ARCHITECTURE AS INTERFACE: ARCHITECTURE IN THE DIGITAL WORLD

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/ Abstract

Today's world exists in constant flux, as the increasing reliance on digital interfaces like smartphones and AI has shifted our experience into fractions of what it once was. Yet, current architectural practice has primarily only utilized digital tools to speed up old processes for greater productivity and profit. A tension has been created by the discipline between its slow traditional architectural model and its inability to keep up with the hyperfast digital age we are situated in.

Architecture as interface speculates the synthesis between the physical realm of architecture and the variable possibility of digital space to develop a new architecture. This requires an evolution in the operation of the architect to think more like a spatial programmer. Through the utilization of digital robotics and 3D printing, this speculation seeks to respond to the user and their behaviours and needs as their lives change and requires a spatial framework that can better respond to them over time and at multiple scales.

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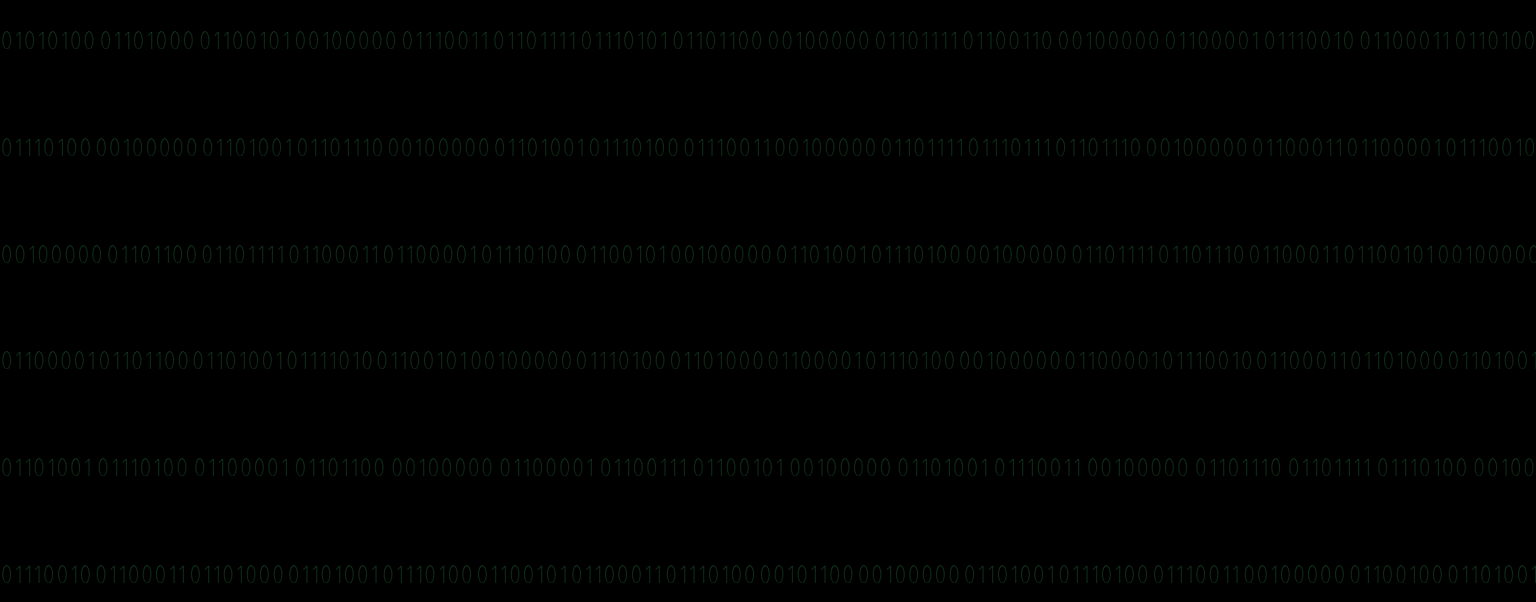
/ Dedications

This project is dedicated to my parents, Doug and Karen, who have always shown support in the pursuit of my passions in life, sacrificing whatever to ensure a life of happiness for me.

Thank you for all that you do for me.



PART I: ARCHITECTURE OF THE MACHINE AGE

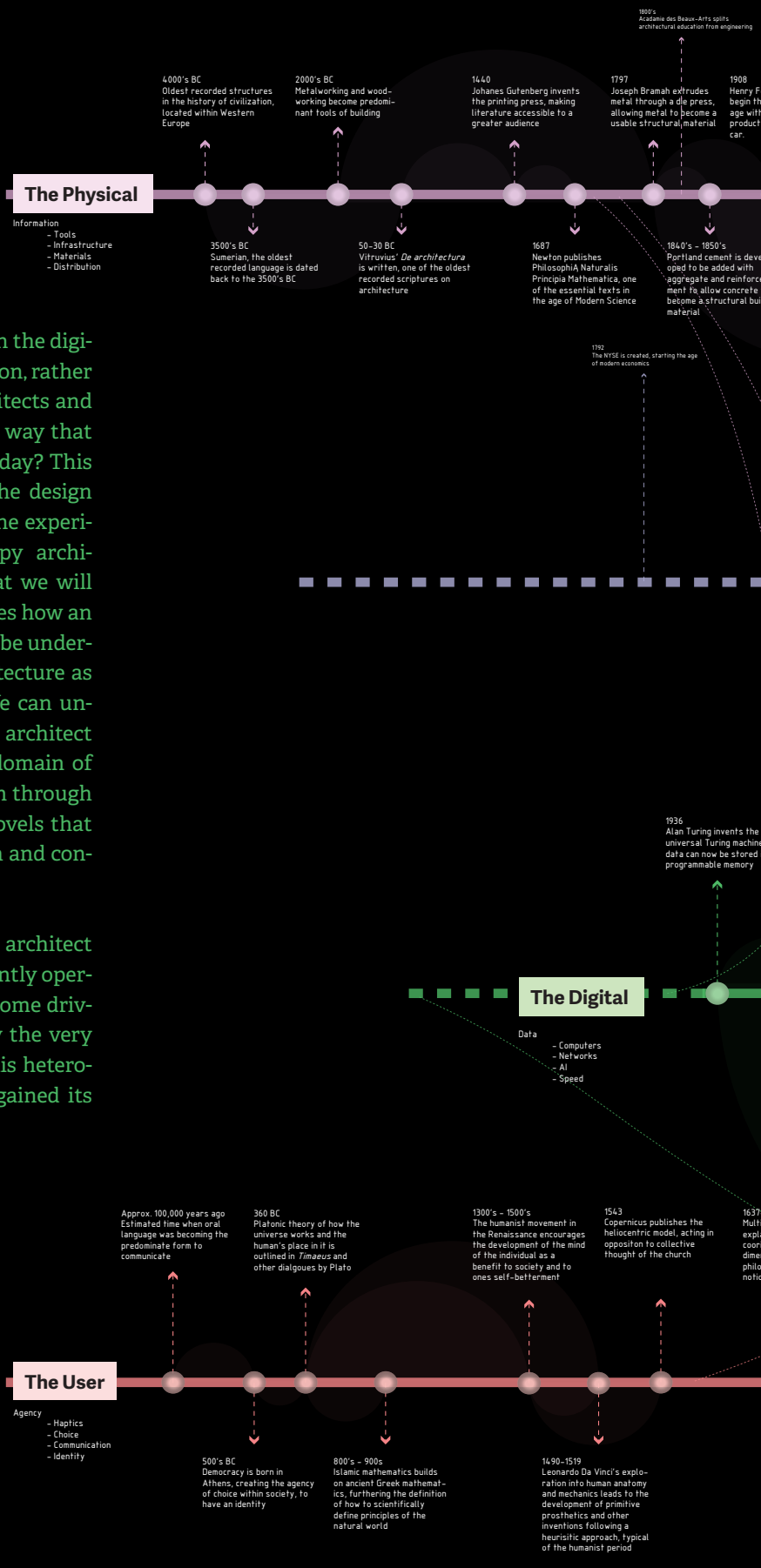
'The origin of modern architecture is to be found in the erosion of the metaphoric relationship between the body and architecture and thus of architecture's necessary condition itself.'

– Christopher Hight

/ Introduction

What does it mean to be an architect in the digital age? This goes beyond its value as a profession, rather interrogates the processes and tools that architects and designers operate with. Why do we design the way that we do and is that still relevant to the world today? This research looks at the relationship between the design methodology of architecture as a whole and the experience and inhabitation of the people that occupy architecture. This spans the previous century, what we will call the Machine Age. While this project explores how an architect might operate in the future, it should be understood as part of a larger speculation for architecture as a whole could become in the digital world. We can understand at its core meaning what makes an architect is an ability to communicate space. It is the domain of operation that allows one to define their design through simple sentences like diagrams, or complex novels that must be understood through long inhabitation and contemplation.

This forms the spectrum in which an architect operates in. Practicing architecture firms currently operate within a finite point along this spectrum; some driven by economy, some by culture, and some by the very digital nature of the world today. It is from this heterogeneous flow of designing that architecture gained its



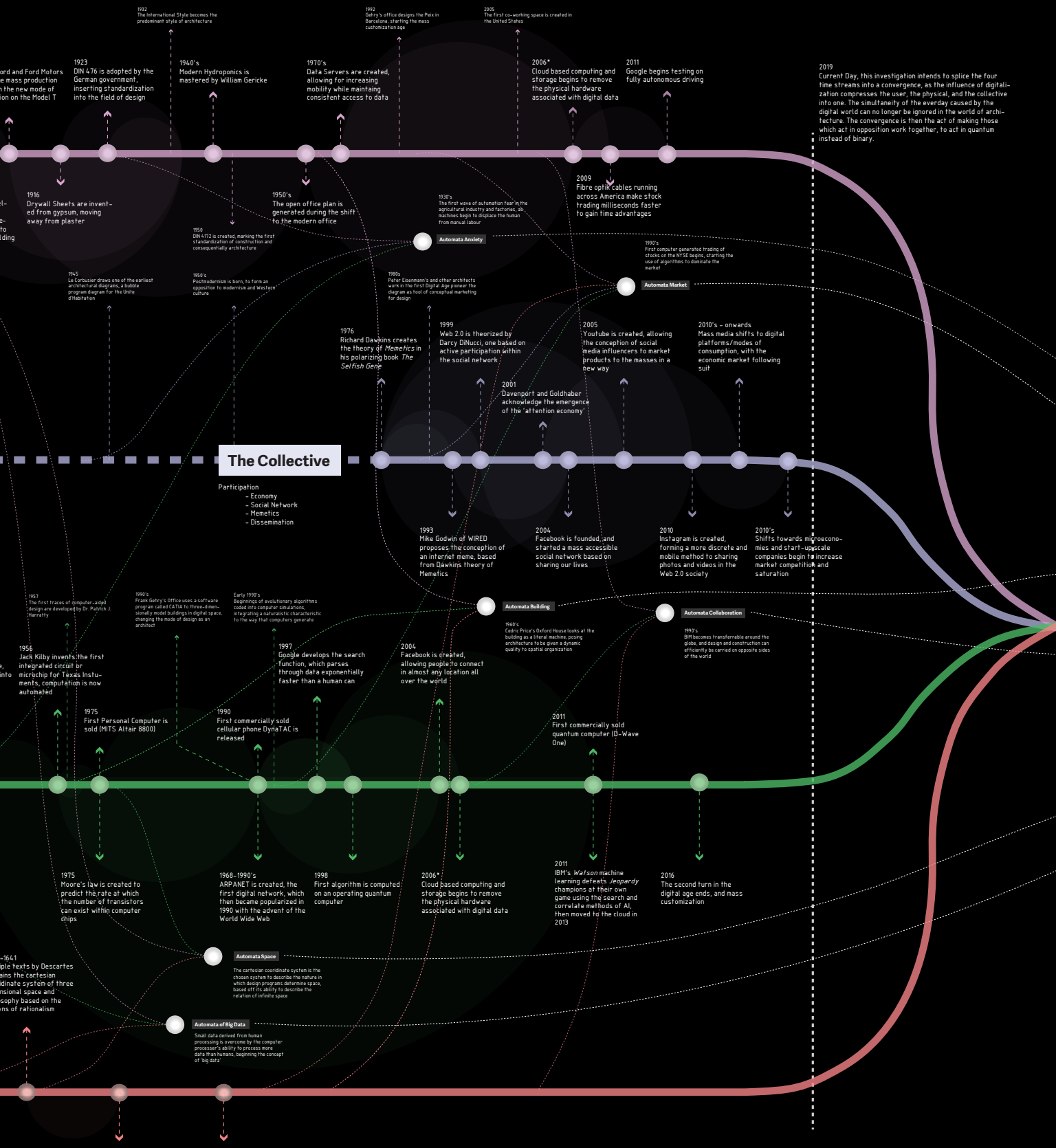


Fig. 1 - Timeline of four streams within humanity that have been converging as a result of the digital world and its influence on the other three streams

