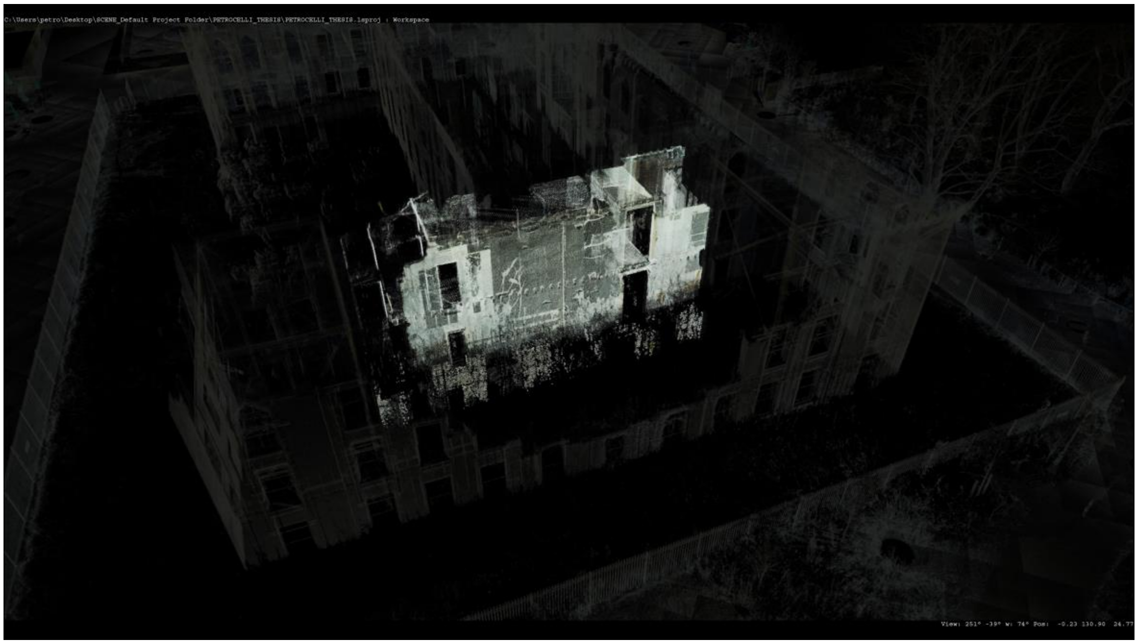

Figure 77: Dark Enclosure: Smallpox Hospital Xray
Drawing by author, 2015.

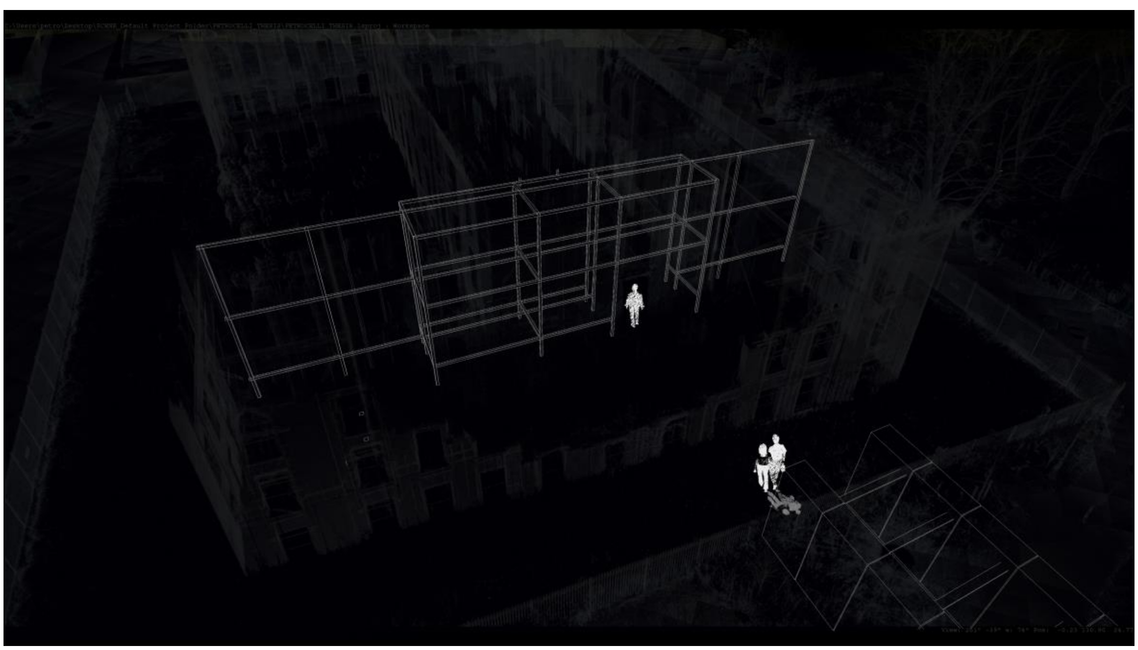

Figure 78: Dark Enclosure; Smallpox Hospital Intervention
Drawing by author, 2015.

View to the Sky

Figure 79: View to the Sky; Temple at Paestum, Italy
Photo by author, 2012.

Once released from the dark enclosing chamber, the visitor enters the original structure of the Smallpox Hospital on its primary axis moving into a large, framed view of the open sky and tree growth. The experience of being within a once-enclosed room that is now unprotected is unique to ruin, and reminds us of its apparent decay. This effect is amplified by the contrasting experience just prior, *dark enclosure*.

Figure 80: View to the Sky; Ruins at Caserta, Italy
Photo by author, 2012

Figure 81: View to the Sky; Smallpox Hospital Xray
Drawing by author, 2015.

Traces of Inhabitation

Figure 82: Traces of Inhabitation; Villa Arianna Wall Fresco Detail
Photo by author, 2012.

Typically in a more intimately sized space, *traces of inhabitation* occurs when occupants come in close contact with better preserved areas of a ruin, painting more of a picture of its former uses and users. A small room located along the central path of the original Smallpox Hospital structure is proposed for restoration to provide a more accurate representation of its former condition. The location's naturally well-protected positioning makes it ideal for such an experiment, but the proposal suggests a light-frame glass enclosure that only further preserves it. This also allows for a more controlled setting in terms of climate and comfort for year-long research, and gives inhabitants the opportunity to directly touch and experience the restored traces within it. This is in contrast to most preserved areas of ruin that exist behind their own immediate enclosures or barriers, preventing the genuine experience of them.

Figure 83: Traces of Inhabitation; Smallpox Hospital Xray
Drawing by author, 2015.

Spatial Centering

Figure 84: Spatial Centering; The Pantheon Oculus
Photo by author, 2013.

Not unique to ruin, the idea of spatial centering has been a phenomenon in the design of architectural and natural environments for millennia. This spatial condition may be related to the self-reflection evoked by ruins in that locating oneself in the center of a space allows for the understanding that the given viewpoint is a unique one and only being experienced by one individual at any given time. The act in and of itself allows the inhabitant to feel framed by the architecture, in effect heightening self-awareness.

In the case of the Smallpox Hospital, an octagonal oculus remains in a decaying state at the very center of the structure. Restoration efforts should be geared toward preserving this unique moment to allow neuroscientists and architects to research its profound effects.

Figure 85: Spatial Centering; Smallpox Hospital Xray
Drawing by author, 2015.

Framed Contrast

Figure 86: Framed Contrast; Column at Perge
Photo by author, 2013.

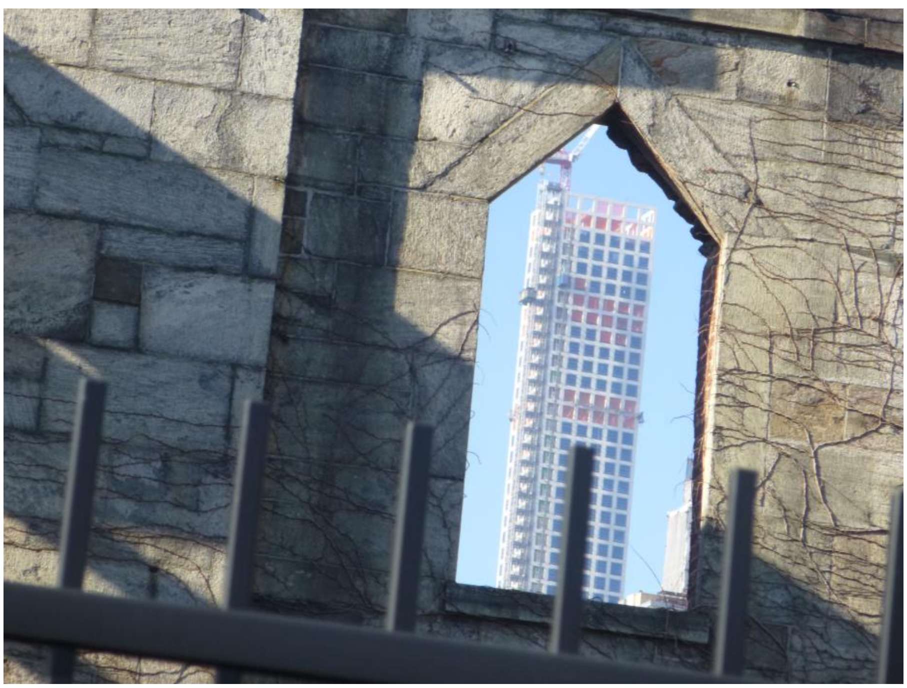

Figure 87: Framed Contrast; Manhattan through Ruin
Photo by author, 2013.

As explained, the act of *Relation* is in essence one that occurs when we become aware of our own conditions in the context of another's. While occupying and being immersed within the context of the ruin leaves us imagining the former users, there sometimes exist moments when we catch a glimpse of the contemporary context that may or may not surround the ruin. A partially restored portion of the Smallpox Hospital is infilled up to a height of 10', blocking the immediate context of the path and passers-by just outside, but at the same time framing a view up to the Manhattan skyline. After inhabiting the ruin becomes commonplace, a view back to the contemporary world may seem as jarring as when the inhabitant first came across the ruin. In a way, after imagining a story of where we were, we are shown again where we are. This experience of contrast is again unique, and should be preserved and maintained as is.

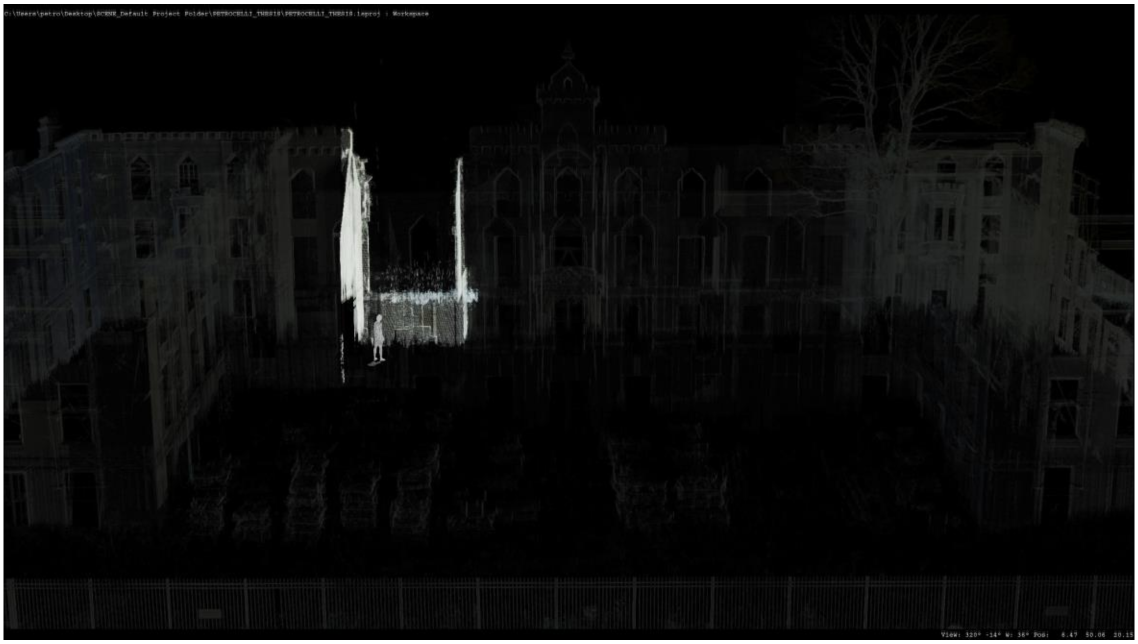

Figure 88: Framed Contrast; Smallpox Hospital Xray
Drawing by author, 2015.

Informal Gathering

Figure 89: Informal Gathering; Collapsed Temple at Sagalassos, Turkey
Photo by author, 2015.