most dangerous quality, the one of self-reference. Shumacher describes in the *Autopoeisis of Architecture*, as the system where, "Communications recursively refer to each other. Across the boundary lies the "environment" which remains an unpredictable source of irritation" which compresses architecture into an isolated system operating away from the interests of the people who utilize it.[1] It is the quality of self-reference I argue that has devalued the role of architects and designers in the digital world. As the world transitioned into the digital age, this internal hubris failed to maintain pace with ever-changing societies in the developed world. What was once referential to societies no longer were, and architects did not adjust. In our next digital context, as aptly put by Carpo, "architects tend to be late in embracing technological change."[2]

Acknowledging that the architecture of the Machine Age no longer holds relevance in developed societies today frees the possibility to explore new meaning in the current Digital Age. Here, a new architecture could negotiate the relationship between our physical world and digital world and its influence on the daily life of humans. Architecture in a digital age relies not only architecture, but users, as the agency of design. Architecture becomes an interface between the walls, floors, and ceiling above us and how it acts and reacts on the users of a space.

The thesis states that the evolution of architecture in a digital world is through 'architecture as interface'. This synthesizes physical and digital systems into an adaptive framework that acts and reacts to the users of the space as they change over time. The architect becomes the programmer of this system, developing and maintaining this framework like software, constantly

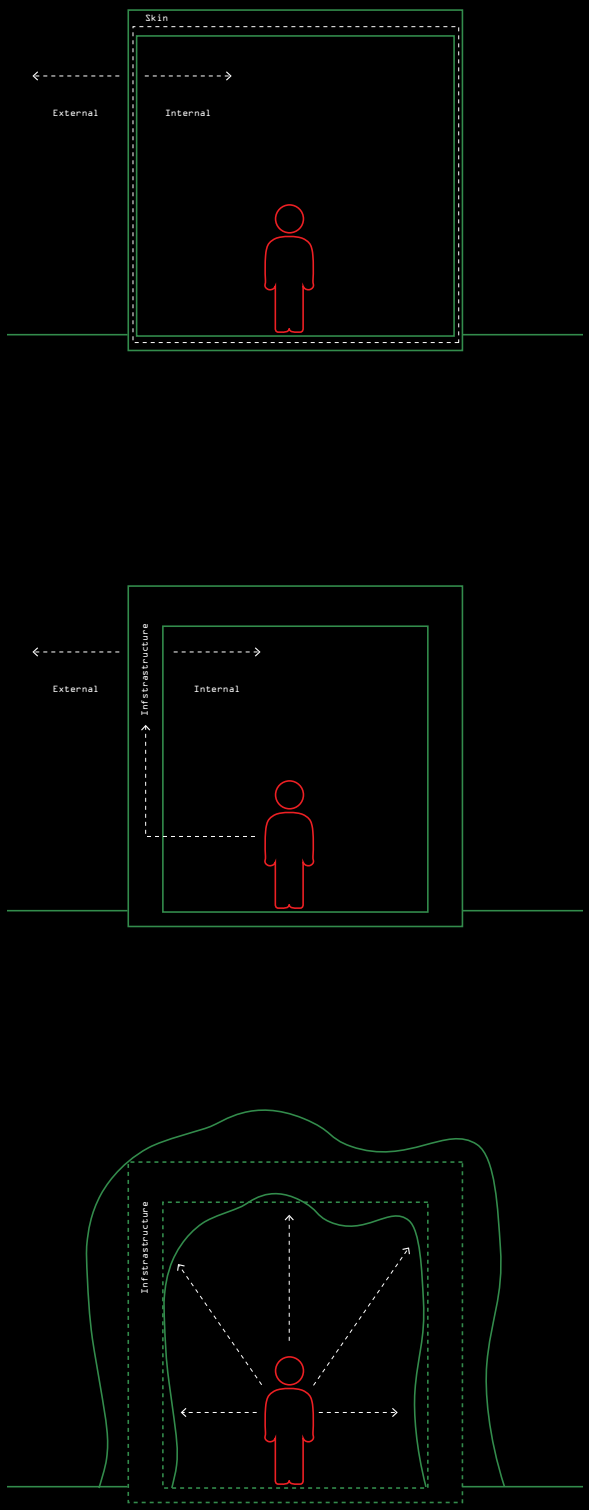


Fig. 2 - Relationship of Architecture as Interface through the infrastructure of the building

[1] Patrick Schumacher, "The Autopoeisis of Architecture," from *Latent Utopias: Experiments within Contemporary Architecture* (New York: Springler Verlag, 2002) 11-17.
[2] Mario Carpo, *The Second Digital Turn: Design Beyond Intelligence* (Cambridge, Mass.: MIT Press, 2017) 1.

updating as changes occur.

This adaptive framework uses the digital field as an interface to reconfigure the physical world around us. It responds to the change over time at all scales, from the building to basic objects, so that they might better respond to the human experience. This field is engaged by the human (subject), which utilizes a series of physical hardwares (objects) within the architecture to adapt their surrounding field (space) to their needs. These objects (such as mobile robots) enables the users of a space to tap into a digital infrastructure that can alter their physical structure as they need.

Furthermore, architecture as interface is a reaction of twofold, the first: to the invasion of attention created by machine-human interfaces like smartphones have dissolved the notion of place and meaning. Secondly, it breaks the isolated streams of self-referential thought in architecture by making the user the context of design rather than the building itself. This will discuss how architecture as an interface extends the agency of design into the user's realm, as they become integral to the design process. This dissolves our previous traditions of what Hight describes as the, "God's eye view of the architect himself."[3] Architecture as interface is not self-referential, nor is it referential design, it is both, so that a building can influence and be influenced through time by the people that occupy its space and designers alike over time.

Why and how these choices are arrived at are in this project are not always architecturally related nor within the scope of an architect at all, but it will address when a lack of response by the discipline of architecture occurred. This results from the erosion of social relevance when three streams of interconnected existence

[3] Christopher Hight, *Architectural Principles in the Age of Cybernetics* (New York, NY: Routledge, 2008) 105.

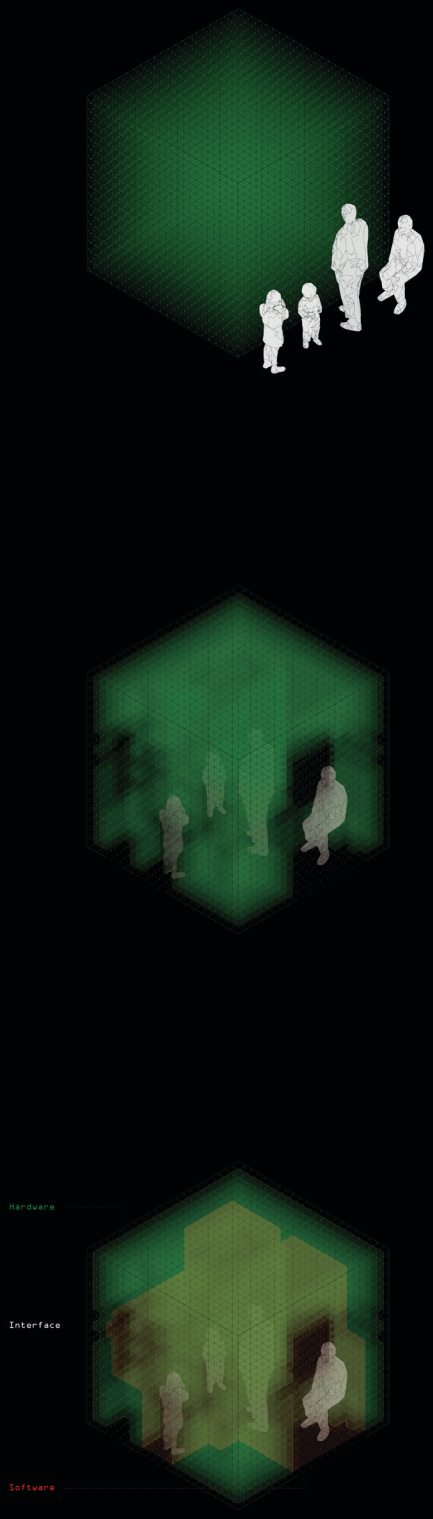


Fig. 3 - Hardware, Software, and Interface changed through human inhabitation.

(economy, culture, and identity) were increasingly intersected by a fourth digital stream. This will develop how the intersection of the digital world has increasingly delaminated both the consistency and relevance of the physical world. From this erosion, I will pose how architecture as interface could act as an evolution not only how we think, but how we design, who we design for, how we build, and challenge the idea of how architect's maintain buildings past occupancy.

Part I will create a groundwork for the ways in which an architect commonly operated through what I call the Machine Age (early 1900's till now). This will discuss how the intersection of the digital world has mutated the connection between process and building by the architect. Part II will theorize how we can relocate a connection between process and building, using the possibilities of the digital world as the main tool against change. Finally, Part III will discuss what becomes of the architect of the digital age, what I will refer to as a spatial programmer. A design scenario looking at the home then depicts how the digital age architect operates and the new connection developed with the user.