If Relation occurs by the heightened self-awareness through ruin, then what occurs when we share in that experience with others nearby? Does it only occur when we are in isolation, or can it be amplified or better realized when shared with others? Neuroscientific and behavioral research records a distinct difference between isolated and shared experience. By clearing out the inventory of fallen stones that exists in the east-facing courtyard of the Smallpox Hospital, the existing space can be more freely used as a place for gathering and sharing, allowing researchers to understand how the experience of ruin might change when it is shared with others. This also provides one of the only spaces in the enclosure of the ruin where inhabitants can rest for a longer period of time, allowing researchers to study the effects of prolonged exposure to ruin.

Figure 90: Smallpox Hospital | Central Bay Xray
Drawing by author, 2015.

Wandering

Figure 91: Wandering; Interior of Lower Church in Aperlae, Turkey
The central nave of the church is almost completely gone and overgrown, but exterior walls remain to enclose the space and suggest that it was at one time more defined. Now omni-directional, the experience of the church becomes less an axial procession and more an act of wandering. Photo by author, 2013.

Typically, most experience of ruins deal with an act of multi-directional wandering. Structures which at one point had a very clear sense of navigation and circulation might not any longer, leaving inhabitants to aimlessly wander throughout. This act of wandering is not unique to ruin, and directly correlates to many studies being conducted in terms of attention and spatial perception and navigation.

By removing the structural steel in the southernmost wing of the Smallpox Hospital, the most naturally open space existing in the ruin may be allowed to decay at a natural rate and in the process become more open to the act of wandering. This will allow researchers to understand if cognitive attention plays a role in the process of *Relation*.

Figure 92: Smallpox Hospital | Southerern Wing Xray
Drawing by author, 2015.

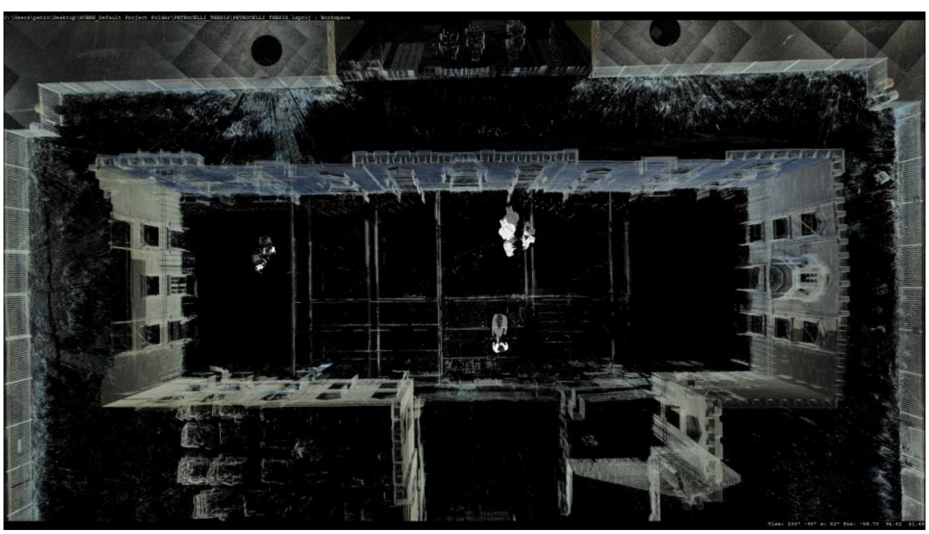

Figure 93: Smallpox Hospital | Southerern Wing Xray
Drawing by author, 2015.

7 METHOD & PRACTICE

Maurice Merleau-Ponty once said, "Science manipulates things and gives up living in them."[84]

As I am not a proven or practiced scientist, I feel the need to clarify that the experiments conducted were of mostly amateur means, and not always perfectly controlled as in the case of a typical neuroscientific research lab. The purpose of the architectural Master's thesis did not dictate or (in terms of time) allow for perfectly controlled experimentation. Instructions were given loosely, conditions were varied, and variables were, to say the least, varied.

"Statistics", as understood by the economist E.F. Schumacher, are those constructed sets of data meant so perfectly controlled and trimmed around the edges that they can prove any opinion or theory that an individual is attempting to sell. It is not my intention to retroactively sell the results of these experiments to this developer or that investor and empower their efforts. It is not even my intention to strictly prove a definite theory or concept. It was my intention in these experiments to frame an understanding of human reaction and interaction in respect to the environment, and creatively, intuitively analyze the results. In a way, this allows a more rapid reinsertion of science to the subjects it examines, as Merleau-Ponty abhorred.

[84] Merleau-Ponty, *Eye and Mind*

7.1 **The Archetypal Primitives**

"You are designing the structures that we live in. You are affecting our brains. You are changing our brain structures and you are changing our behaviors, and you have been doing so for a long time… Many of you know implicitly, in many ways, the correct way to do it. Those ideas, in some sense, can become testable hypotheses." [85]

The problem of Neuroarchitecture is shaping up to be then, a massively complex one. How, in all of the findings and research, self-build architecture, unexpected events, and naturally learned inclinations can we begin to sort the effects of the environment on the brain? Where do we begin? Do we focus on new technologies, futurist perspectives, the bottom-up, or the top-down? Like any scientific or design method, we must first develop a controlled experimentation based on simple building blocks. Using chemistry as a metaphor, how could we possibly understand a chemical compound without first knowing its basic, elemental parts?

There exists a seminal text which I'd like to bring to the forefront of the discussion between Neuroscience and Architecture that may facilitate an early set of experiments: Thomas Thiis-Evensen's *Archetypes in Architecture*. The text, developed in partnership with Christian Norberg-Schulz, dismantles architecture into its core, basic elements: Floor, Roof, and Wall. Within each, the architect identifies the various facets and motifs for each and, more

[85] Fred Gage, *Lecture at the AIA 2003 National Convention & Expo*. May 8, 2003.

importantly, makes sure to provide an intuitive explanation for how we, as humans *universally* experience these motifs in the environment around us.

The following is an abridged version of the text, with notes by the author.

Familiarity

There exists another aspect to these experiments, especially E-I, which most have identified. How does the background of the individual affect the experiment? How soon does the novelty / familiarity factor come into play? In response, as aligns with Christopher Alexander's notion of how much more rapidly we can identify conflict rather than compromise, it was not 'familiarity' which affected participant's responses. When asked to rate how much the 'familiarity, ambiguity, orientation' affected their liking of the space, how ambiguous or transparent a space was played more of a role, and familiarity was less influential. So what does this tell us? That, in fact, a person's personal preference or understanding of 'home' or 'familiar' is more of a moot point than most would anticipate. Furthermore, stability and symmetry did not factor in as well. The rapidity of the exposure to the imagery also didn't allow for much time to gather an understanding of 'familiar' or not. This rapidity allows an *instinctual* response, not a calculated one. This is, what I believe, what I was trying to achieve in titling Experiment I a "one minute experiment". (Topical Session I Panel Discussion; ANFA Conference 2014) This is what is known as the "pre-cognitive" response, i.e. that which occurs before logic and reason kick in.

2-Dimensionality

Another major issue to this experimentation method is the abstraction of 3-Dimensional space into 2 flattened, non-experiential imagery. Of course, we are short circuiting parts of the brain, taking a detour through the imagination pathways in order to elicit response. In response, a 3-Dimensional representation would be required, and virtual simulation of it, in order to rely less on this detour.

Bias

Image selection bias, which, in the case of E-I, was present, can be avoided in the future by a pre-test by outside subjects. The pre-test would lay out all the possible images and ask subjects to select the extremes from a larger pool, the end selection set being the actual experimental base.

7.2 **Lidar; New Prospects**

So, if architecture and neuroscience are to begin a conversation, what then may be the language they share? Neuroscience speaks in data and numeric readouts, while architecture speaks in poetic and experiential prose. Is there a translator between the two?

On Simulation

Architecture has never been simply the built. “Architecture” implies a process of planning and instructing through abstractions and illustration. In a way, we learn to draw, and we draw to learn. How do we draw? Our tools, instruments, and methods have evolved alongside technologic revolutions, but the basic principle has remained: drawn image and abstraction is universally communicative and rarely falls prey to loss in translation. Rather, it rarely even needs translation. The human brain's capacity for processing symbols and interpreting meaning is a basic function of survival.

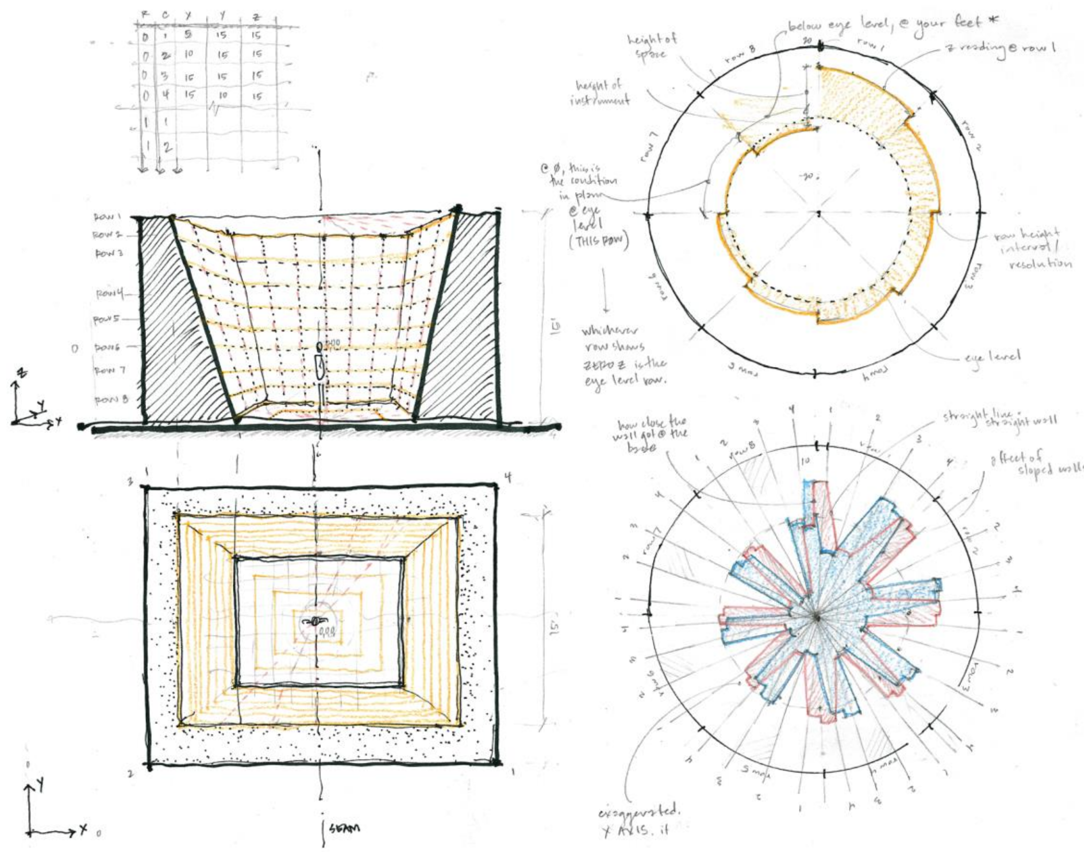

Figure 94: Spatial Type Process Sketch
Left: Section & Plan Perspective Views, Right: Radar graph views and labeled explanation of anomalies. Sketch by author, 2015.