1950
DIN 4172 is created, marking the first standardization principle of construction and architecture

1980s
Peter Eisenmann's and other architects work in the first Digital Age pioneer the diagram as tool of conceptual marketing for design

1990's
BIM becomes transferrable around the globe, and design and construction can efficiently be carried on opposite sides of the world

1990's
First computer generated trading of stocks on the NYSE begins, starting the use of algorithms to dominate the market

2010's
Housing and Refugee Crises have created needs for mass housing solutions

Standardized Mass Timber structures begins to be reintegrated into building practices

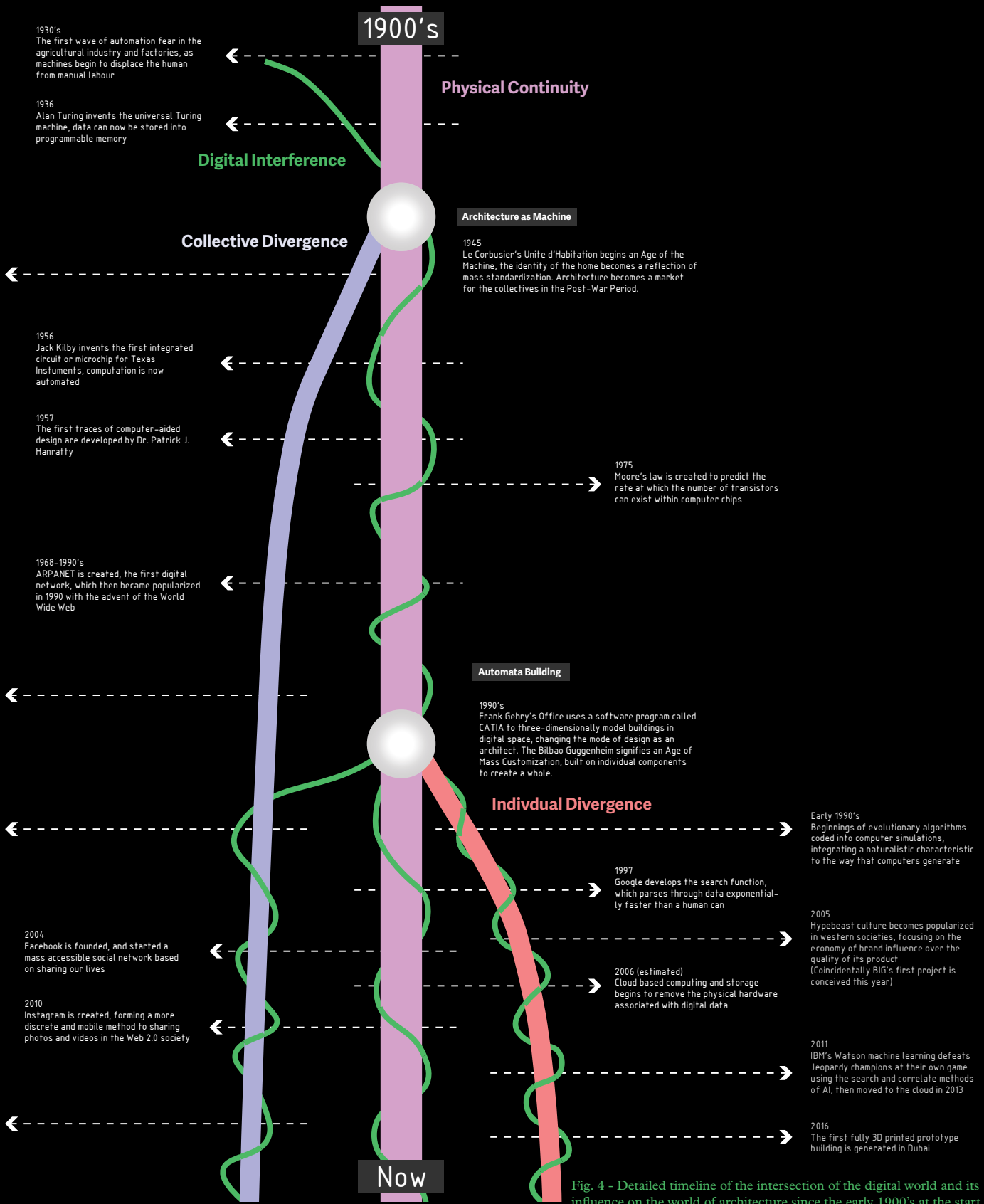


Fig. 4 - Detailed timeline of the intersection of the digital world and its influence on the world of architecture since the early 1900's at the start of the Machine Age

/ Disruptions of the Machine Age

What constitutes an understanding of architectural soul is traceable back to the principles defined by Vitruvius in his treatise *De Architectura*. His seminal readings develop what Alberto Perez-Gomez described as the, "Beginning of our tradition," with "*a priori* of the body's structure and its engagement with the world."[1] From the beginning, it seems that the body was the core of architecture's engagement with the world. What is important to note within this claim is that body and building are symbiotic to one another, relying on one another to define the parameters needed for architecture to exist, and how the body uses this to define place within space, or architecture. Body as building is a metaphor used by many Humanists to come to terms with the basic human desire to dwell, driven by a sense of the body's comfort within the bounded system. Anthropologist Mary Douglas' argued that in traditional cultures, "the body has provided the model for all symbolic boundaries and architecture duplicated this symbolic schema."[2] Here, we add another layer to the core of architectural intent, which will prove to be the very reason for its downfall in the Machine Age. At a primitive understanding, I argue that the architectural soul stemming from Vitruvius' treatise, is defined by *the effect that a body can use to identify itself within a material and immaterial bounded system*. This uses material operations like physical walls, floors, or ceilings, and immaterial operations like collectives, culture, or economy.

In the material realm, the architectural soul is best exemplified to connect to the body through the senses. It helps understand architectural scale, as Pallasmaa describes as the, "Unconscious measuring of the object or the building with one's body, and of projecting one's body scheme into the space in question."[3] In this context, it allows materials, scale, proportions, and what can be called harmony, or what I derive as a judged balance between the latter three. These are perceived by humans to generate binaries like heaviness or lightness, compres-

[1] Alberto Perez Gomez, *Architecture and the Crisis of Modern Science* (Cambridge, Mass.: MIT Press, 1983) 3.
[2] Mary Douglas, *Purity and Danger* (London: Routledge, 1966) 115-116. Hight in *Architectural Principles in the Age of Cybernetics* used the discourse between Douglas with Rykwert to develop how the body is the primal source for how architecture was defined through the human.
[3] Juhani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* 3rd edition (Sussex, UK: John Wiley & Sons Ltd., 2012) 71.

sion or expansion, lightness or darkness, as they are all compared and contrasted to one another through society to understand what is perceived to be 'right.' What commonly defined this system was the body, using it as a increment to determine the desired architectural harmony that connected the body's senses to its bounding system. This frame of reference however was disrupted during the Machine Age through the intersection of the digital, where universal systems like the Vitruvian Man and *Le Modulor* no longer were deemed relevant.

Enter the Vitruvian Man, visualized in the Renaissance but its orally existed dates back to *De Architectura*. The Vitruvian Man formed the measure of what constituted the unit of measure for architectural harmony in Western societies. It explained not only the formation of classical orders, but acted as a measure for space itself, determining the proper scale and proportion, connected through the structure of material. It has acted as the main root of architectural syntax for centuries. It illustrates how this harmony is undeniably influenced by the immaterial bounding systems of collectives, culture, and economy. While the Vitruvian Man provided a conduit for a universal language of measure for architecture, it admittedly only existed within the context of Western Europe and eventually North America. Architectural harmony relies not only on the body, but the body's immaterial bounding systems that define said body's behaviours. These behaviours will explain why the fall of the Vitruvian Man is a reflection of architecture's failure to respond to the immaterial bounding systems of the digital age.

Greg Lynn characterizes the Vitruvian system as a, "Set of formal principles derived from an understanding of the body as whole, ideal, static and organic."[4] Agrest argues that the system major flaw is that it natural order rather than culture itself, "transforming the body into a geometric set of "abstract" relationships

[4] Greg Lynn, "Body Matters," *Journal of Philosophy and the Visual Arts: The Body*, edited by Andrew Benjamin, 1993. 61-69. .

that appear transcendent of both culture and physical form.[5] The argument made here is if architect's negate the bounding system of culture within design, any material bounding system generated no matter how harmonious will hold minimal value to the body's that inhabit it. When determining architectural longevity in *Buildings Must Die*, Cairns and Jacobs describe it not as a core value of a material architecture, rather "an attribute of how the social world approaches architecture. Architecturally speaking, staying around for a long time – approaching permanence – is possible only if malleability and relationality are admitted."[6] So through a cultural frame, building's that rage against the entropy of time, are the ones that can dynamically remain relevant to the immaterial bounding system of the body.

Adapted to Stewart Brand's graphic in *How Buildings Learn,* the building's relevance is determined by the ability to change with the flux of culture and economy, reacting more than imposing the surrounding layers of site.[7] When the immaterial boundary is synthesized with the material boundary, it develops a deeper meaning of connection to the body which inhabits it and also to that body's connection to other body's to form collectives. This sets the context to discuss why a building like the Ise Shrine has consistently remain relevant to its immaterial boundary, while the Unite d'Habitation failed to, even though Le Corbusier adapted and utilized the Vitruvian principles in a modern context for its material boundary. Why this failure is important to architecture will further develop why the Vitruvian Man represents a ghost of an architectural tradition that no longer reconciles the context of today's hyper-individualized world.

In the sense of comparison, the Ise Shrine and Unite d'Habitation are admittedly different fundamentally. They originate in different periods, use different materials, belong to different cultures, have different timescales, and utilize different programme functions.

[5] Diana I. Agrest, "Architecture from Without: Body, Sex, Logic" from K. Nesbit, *Theorizing a New Agenda for Architecture* (New York: Princeton Architectural Press, 1996.) 543.
[6] Stephen Cairns and Jane M. Jacobs, Buildings Must Die (Cambridge, Mass.: MIT Press, 2014) 64.
[7] Stewart Brand, How Buildings Learn (New York: Viking Penguin, 1994) 13.

However, what is important to develop is the mode in which their material boundary negotiates their immaterial boundary and its affect on the bodies that design, build, and inhabit it.

The Ise Shrine provides a housing for Shinto deity's that is periodically renewed every twenty years to provide a dwelling for the deity to occupy when it would enter into the realm of man. Even in the presence of modernity, Ise remained a connection to the history of Japanese culture, so much that it was completely funded publicly post-WWII, no longer funded by political or imperial parties.[8] Extrapolating its presence within its immaterial boundary, even though it is not even inhabited by actual humans, its construction, passing of knowledge, and context all remain relevant to people since its beginnings in the eight century. It relates to what Sand describes as a metaphor that acknowledges the ephemeral conditions that were rooted deeply within cultural boundaries. Even when the Shrine's became a populist based process of renewal, its architectural processes like joinery and assembly, dis-assemblage and temporality held their value within the overall immaterial boundary of Japanese culture.

The Unite d'Habitation provided housing for 1,600 people on the outskirts of Marseille, developed in a recovering post-war France that needed to provide housing for the masses. Here, Le Corbusier designed a seventeen story tower that not only provided the homes, but housed shops, a post office, and even a library. The scale of the project used his modern adaptation of the Vitruvian man as the unit of measure to determine the scale of everything in the building. What is referred to as *Le Modulor*, used, "static geometries and organic wholes" of Virtuvian principles to achieve a harmony of the material boundary.[9] In doing so, he employed his *Breton Brut* style of architecture, using pre-cast concrete elements to efficiently organize a flexible skip-stop system that

[8] Jordan Sand, "Japan's Monument Problem: Ise Shrine as Metaphor," Past & Present 226, no.10 (Feb 2015): 139-140.
[9] Hight, *Architectural Principles in the Age of Cybernetics*, 65. Hight noted Le Modulor as a metaphoric champion of humanistic architecture in the modernist period, seeking to bring back the proportionality of the body to the machine driven world.

allowed for a variety of unit sizes to exist, with the other amenities placed near each other to create a vertical city. For all that he might have achieved through form, his use of *Le Modulor* represents a divergence within architecture's place within society. Thurston William's criticism of the project represents what I argue was the failure of the first Unite d'Habitation, as the "conception seems to dominate rather than liberate."[10] The social organization employed through his bubble diagrams reflect a lack of understanding towards the immaterial boundaries that architecture must represent to invite habitation. It would impose what William's feared would become an architecture of introversion.[11]

I will describe how this moment fits within a larger narrative using the incremental system *Le Modulor* as a starting point for the splitting between the architecture's material boundaries from its immaterial boundaries. The role of digital interference within this will illustrate the causality of the erosion of architecture's relevance as a result of this delamination.

[10] Thurston William, "Views on Le Corbusier's Unite d'Habitation," Architectural Review (1951): 296-297. Republished in digtial format, https://www.architectural-review.com/essays/views-on-le-corbusiers-unite-dhabitation/10008291.article
[11] ibid

/ Failures of the Machine Age

Le Corbusier's *Le Modulor* forms a marker of a specific divergence from a universal understanding for architecture, which seemingly occurs in parallel in larger western and global societal shifts in twentieth century. The idea of the modernized Vitruvian system would no longer be acceptable to discuss the body's relationship to space, due to large paradigm shifts in societies to a more dynamic system.