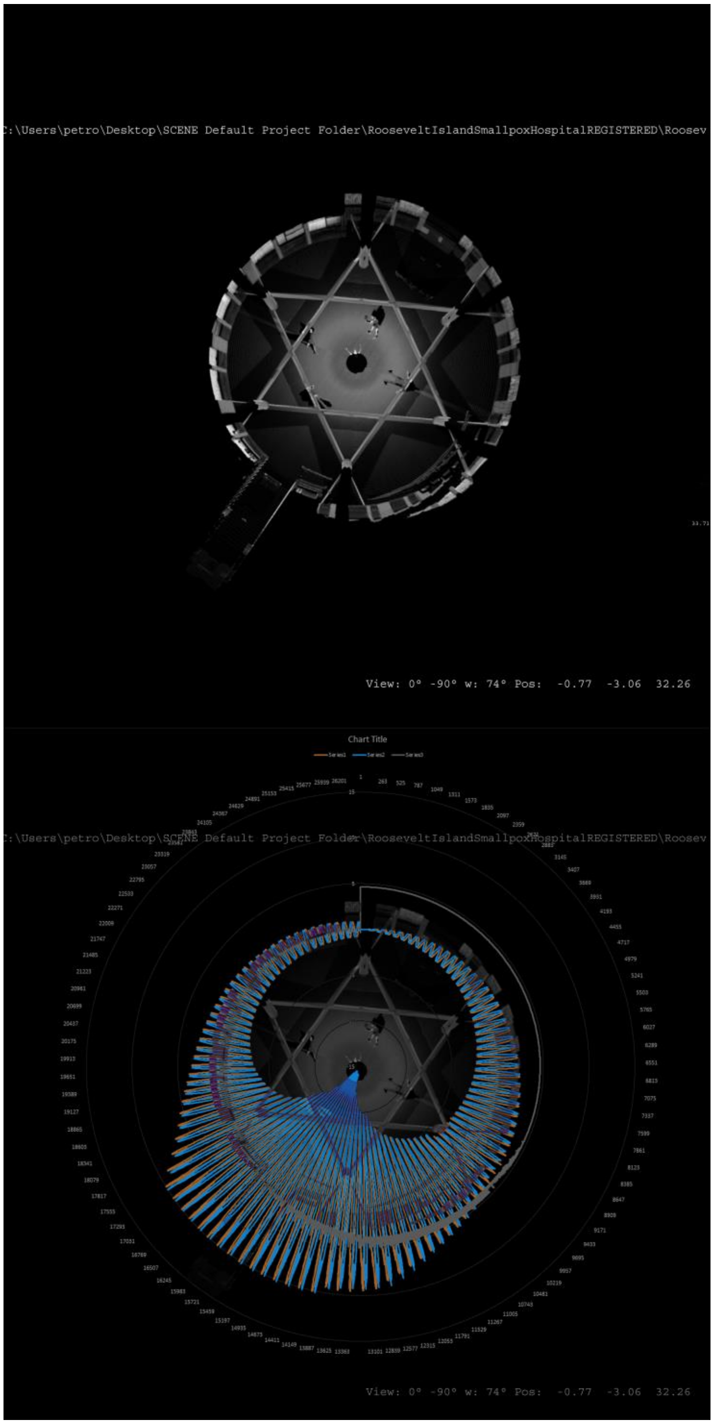

Figure 95: Spatial Type Analysis Test: Castellammare di Stabia San Croce Chapel Basement. Top: Plan Perspective view of raw can data. Bottom: Overlay of XYZ Radar graph, making obvious a releveance to the representational graphing method. Diagrams by author, 2015.

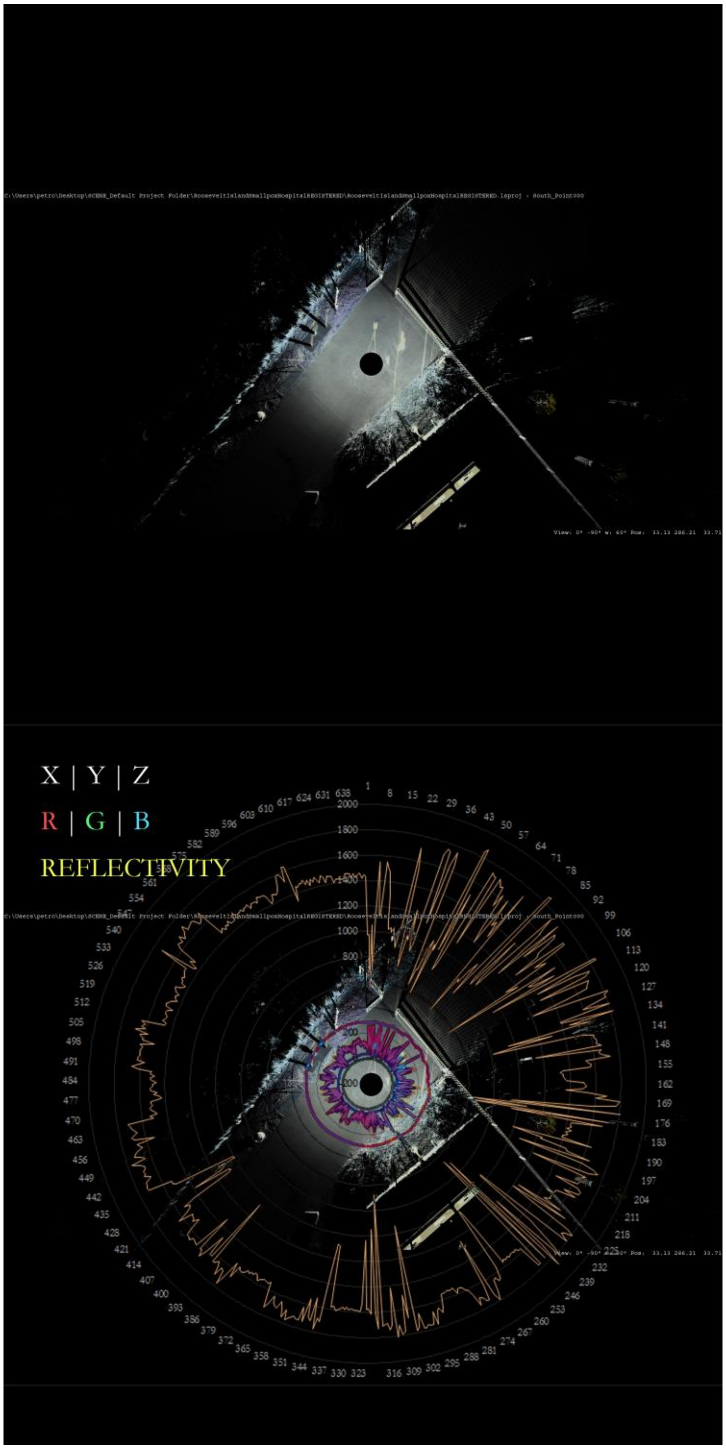

Figure 96: Existing Conditions Spatial Analysis Test
Top: Plan Perspective view of raw can data [SouthPointPark SCAN001]. Bottom: Overlay of XYZ|RGB|Reflectivity Radar graph of same scan, suggesting difficulty in earlier representational methods. Diagrams by author, 2015.

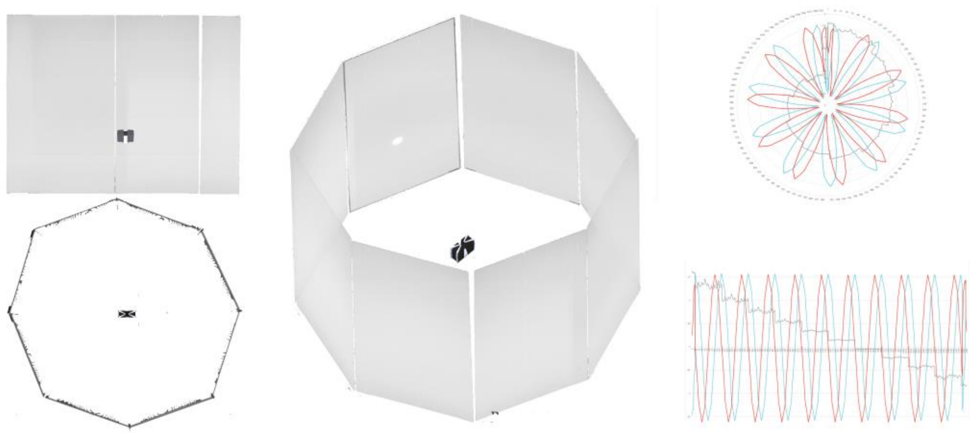

Figure 97: Spatial Type Analysis Composite - "Rounded"
Left: Section & Plan Views, Center: Isometric view, Right: Graphical Analysis of XYZ coordinate data. Diagrams by author and Adan Ramos, 2015.

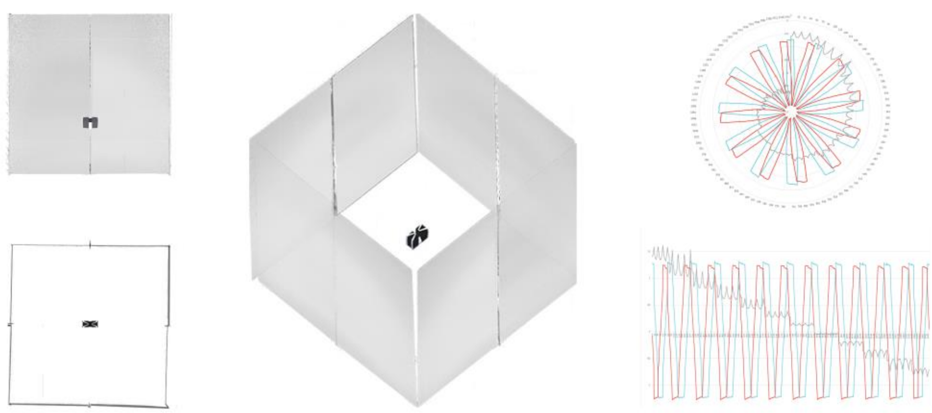

Figure 98: Spatial Type Analysis Composite - "Square"
Left: Section & Plan Views, Center: Isometric view, Right: Graphical Analysis of XYZ coordinate data. Diagrams by author and Adan Ramos, 2015.

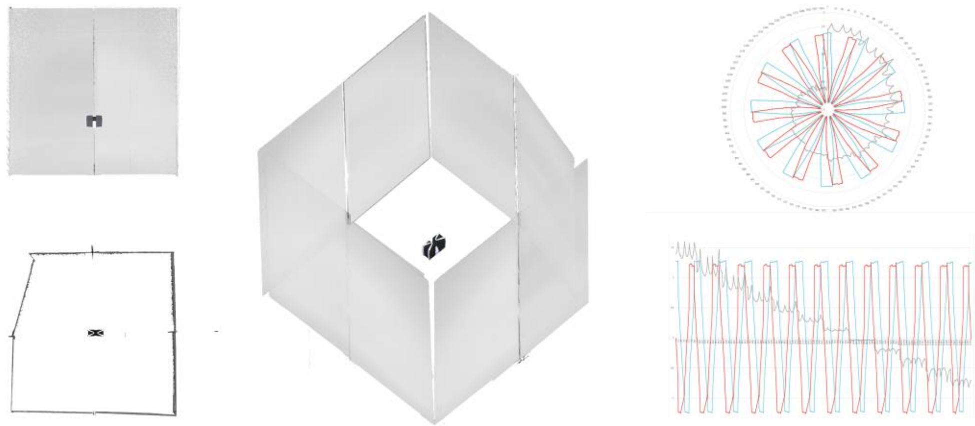

Figure 99: Spatial Type Analysis Composite - "Imperfect Square"
Left: Section & Plan Views, Center: Isometric view, Right: Graphical Analysis of XYZ coordinate data. Diagrams by author and Adan Ramos, 2015.

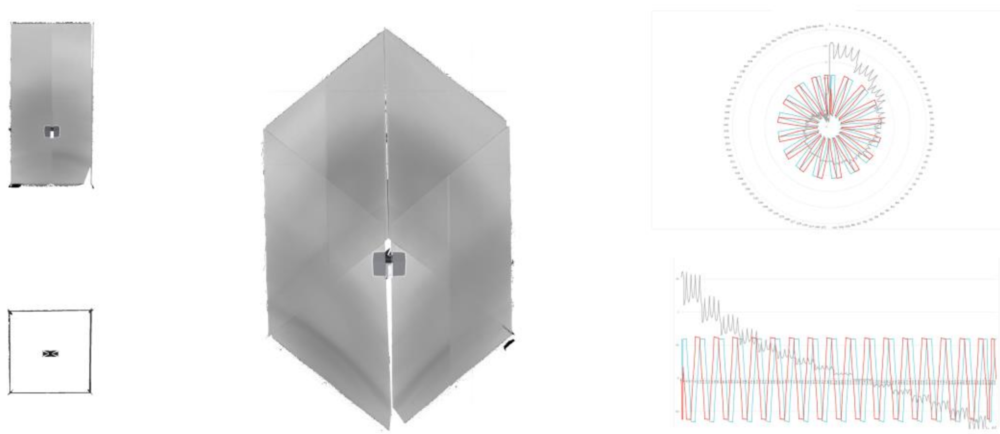

Figure 100: Spatial Type Analysis Composite - "Tall Square"
Left: Section & Plan Views, Center: Isometric view, Right: Graphical Analysis of XYZ coordinate data. Diagrams by author and Adan Ramos, 2015.

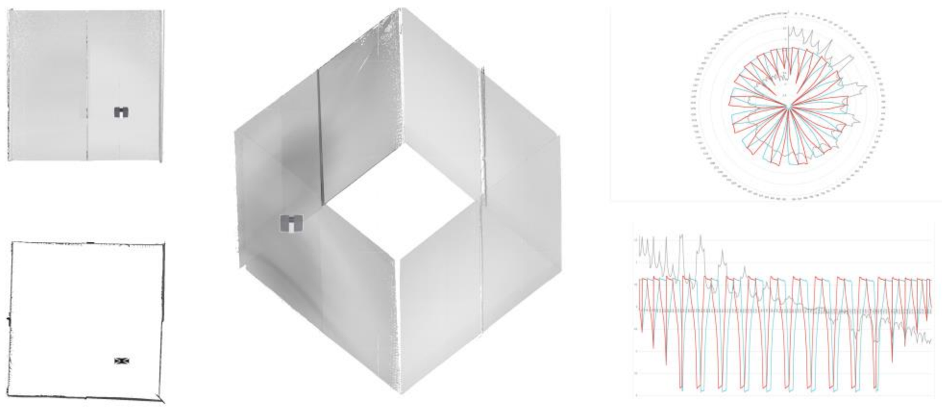

Figure 101: Spatial Type Analysis Composite - "Off-Center Experience of Square"
Left: Section & Plan Views, Center: Isometric view, Right: Graphical Analysis of XYZ coordinate data. Diagrams by author and Adan Ramos, 2015.