This has challenged the ways in which the architect could apply previous notations of material and immaterial boundaries to their context. Luhmann refers this shift as the theory of functionally differentiated societies, where isolated functional systems like law, economy, or architecture are allowed to operate self-referentially to one another.[12] These self-referential systems allow for freedom to increase complexity in an attempt to maintain pace with the complexities of contemporary society, however at the sacrifice of a body's deep understanding of each system. Schumacher notes that the danger within this is that, "This process of adaptation in turn implies self-referential autonomy for the system with respect to the task of organizing its response. The impact of the environment does not pervade and directly determine the system."[13] This describes how architecture's response to operating as a self-referential system removed its response to larger immaterial boundaries, becoming like the Unite d'Habitation in Marseille, as a domination rather than a liberalization in the digital age.[14]

I argue this occurred in three-fold: the first through cultural evolution, in respect to both individual and collective identity. The second, through economic drivers that shifted architectural interests into the market; and thirdly, through the overall influence that machine-human technologies have caused since Fordism and what its impact on the way architects communicate space and how people experience that contribute to the

[12] Schumacher, "The Autopoeisis of Architecture," 12-15 . Schumacher uses Luhmann's theory of functionally differentiated societies to discuss how society operates within discursive self-referential systems of knowledge. The system in which architecture only references it own action and further isolates its discourse past everyday dialgoue.
[13] ibid
[14] Thurston William, "Views on Le Corbusier's Unite d'Habitation," 296-297.

death of the traditional architectural soul.

This begins with use of *Le Modulor* to dialogue the cultural shifts towards what I will call polymorph societies. Then, shifts to the more recent economic drivers of architectural practice and its affect on the way architecture can be thought of as brand. These first two phenomena will explain how moments of digital interference within society through the Machine Age has created paradigm shifts that architecture failed in its attempt to respond to. What is left is today's contemporary understanding of architecture, driven with technology but not by it. I will discuss how the digital landscape that so much of practice uses has ultimately been what has killed the soul of architecture in the digital age, primarily through the lens of data, and what it can't do for us.

Thurston William's argument was brought up not to specifically criticize what Le Corbusier had created in Marseille, it was actually the implementation of *Le Modulor* that was of importance. It signified a split within the role of material and immaterial boundaries acted upon the body in an architectural setting. Hight's discussion on the erosion of the body from architecture by modernists might think that *Le Modulor* would bring back a Vitruvian spirit, but it only stratified a change was occurring in collective consciousness.[15] The first flaw in *Le Modulor* was that it still merely represented an 'ideal' modern man, rationalizing the variation within not only size but gender. Lynn acknowledges that for architecture, "Since the time of Vitruvius and throughout history, the whole concept of architecture has been dependent on the model of a unified body."[16] If his attempt was to create a vertical city that could theoretically allow for consistent occupation throughout the day by the 'housewife', why were the proportions of *Le Modulor* set out for the male body? Even though "the Modulor attempted to tame modern technology for the embodied subject," it was only for the male subject, which even then only

[15] Hight, *Architectural Principles in the Age of Cybernetics*, 20-22.
[16] Hight, *Architectural Principles in the Age of Cybernetics*, 45.

represented an idealized version of itself.[17] His Modulor 2 was merely a reproduction of the first, now with a female who stood 1.83m tall, which Hight would describe as a degraded reflection of the original model.[18] Hight then refers to *Le Modulor* as an anachronism, as its negation of broader cultural shifts made these architectural principles severely outdated.[19]

The criticism of it represents a realization of Le Corbusier's use of material boundaries, as they act against or ignore immaterial boundaries in favour of developing what Delueze calls "the logic of the Same."[20] This principle would come to define the first architectural divergence in the Machine Age from what its immaterial boundary's context. Principles of material standardization during Post-WWII attempted to act upon immaterial boundaries through sameness. The order of the system is the overlying principle. Here, individual identity is lost within the collective voice, and as the house transforms into a machine for living, so does the body.[21] The body has now been severed from its original meaning in favour of the binary condition of an individual or collective within design. This would begin a century long introverted battle within architecture that still is ongoing today, between the representation of individual or collective within the material boundaries of architecture. This battle was amplified by larger roles of globalization and economy, resulting in the self-referential system of architecture, furthering itself from the body as root of architecture's bounding system.

[17] Hight, *Architectural Principles in the Age of Cybernetics*, 38-40. Agrest's discourse on the inherent gender bias of Le Modulor and the Vitruvian Man illustrates fundamental flaws within the 'unified body' of architecture.
[18] Hight, *Architectural Principles in the Age of Cybernetics*, 164-167.
[19] ibid
[20] Hight, *Architectural Principles in the Age of Cybernetics*, 166.
[21] Hight, *Architectural Principles in the Age of Cybernetics*, 47.

/ Digital Context

A main principle developed by Patrick Schumacher in the *Autopoeisis of Architecture*, was that in capitalist driven societies, the idea of Luhmann's functionally differentiated society would accelerate cultural evolution.[22] "The "loss" of a single, integrated social formation" would generate co-evolving subsystems, ones that operate self referentially to one another.[23] His criticism towards architecture is that it has not allowed "itself to be irritated by its societal environment and in turn should become a productive irritant."[24] If architecture acts as an isolated system, it does so ignoring the basis of an architecture's root intent, that is to respond to *both* the material bodies and immaterial bodies that are influenced and influence on architecture.

As expressed with Le Corbusier's *Le Modulor*, even though the society that Unite d'Habitation was designed for may not have reflected the values of 'sameness', it was imposed upon by the architect as a response to a new condition of modern living. If we flip to the opposite end of the spectrum of sameness, we find pure individuality, dictated by differentiation. In late twentieth century capitalist societies, a reaction was made against this notion of sameness, as culture gives way to economy and a market driven approach of the individual entity. This market driven approach is built for a singular, non-reproducible individual, which represents the consumer.

As it will show however, the self-referential system architecture operates within now has only accelerated the reproducible aspect of mass individuality. This system uses the market to brand itself to the global consumer body (the client), however commonly failing to again acknowledge localized immaterial boundaries (microcultures) instead favouring the pursuit of pure form to establish its identity. This will form a a secondary delamination of individual divergence from the traditional architectural lens and ultimately lead to the death of the

[22] Schumacher, "The Autopoeisis of Architecture," 13-15.
[23] ibid
[24] ibid

architect in the Machine Age.

What caused this death in the Machine Age was the *meme*, coined by Richard Dawkins to describe the way in which culture's transfer packets of information, or knowledge to one another to determine what is relevant and what is not, much like gene replication.[25] When allowed to operate in an isolated system, the meme will use self-replication to further isolate its discourse and language.

If we look back at what an architect does in a primitive sense, their spatial communication now becomes hyper-specific and non-referential to other autonomous systems. This process of design no longer uses localized referential aspects to a building's immediate microculture, instead favouring more global cultural cues like economy to drive the process in which 'architecture creates value.' The way in which we utilize the meme as a means of communication to the other systems of this value is through the diagram, in which all self-referential decisions made within a design are packeted into a set of formal moves that makes the building unique (although not applicable to all architecture).

These are then communicated to the general public, who do not share the same level of architectural discourse that an architect obviously would, so the diagram becomes a means of extending the transfer of knowledge to the wider public. The more easily the diagram can replicate, the more likely it becomes referenced within the architecture system as well outside of it.

In contemporary context, the collective consciousness has been dominated by the attention economy, where the digital interference of the Internet has allowed for the never-ending pursuit of people's attention towards something, making it a means of profit rather than transfer of knowledge. Lanham described this idea

[25] Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 2006) 189-191. The nature of the meme for Dawkins is analogous to how a gene replicates, except in cultural terms the evolution of a meme is much faster than in genetic evolution, vindictive of our society today.

of the attention economy as a move from 'stuff to fluff', as possessive ownership is proliferated in wake of the digital age, electronic information is, "Effortlessly duplicated and distributed, we can eat our cake, still have it, and give it away to."[26]

Applied to architecture, the spectacle of architecture is able to unfold in a never-ending competition of 'star-chitecture', trying to create the most unique building using the image of the diagram as the means in which they brand their style. When the diagram is allowed to drive the design, it allows in its very nature to for generalizations that further dissociate a design from context, while accelerating its duplicability within architecture and other functional systems within society.

This has been one of the major flaws of architecture in the digital age, delocalizing context of the body's role in architecture in favour of the economy that can be driven through a body. Architecture in the digital age has become a, "Psychological strategy of advertising and instant persuasion; buildings have turned into image products detached from existential depth and sincerity."[27] Pallasmaa's criticism is that building's are now designed to sell and not to be occupied. If the building is now commodity and inhabitation becomes secondary, or even tertiary, then what the driver of architecture has become is no longer the body at all, and so comes the death of the architect and their purpose.

The digital interference caused by machine-human interfaces will now extend into the occupation of the architect, and we will discuss the mode in which we utilize these interfaces has created negative effects on our domain of physical space, and what has taken our place in the spatial domain of society.

"Search don't sort." This tag line produced by Google for its Gmail platform exemplifies the dichotomy

[26] Richard Lanham, The Economics of Attention: Style and Substance in the Age of Information (Chicago: University of Chicago Press, 2006) 12.
[27] Pallasmaa, *Eyes of the Skin*, 33.

of the machine-human world of the past century.[28] Since the Ford Model T in 1913 revolutionized how we built machines into complex mechanisms, society has ever increasingly relied on machine-human interfaces that connect us to one another or to other machines. The reason for this accelerating reliance is embedded within one simple fact: "Computers can search faster than humans can sort."[29] If we think of the way that a human processes versus how a computer processes, we are much slower at processing data because the fundamental need for humans to organize data into a coherent structure of information, while the computer can use its search capability to search through large quantities of data at incomprehensible speeds to find what you are looking for. Machine-human interfaces allow for nearly infinite scalability, because in the digital space where they operate and communicate to other machines they are only limited by their physical hardware.

In the discipline of architecture, their place has become essential to the workflow and decision making of the architect. The design usually acts as reflection of the program being used. However, I will argue that the accelerated use of machine-human interfaces in the digital age has caused what Carpo has described as "data opulence."[30] This data opulence allowed for nearly infinite possibility of design and infinite variation within those possibilities; and the discipline got lost in its own Cartesian space. This comes twofold: first by the self-referential nature of contemporary architecture and its place within the market, and secondly through a lack of understanding the human condition within data. They are connected by the neo-naturalist movement, as Alexander describes design through "a diagrammatic impulse that is predicated on the epistemic unit of data."[31] I will argue that these two qualities since the 1990's has slowly dissolved our presence within physical space, as machine-human interfaces now hold a greater authority over attention then architecture does: the body does not

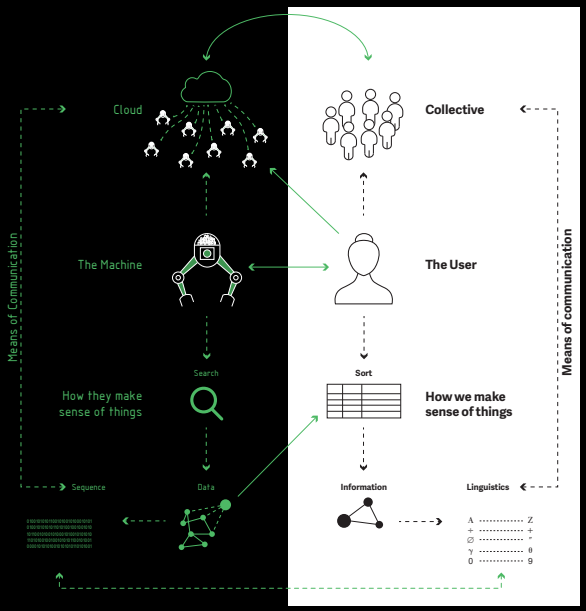


Fig. 17 - Dichotomy of how humans vs machines communicate with one another. Based from Mario Carpo's interpretation of what computers can do better than humans in *The Second Digital Turn*.

[28] Google's tagline with the release of Gmail. Carpo dialogues the nature of searching rather than sorting as the fundamental difference between humans and machines when working in a human-machine interface, they search, we sort.
[29] Carpo, *The Second Digital Turn*, 48.
[30] Carpo, *The Second Digital Turn*, 9.
[31] Zeynep Celik Alexander, "Neo-Naturalism," Log 31, (2014): 24.

care what material boundary it occupies.

Architectrual neo-naturalism is what Alexander calls a, "Self-referential system of signification."[32] He attributes the medium in which this signification is communicated by an architect to be data and diagram.[33] Everything here can be reduced past its sign, where the form decided upon is not conceived through human intuition, rather pure machinist process that humans cannot relate to unless an interface exists to make sense of it all. This dematerialization of space obliterates *signification*, which Alexander describes as "moments of friction and pressure in the system."[34] Like Schumacher's 'irritation' within the autopoeitic system, if data is allowed to drive decision making within design, especially data that does not have human tangibility like form-finding for an economy of scale, it dissolves the attention given to the material boundary system. If a human cannot relate to a form, scale, material, they will simply no longer care about it. The attention economy will shift their attention somewhere else.

This nature was developed when one of the very first fully 3D-modelled buildings was built in Bilbao, Spain in the 90's, The Guggenheim Bilbao by Gehry Partners. Using the firm's recently developed 3D modelling software CATIA, they deployed an ability to create an new economy of scale, where, "Digitally mass-customized objects, all individually different, should cost no more than standardized and mass-produced ones, all identical."[35] This building popularized the mass customization wave, but I will refer to it as the second delamination from the architectural root of intent. The ability for data to be the main driver of the material boundary only further dissociated the idea of the traditional architectural soul from a contemporary understanding of what it is. Like when Alexander acknowledges data's role in design, Carpo laments the fact that "any parametric notation contains by definition an infinite number of vari-

[32] ibid
[33] ibid
[34] Alexander, "Neo-Naturalism," 29.
[35] Carpo, *The Second Digital Turn*, 57.

ations (one for each value of a given parameter). Who is going to design them all? Who is going to choose the best among so many options?"[36]

We are given limitless possibility in design for form finding with digital technologies, but without an immaterial boundary to define its 'limits' will ultimately be lost within its own self-referential decisions to define its material boundary. So while the Guggenheim Bilbao created a new style of spectacle in architecture, the attention economy only forced the discipline to use our new found digital tools to generate more spectacle. This acceleration did not allow many designers to fully understand what it meant truly meant to design as the world shifted into the digital age, but architects still operated in the machine age.

The discipline failed in maintaining pace with this acceleration and in turn used data to post-rationalize what designers were doing through data and diagram. Instead of making the buildings respond to data built upon the immaterial boundaries of a building's context, it only responded to itself as an object, or an image.

Social media platforms and the Internet at large today allow for the architectural meme to flourish, or fail. The issue with this meme is the level of detail that can be packaged within it to convey its message while being easily understandable. This package reduced decisions of design to diagrams based on numbers, or spectacle-oriented images or renders to convey emotion to consumers. This flattened architecture is what Harvey describes as, "A rush of images from different spaces simultaneously, collapsing the world's spaces into a series of images on a television screen,"[37] one where we consume architecture like the public consumes fashion. When reduced to the two-dimensional screen, architecture logically relies on the attention economy to have people want to consume (or occupy) our buildings. As soon as a particular

[36] Carpo, *The Second Digital Turn*, 132.
[37] Pallasmaa, *Eyes of the Skin*, 24. See David Harvey, The Condition of Postmodernity (Cambridge, UK: Blackwell, 1992) 261-307.

style or fashion is worn out, attention is taken to a new fad. Cairns and Jacobs described this issue as, "the fate of a materialized object is unavoidably linked to processes of valuation, be they economic, social, or cultural."[38] So while a building is likely to last at least 50 years in North America, if its material boundaries are more linked to the life-cycles of the fashion industry, there lies a fundamental flaw in its longevity, which is heavily tied to a building's ability to create 'place' for its users.

As a response, society has now entered an age of hyper-focus, where more attention is given to the smartphone that takes the picture than content that lies within the frame. This creates a system of an active digital audience, but inherently passive physical occupants, as the machine-human interfaces that we have come to rely on to connect with one another hold our attention, and the physical world around is dissolved. Pallasmaa describes that the "quality of an architectural reality seems to depend fundamentally on peripheral vision."[39] So if our attention has fallen into tunnel vision towards the objects in space (smartphones, computers, televisions, smarthome objects), then architectural no longer holds an agency over space.

If all this has truly occurred, then how do architects change this perception and fundamentally bring back the peripheral experience that defines an 'architectural reality'?[40] This, is where I will pose architecture as interface can cause a rebirth for architectural meaning in the digital age. However, this must evolve past our traditonal understanding of the architect, as the past century of societal and technological evolution cannot be reversed. It must work within and challenge the framework of today's ever-dynamic existence to properly respond and instill change in the way an architect thinks, designs, and fundamentally communicates space.

[38] Cairns and Jacobs, *Buildings Must Die*, 32.
[39] Pallasmaa, *Eyes of the Skin*, 14.
[40] ibid

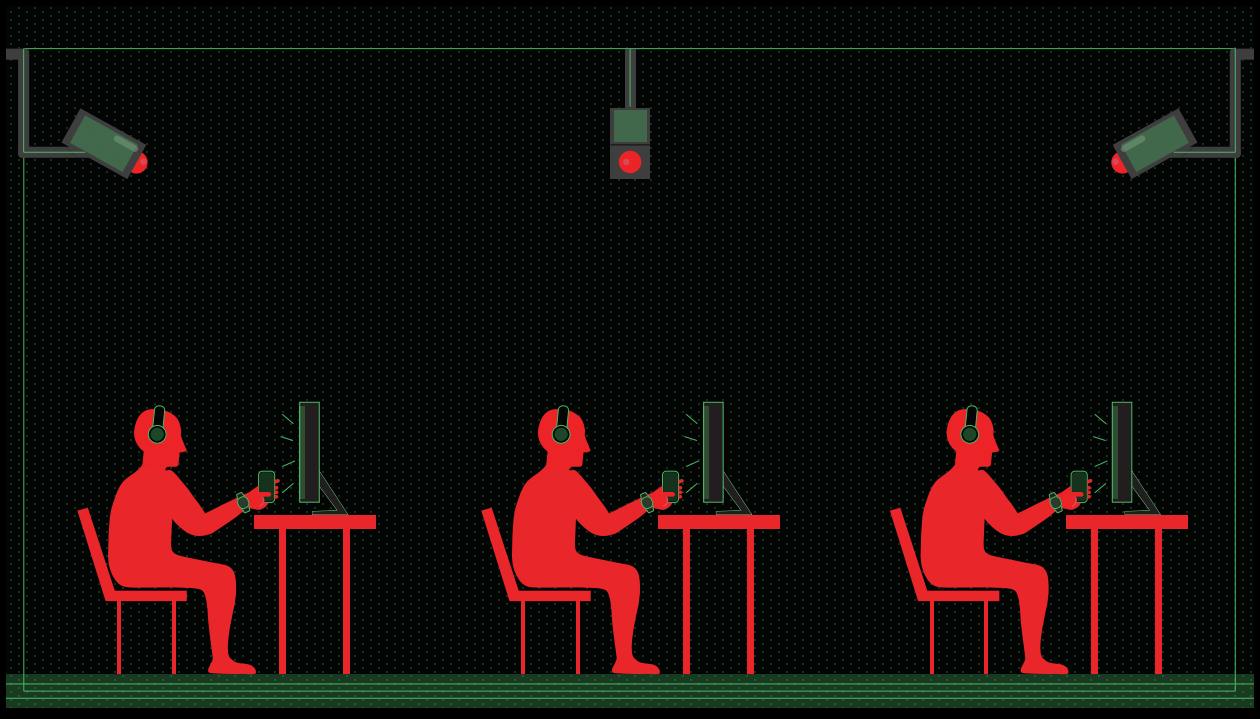
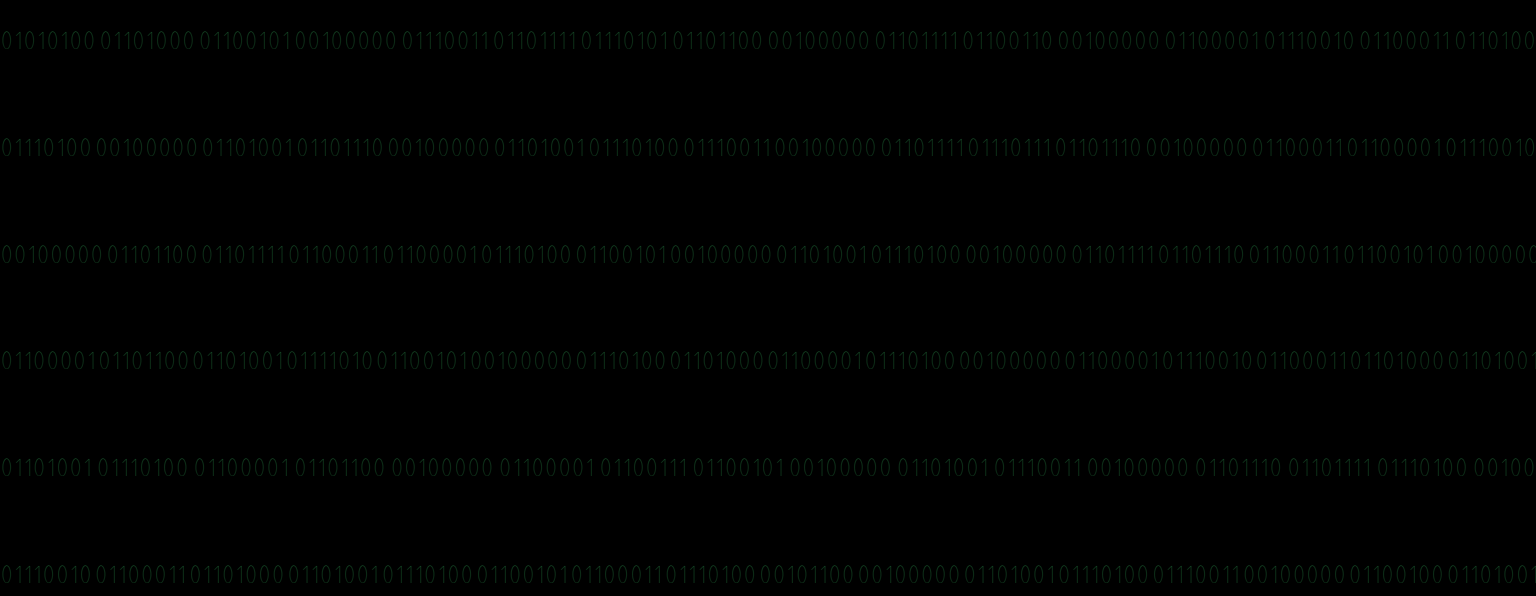


Fig. 23 - The sensory overload and hyper-focus of society in the digital age



PART II: ARCHITECTURE OF THE DIGITAL AGE

‘The body is a model which can stand for any bounded system.’