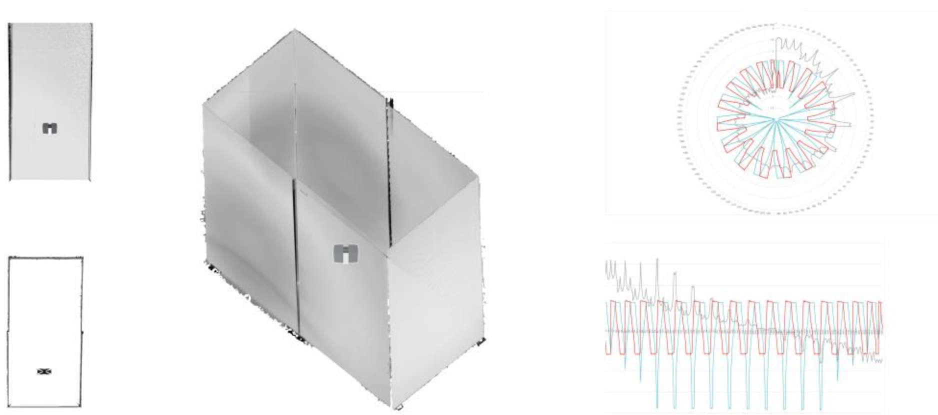

Figure 102: Spatial Type Analysis Composite - "Rectangular"
Left: Section & Plan Views, Center: Isometric view, Right: Graphical Analysis of XYZ coordinate data. Diagrams by author and Adan Ramos, 2015.

Recording as Preservation

"The more one studies architectural problems, the more he understands about them…Before long he finds that he has joined the scholars who are increasing our knowledge of the past, no matter what civilization or era it may be with which he is working."[86]

William B. Dinsmoor, one of the first architects to claim title of "field architect" on archaeological sites, spent his life recording the ancient world, with an obsession for specificity and methodology. Surveying remains a critical part of both archaeology and architectural practice.

The complexity of our built environment exponentially increases over time. Buildings, landscapes, and infrastructure change, adapt, deteriorate, join, and split - all as a result of multiple decisions being made within the bounds of decreased physical space. These evolutions and their compounding effects over time are the source of this complexity, but also, and more importantly, are the source of its overwhelming richness.

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[86] William B. Dinsmoor, Jr.; *The Archaeological Field Staff: the Architect*

Technology is rapidly becoming more capable in terms of recording the built environment. The most recent of these, Lidar (or light/radar) uses a laser light to record 7 attributes of any given point in space. Those attributes are:

X-coordinate

Y-coordinate

Z-coordinate

R (red) value

G (green) value

B (blue) value

Reflectivity

This data begins to quantify certain aspects of the environment in a numerical way, allowing for a different means for communicating space. The following case studies provide a demonstration of how this data is recorded, extracted, stored, and represented in means that architects might not be used to, but that would aid in the dialog between the neuroscience and architecture communities. In other words, this technology acts as a translator between architects and neuroscientists, using data as the language.

7.3 Experiment: Preference Study

E-I: construct

This experiment, conducted over the course of three days, attempted to prove a basic hypothesis: that people are more inclined to prefer environments or images of environments which promote a general sense of freedom (see ‘freedom’). While more popular images were usually those with more natural plant life, this was not an exercise in natural v. built environments, as most of the images constituted manmade environments.

The photographs were chosen in pairs, representing essentially the same scenario. Each pair consisted of a more restricted environment and a less restricted environment. The hypothesis was that subjects would, regardless of age, perceptual bias, or cultural background, more or less agree on those images which were predetermined by myself as either less or more free.

Figure 103: Experiment 1A photograph grid
As displayed on wall. Images were placed in random fashion, but in a way that split correlating pairs. L. Petrocelli, 2014.

The construct consisted of a grid of (16) 5” by 7” photographic landscape images, laid out on a wall panel in a 5x5 grid (Fig 103). Subjects were given a blue marker, a red marker, and a scaled down grid handout that corresponded to the one on the wall. Subjects were asked to observe the images on the wall, determine which of them represented environments that were either “pleasing” or “uncomfortable” and “irritating”. They were asked to place a corresponding color-coded dot on their grid handout. Blue for pleasing, red for not pleasing. Subjects chose three of each, and had under one minute to complete the experiment. No inclination was made toward the hypothesis being tested as to not sway results.

E-1: results

The results (Fig 104) represent a confirmation of this hypothesis, but some unexpected results have sparked an even more interesting analysis of how we determine environments which can be evaluated by our brain as either good or bad.

While most of the images were unanimous when chosen, the model apartment meant to imitate real life, was one of the only images with nearly perfectly divided results. The result demonstrates that the artificiality set up to create empathy was sometimes successful, but sometimes not. Considering the ability for architecturally-minded individuals, as were the subjects, to recognize authenticity in spatial treatments, the split result is not surprising. My guess would be that a more diverse base group would be swayed more toward liking the model apartment.