– Mary Douglas

/ Architecture as Interface

Architecture as interface is built upon the relationship of what the traditional version of the architectural soul: *the effect that a body can use to identify itself within a material and immaterial bounded system.* This definition stays very consistent, but adds in the interface as means of identity. The architectural soul in the digital age is this: *the interface between body and its material and immaterial bounding system. The interface preforms the connection between the infinite possibility of digital space and gives it a physical tangibility. All physical change is acted through the agency of the user, and architect's facilitate that exchange.*

Pallasmaa describes architecture as, "Lived space rather than physical space, and lived space always transcends geometry and measurability."[1] If architecture is about truly about occupation, or inhabitation, then there needs to be a better response to an individual's cognitive functions that creates the need to stay. This however must also invite inhabitation at collective scales as well. If we utilize the scalability that machine-human interfaces offer, architecture as interface provides a conduit that takes the humans senses and pairs it with hijacked versions of consumer products, that are deployed in space to better respond to the 'peripheral' quality of architectural experience. Attention can then be taken away from the objects like smartphones, and deployed into the space we occupy. This process is part of a system that is defined by the subject, object, and their field. In a user-based boundary system, this system, can develop a convergence between how architects design and the user's relationship or place within that process. For Carpo, "the logic of convergence to the mean of the statistical model still defines most practical strategies deriving from it. In order to self-correct, the process must remain open to as many agents as possible for as long as possible."[2] Architecture as interface allows the process to always remain open, as for Pallasmaa "a building is not an end in itself; it frames, articulates, structures, gives

significance, relates, separates and unites, facilitates and prohibits."[3] It is a constant process that the user can engage within.

The subject, object, and field is the composition in which bodies (subjects) interact with interfaces (objects) within a defined boundary (field), which has both a digital and physical presence. In Questions of Perception, Steven Holl discusses the relationship of Merleau-Ponty's 'in-between reality' as the field. He summarizes Merleau-Ponty's idea as, "Analogous to the moment in which individual elements begin to lose their clarity, the moment in which objects merge with the field."[4] This core idea illustrates that there are transitions in cognitive perception between the overall space (which I will now refer to as the field) and the components that makes up said space. If architects utilize the way in which humans interact with the objects in space quite literally, there can be a more balanced transition between the scale of human and their physical boundaries in the field. The interface both acts and reacts to user's actions using the digital field component, which creates a physical transformation.

As a thought experiment, I dissected a series of machine-human interfaces and looked at the hardware to understand what was needed to create the spatial influence within the interface, and what its response creates for both the user and their field. This exercise helped create an understanding of how these components work both spatially, but what input and output is created when a human interacts with machine. These dissections decipher how the subject interfaces with the object, and its affect on the digital and physical fields. They primarily focus on the haptic qualities that the mind and eye can share, and how it can be used to create a tactile feedback system when a human interacts with the architecture.

As buildings have shifted towards an idea of commodity, firms have become responsive to the cycles of economy rather than humans. Architecture has become what Berman describes in All That is Solid Melts Into Air as, "Everything that bourgeois society builds is built to be torn down....all these are made to be broken tomorrow, smashed or shredded or pulverized or dissolve, so they can be recycled or replaced next week, and the whole process can go on again and again, hopefully forever, in ever more profitable forms."[5] If the nature of architecture is to build to bring life to a building, should it not also include an attention to the entropy of said building as well? As Cairns and Jacobs discussed in *Buildings Must Die* and Brand in *How Buildings Learn*, what role can the architect play within the maintenance or death of a building?[6] The thesis will wrap a secondary layer onto the interface, one built on the 'hardware' and 'software' that defines a building. Hardware is the: facades, structure, mechanical and electrical systems, or the basic needs to satisfy an architectural enclosure. The softwareis the: sensors, doors, partitions, cameras, furniture, or the 'stuff' that can be easily removed, replaced, and upgraded.

The idea of hardware and software is to create an understanding of what makes a building a building (hardware) and what makes a building inhabitable and dynamic (software). These two systems undergo different life cycles both physically and culturally, so it will be important to find a way to create a framework that understands how a building is built so it might last long enough within a simultaneous world. This framework looks at buildings like Cedric Price's Potteries Thinkbelt in England as source of reference. It looked to create what Cairns and Jacobs described as an, "Anti-building" that understood the time factors and cycles that buildings would be subjected to.[7] This process offers the ability for a building to be curated for its deaths and rebirth from the start, so that while its function may shift, its

making of place and context can remain relevant to its microculture.

/ Hardware, Software, and the Architect

To investigate the relationship between hardware and software, common consumer tech products were dissected and 3D-modelled to understand how the organization and makeup of the components allows for a seamless interface with its user. This creates a direct connection between the physical architecture of the product and how it allows the digital architecture, or software to operate for its users. Therefore, the relationship between hardware and software is one that becomes increasingly pertinent to the language of an architect in the digital age.

This new language speaks to an evolution of the digital age architect to operate in a completely new ways, that one could consider that the term architect itself might even be outdated. For the purpose of this theory, the term Spatial Programmer would better describe the way in which we communicate space in a digitized world. The spatial programmer sets up base rules and constraints for a project through its hardware, and allows the software to be malleable to change by its users. Over time, as the software evolves along with its users, the hardware will need to adapt to maintain that fluid continuity with the 'interface' of architecture.

What we look at in this next section describes what constitutes the possible evolution from the architect to spatial programmer, and how the changes to the way in which one might operate in the future. This change sets up the framework for a scenario to play out in Part III, which looks at how a spatial programmer would go about forming digital age architecture.

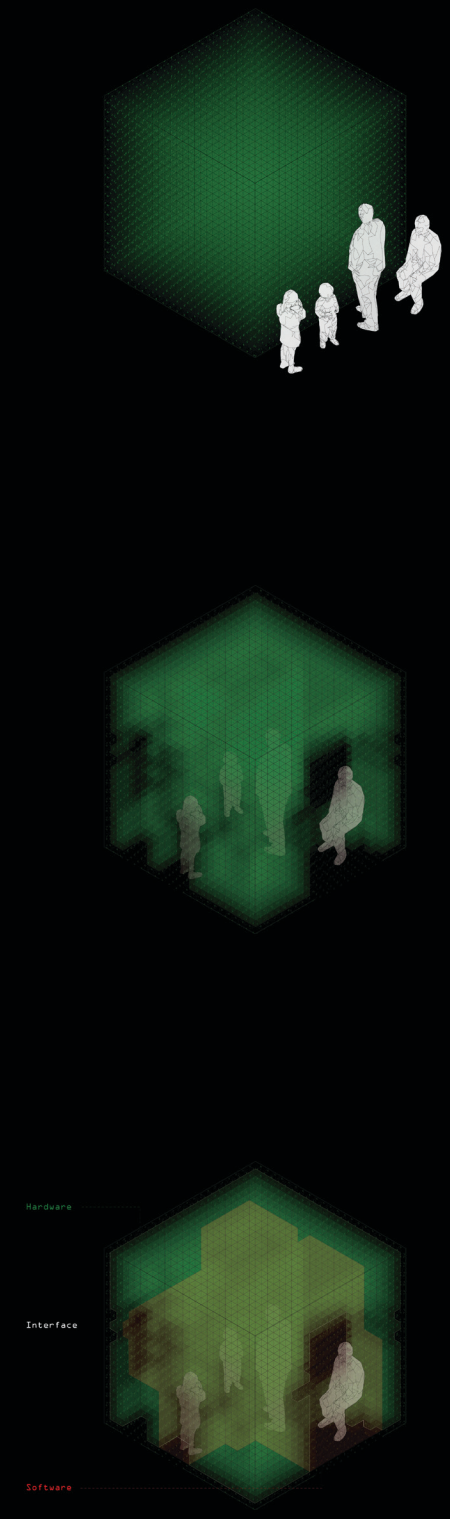


Fig. 24 - Hardware, Software, and Interface changed through human inhabitation

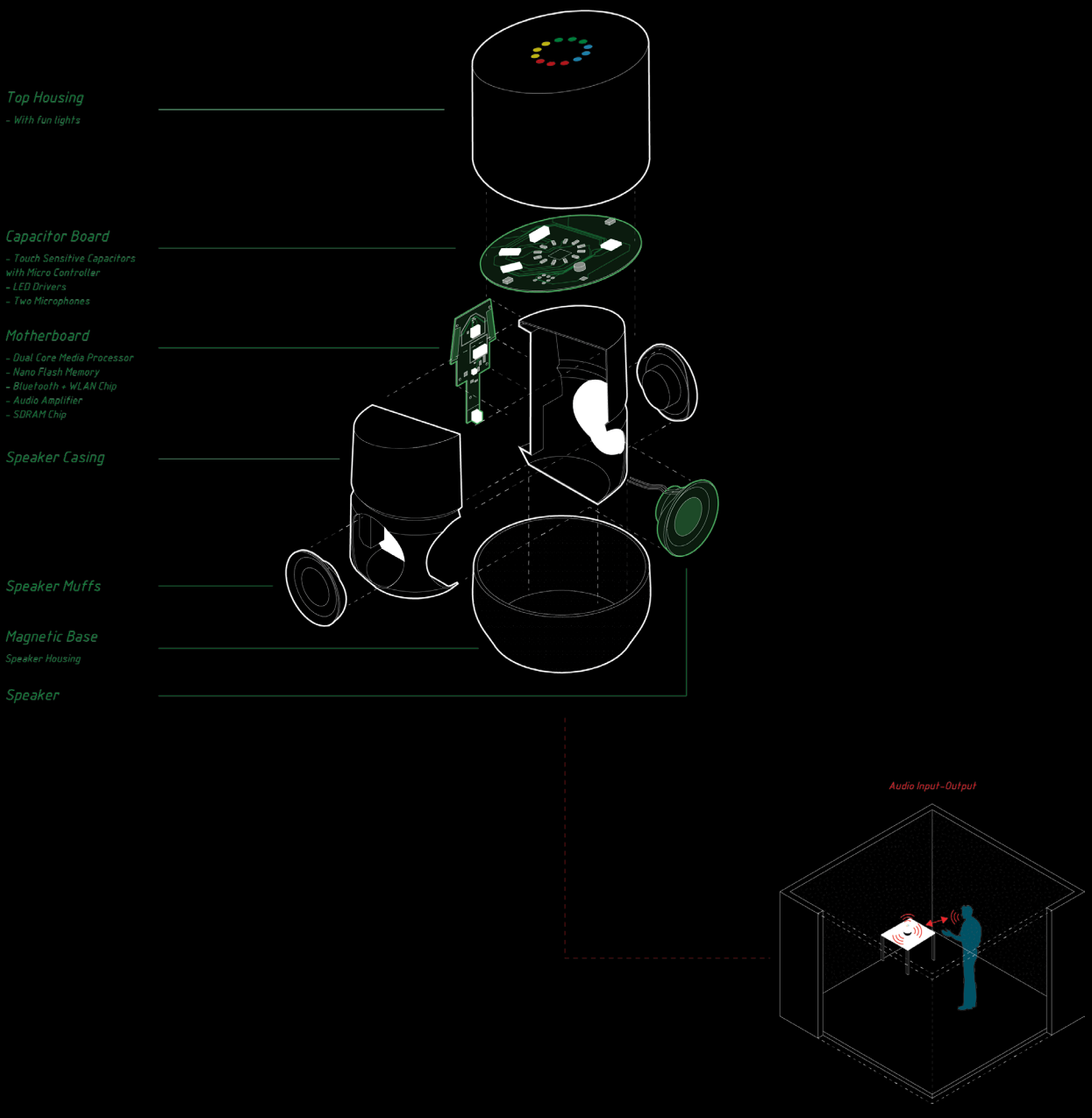


Fig. 25 - Dissection of the Google Home, looking at the form of its audio feedback system