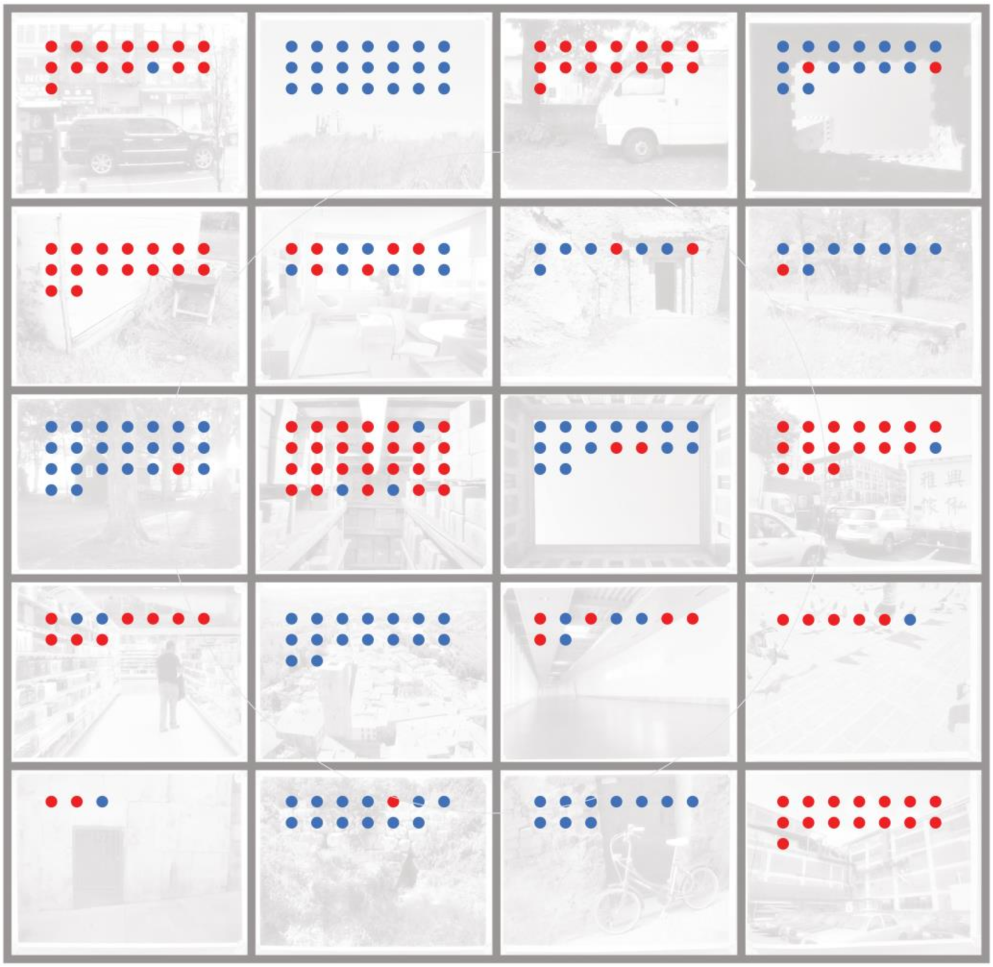

Figure 104: Experiment 1A results
When chosen, most images were unanimously good or bad, with some unexpected results. L. Petrocelli, 2014.

In researching the logical reasons for the outcome of this experiment, I've actually proven something very close to what the ANFA is developing now, which is an understanding on the neurological restorative qualities of environments. Environments, can either be "natural, positive (non-natural), or neutral". When processing 'positive' environments, i.e. urban environments, the brain, most specifically in the "Brodmann 32 anterior singulet" shows a higher level of attentional engagement, meaning we struggle to understand rapidly in order to survive. When processing ‘natural’ environments, a “desynchronization” occurs because the individual is not directed toward anything in particular. “There may be evidence of an attentional disengagement which allows cognitive resources to reemerge.” (Topical Session I Panel Discussion; ANFA Conference 2014)

8 “CONCLUSIONS”

I place the title of this section in quotations because the goal of this thesis was not to establish any sort of conclusions; in fact, in the case of Neuroarchitecture, this would be an illegitimate goal at the time of this thesis. The thesis was more so an act of framing the question of what neuroscience and architecture may result in, and how that may applied in the future. With that in mind, certain revelations or opinions surfaced throughout the process. They are included here.

8.1 A New Role: ArchePolitic

In terms of what we call ‘architecture’, self-consciously or not, I question the societal, professional role of the architect. Our current application for a skill set of analytical synthesis being relegated to simply the production of buildings and urban fabric is an inefficient use of resources.

But where does this all end up? How can this approach find its way to making real, positive change in the way we approach designing bedrooms, towns, cities, or technologies? The social system in place to protect ourselves from ourselves is known as politics. That is where the study must find itself.

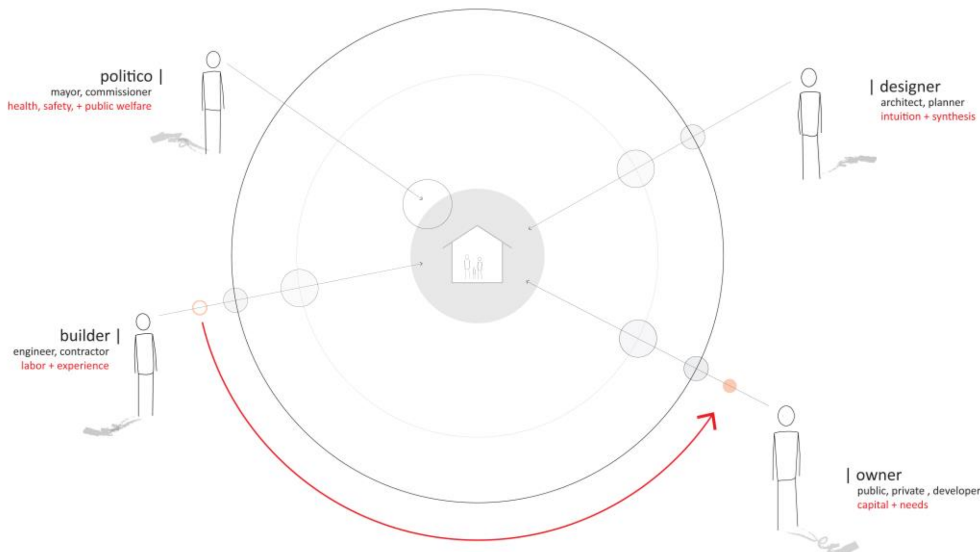

Figure 105: The shifting players in the realm of the built environment.
Diagram by author, 2014.

Typically, a political body's purpose is to carry out decisions that mutually benefit the citizens which it represents. I would argue the architectural process and the democratic political process are essentially the same. Our current system of politics and building legislation is a mutated agglomeration of all the unfortunate events of our past and their purported solutions. Considering the building code, particularly of New York City ("so goes the country/so goes the world"), this attempt at a purified model of architecture must find its way into a legal framework and, more importantly, be so universal as to not warrant exploitation. Is the architect really just a planner of the built environment, or a representative agent of the users of the environment, i.e., a new-age politician?

8.2 Jury Review; 14 May 2015

The progress of the proposal was presented to a jury of reviewers on May 14th, 2015 at 11:30 am. The panel of jurors included landscape architect Michael Vargason and architects Stephen Quick, AIA, and Nea Maloo. Review was generally positive and discussion was engaged on the topics of neuroscience and its particular relevance to architectural design and process. The site plan interventions were recognized as thoughtful and appropriate. In consideration of Lidar technology and its role in neuroscience, the panel was interested in the prospects for expanding the realm of neuroscience using Lidar imaging and documentation, primarily due to its hyper-realistic representations of existing conditions and space.

In critique, the review panel sought answers for why the architectural solution turned out the way it did in its expression of form and structure. Both the Neuroarchitecture Incubator and Blackwell Tower were seen as “rigid” and “fortress-like” in their formal expression, and questions arose as to why that may have come to be in light of such a now loosely understood thing as neuroscience. This is a valid point, and one to consider in reflecting and moving forward.

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