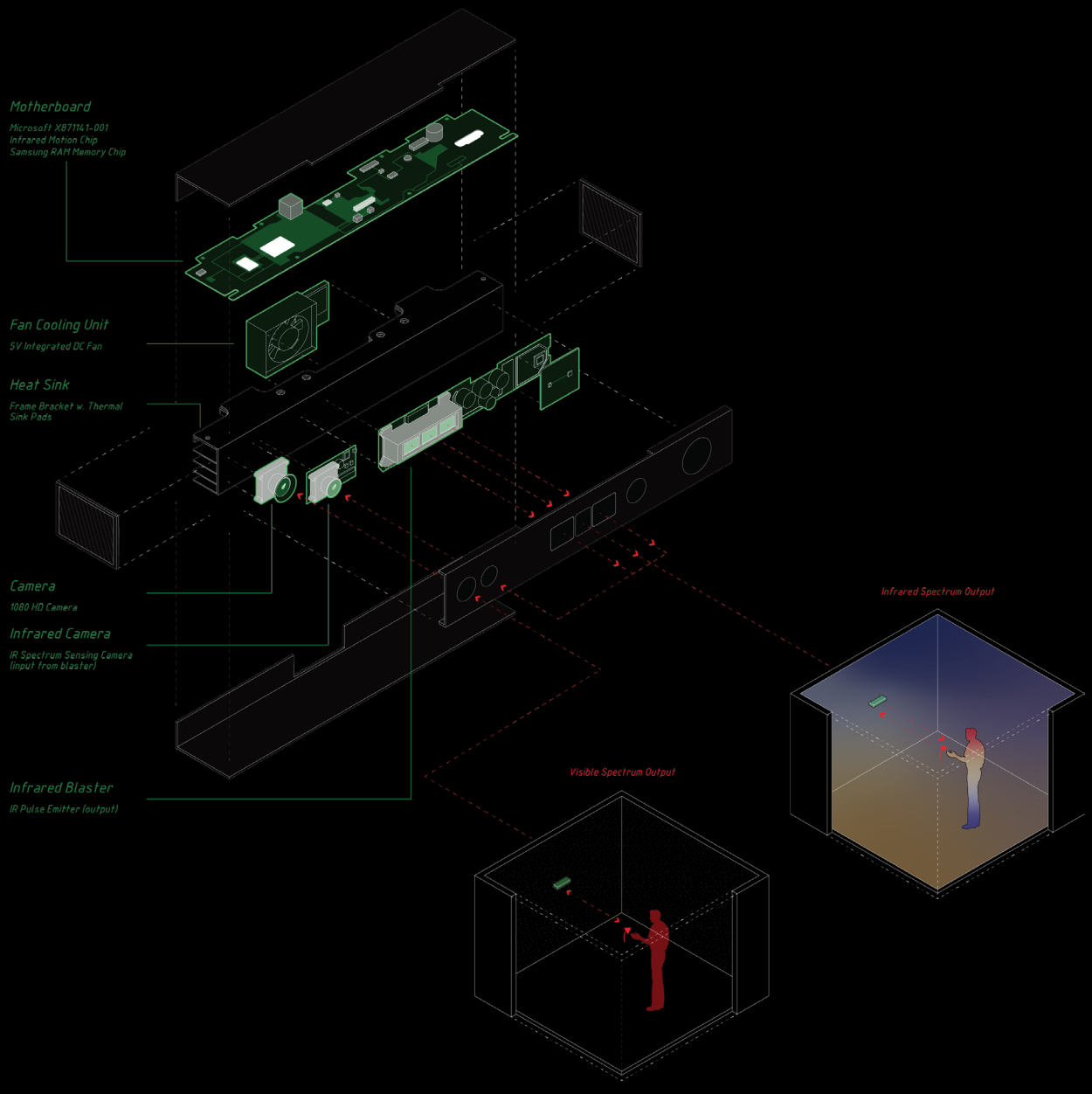


Fig. 26 - Dissection of the Xbox Kinect, looking at its infrared technology and its ability to monitor and adapt to human movement

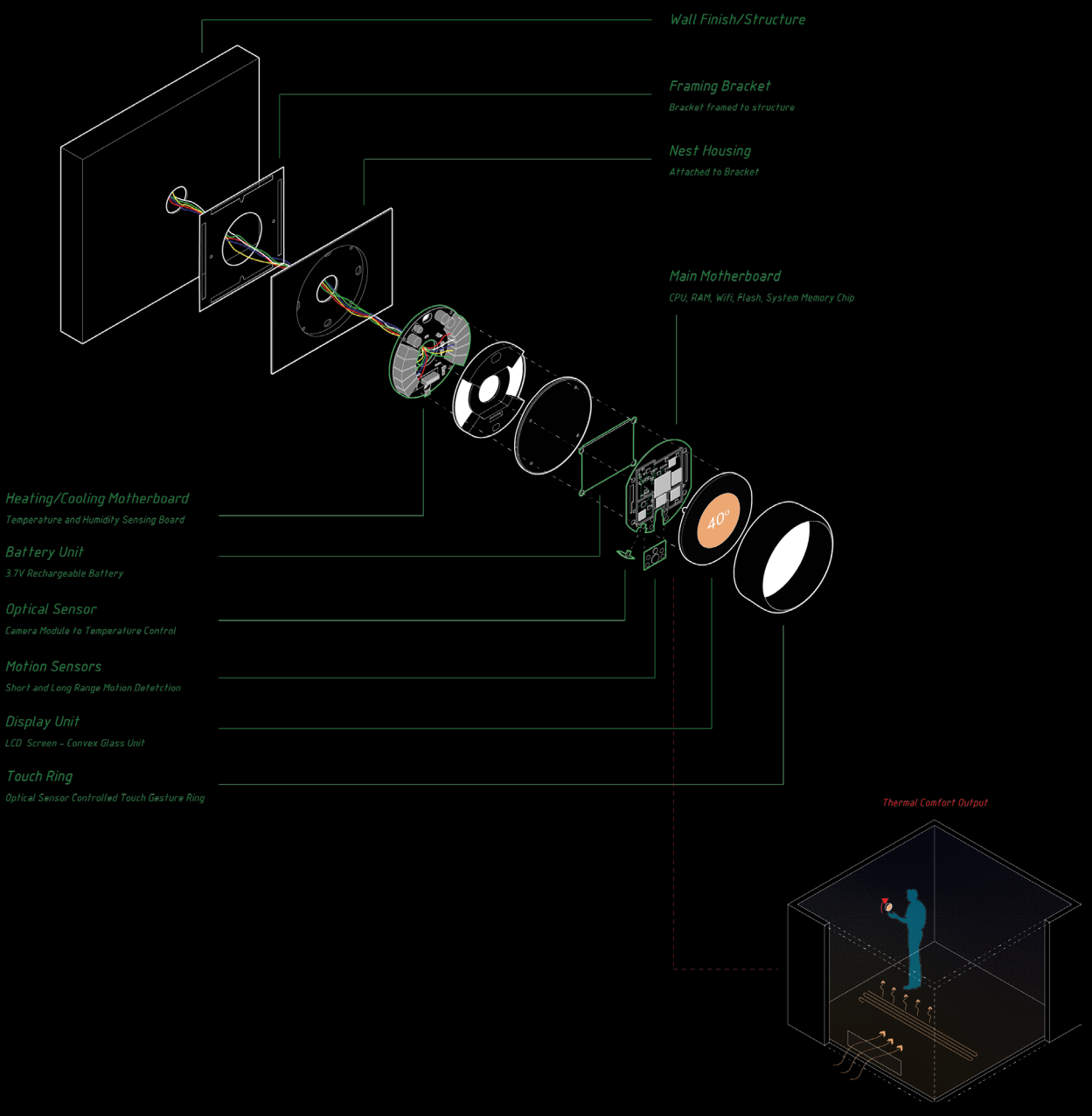


Fig. 27 - Dissection of the Nest Thermostat, looking at the simplicity of the interface and its ability to affect thermal comfort

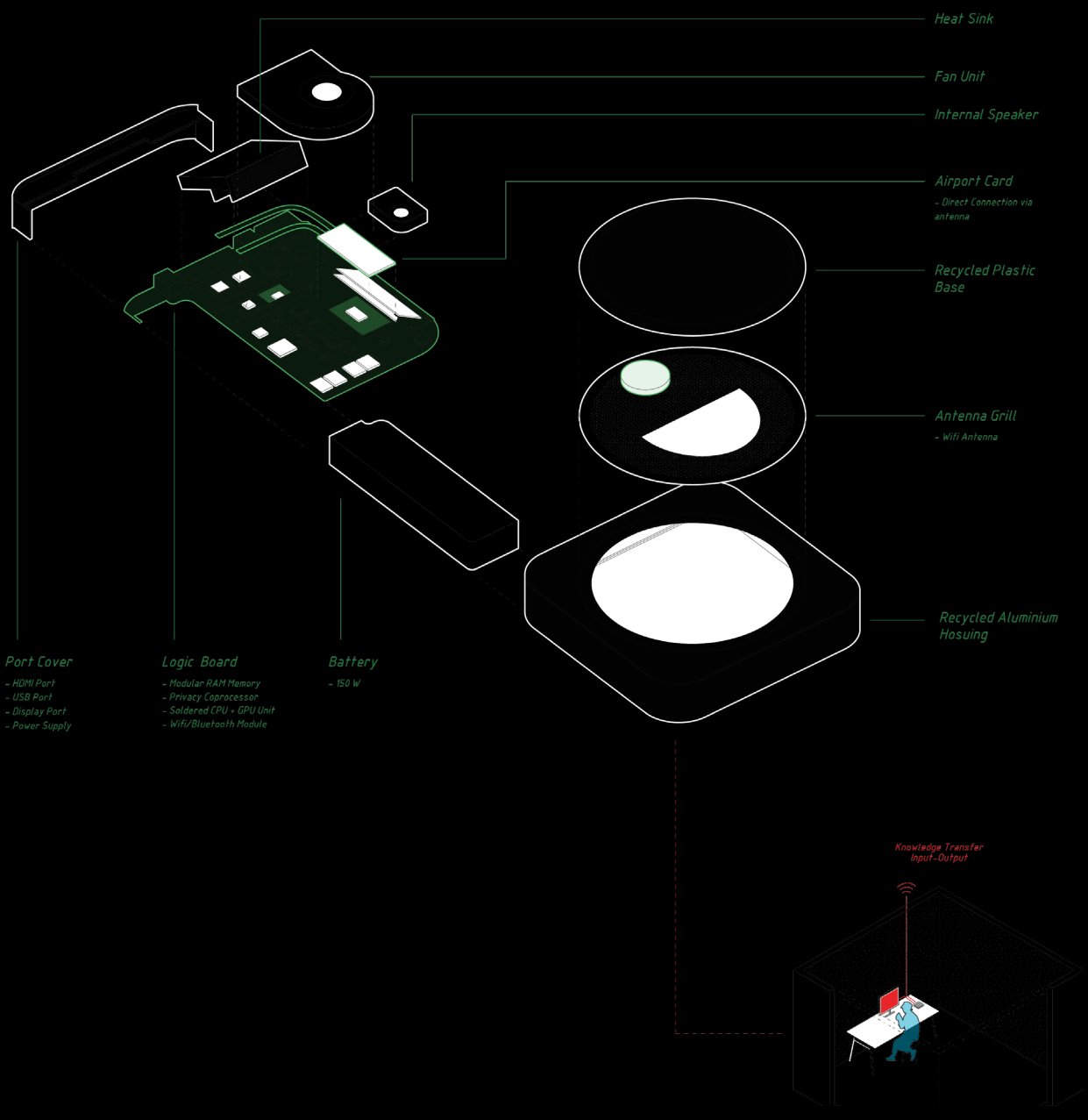
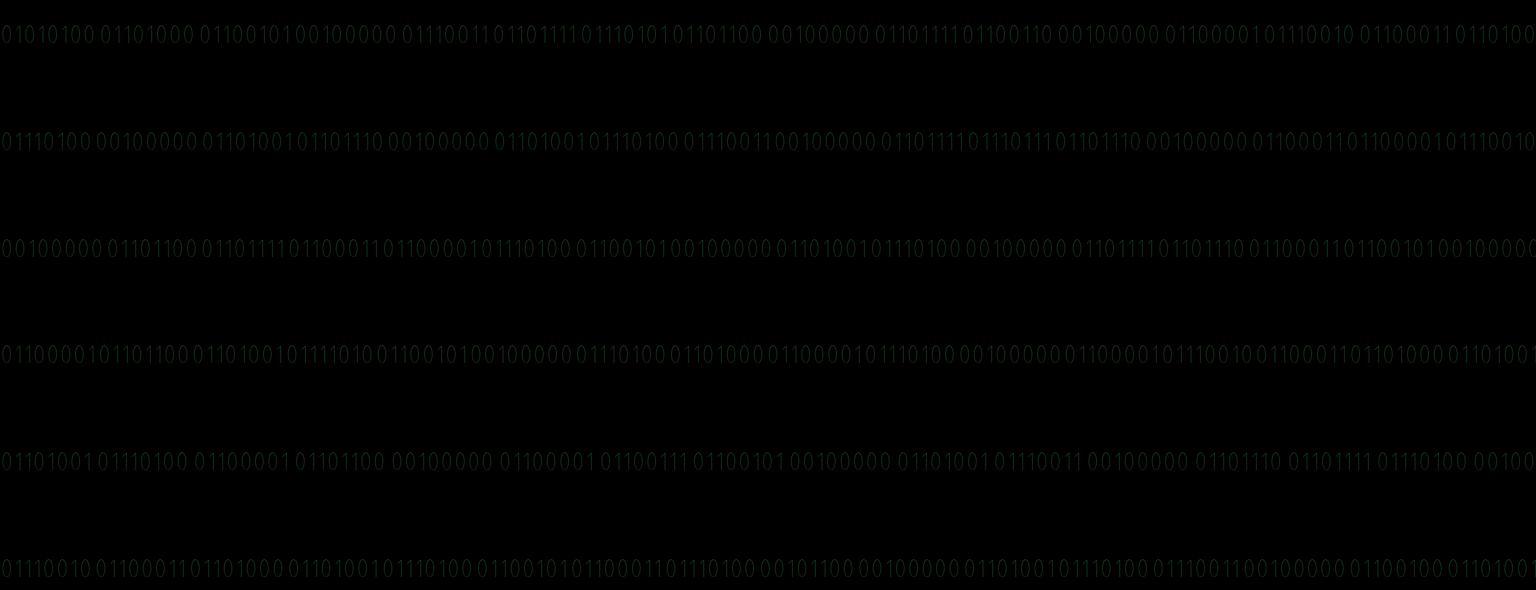


Fig. 28 - Dissection of the 2017 Mac Mini model, to understand the logicboard construction and computer hardware complexities

Fig. 29 - X-ray image of the iPhone 7, develop from the dissection of the iPhone (physical object), to better understand its various components and their responding connections



PART III: PROGRAMMING THE INTERFACE

/ Spatial Programming in the Digital Age

The development of tools like the iPhone, Google, Instagram to name a few has allowed developed societies to access information and change immediately. Primarily, it has challenged our understanding of individual and collective identity to exist on a spectrum of possibilities rather than a universal understanding. I argue that what stops architecture from entering the digital age lies within its inability to embrace a formal and built relationship with the individual and the collectives they belong to.

The thesis challenges that while architecture practice has been changing with society, it has not been able to keep up with the accelerating change of the world. Here, our use of digital tools has only been utilized to speed up old processes of design, construction, and capital. Our classical understanding of architecture must change so that it may remain relevant to the world as it changes, as what I propose is an evolution to what architectural practice might be in the future. The project looks at a potential role of the architect in the digital age as the spatial programmer. By setting up some basic rules and limits to how designers can operate, the designed scenario looks at how to develop a framework that privileges the buildings ability to adapt to the users needs and behaviour. This scenario provides a possible scenario as to what architecture becomes in the digital age.

The thesis argues that the architecture of the digital age can better respond to the user through responsive design that uses real-time building of unified components, that can allow for evolving forms rather than static existences. The evolution of buildings now become more reactive to their occupants based on their needs and behaviours. This connects humans more intimately with their surroundings as they become more tailored to who they are as an individual or a collective they belong to.

Fig. 30 - Transitioning the global top-down and local bottom-up approaches to architecture to be more scalar, which requires operation along a spectrum

This starts through the merging of global top-down and local bottom-up approaches of the machine age to designing, building, and experiencing architecture. These inverse relationships when dealing with scale become the site of opportunity to look at how the intersection of the digital age could progress this scenario past the decade scope we have looked at today. This new theory understands the ability to scale design so they can respond consistently to the experience of each human. This creates a spectrum rather than a linear process to scale, which takes the old understanding that resolution increase as scale increases, and evolves it into the ability to interchange resolution at different scales, using the human as the frame of reference.

Like this scenario you will look through in this book, architecture as interface is about embedding some level of an infrastructure at the beginning of a project to allow the building to adapt to the user's needs and behaviours as they naturally change over time. All the spatial programmer simply does is provide a given boundary and growth limit for this change to happen within. This speculation could be applied to any program and site, as the spatial programmer looks at the users as context, and site as constraints.

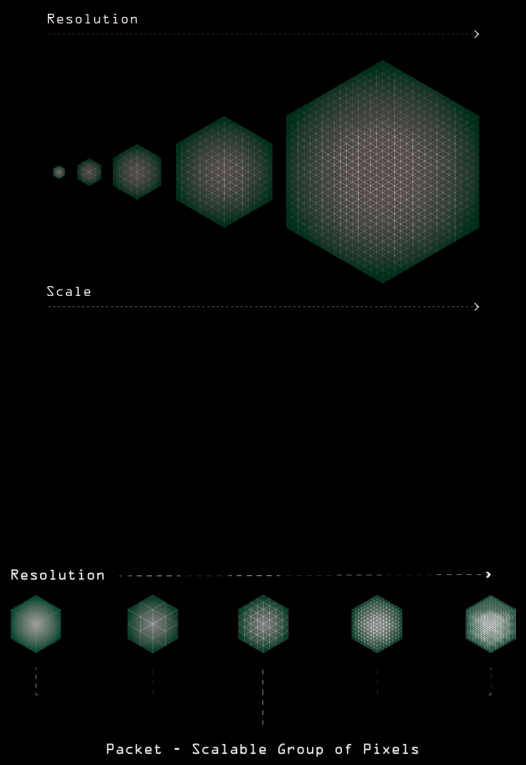


Fig. 31 - Comparison of resolution in the Machine Age (top) and resolution in the Digital Age (below) to be different. The digital age resolution allows for the scaling of information to respond to its given scale, which can respond more to the human along all physical scales

/ The Home as Interface

The chosen scenario situates itself in the programme of the home. This scenario predicts that the death of the single family home and a need to densify particularly in North American suburbia provides an opportunity to test how architecture as interface can maintain the individual qualities of single family home, yet still provide densification of land. This scenario spans a decade of change, using the year as an increment to document this shift.

The building will utilize a traditionally built circulation core, that transfers humans, materials, and robots vertically through the housing units. From this core, a 3D printed bio-polymer plastic frame is extruded up for the units, so that the frame can both minimize its weight, but to operate within a reusable material loop, that minimizes its wastes over time. This material set-up is governed by some global user rules and site constraints:

- Constraints are provided that a fixed 7 storey core is placed on two adjacent single family home parcels, with two units given on each floor.

- 7-axis Robots are attached along rails running at the floor plates on the inside and outside of the units, with their total radial reach to be at least 3m, max 4m.

- Each unit cannot exceed two levels in height, and must remain within the 3m horizontal boundary of its vertical neighbours, so that the robot infrastructure can access all units above and below.

- Users can change their boundaries through three systems of printing and assemblage:

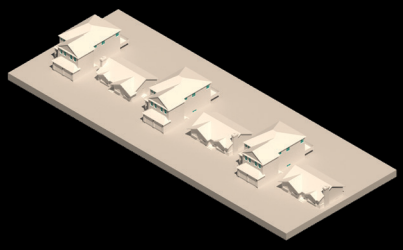
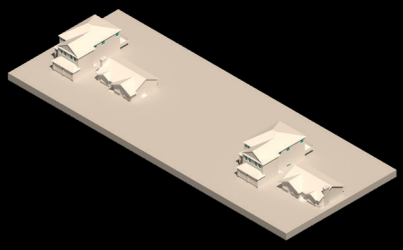
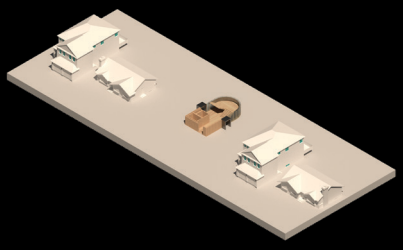
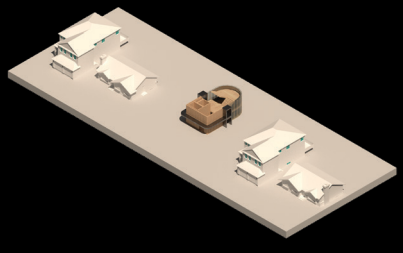
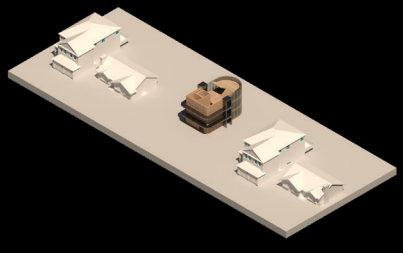
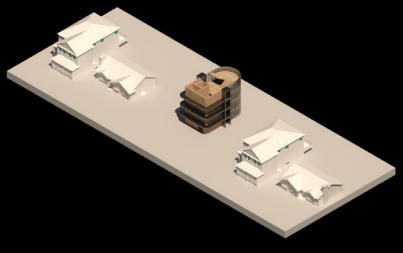
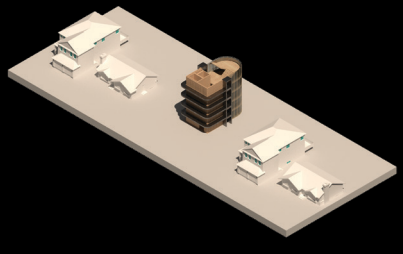
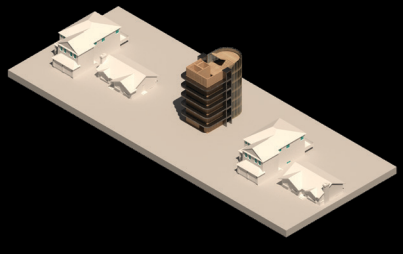
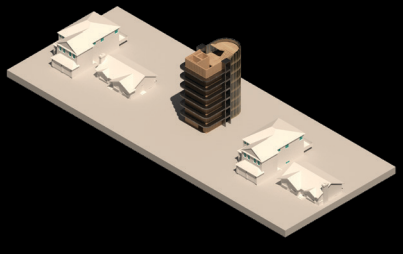
1. *Mobile, interior printing robot,*

named Jack.

2. *Prefabricated 3D printed additions, which are attached and surfaced by the robots*

3. *In-situ, mesh frame print, which connects off of the existing printed frame*

These simple rules and constraints help define how the building can grow and shrink over time as its occupants see fit. What is shown is the process in which the building is created and how it changes over the span of a decade, using three narratives to discuss the difference in how people can utilize this interface, and subsequently how the robotic software adapts the unit hardware through the three types of printing to make that change possible.

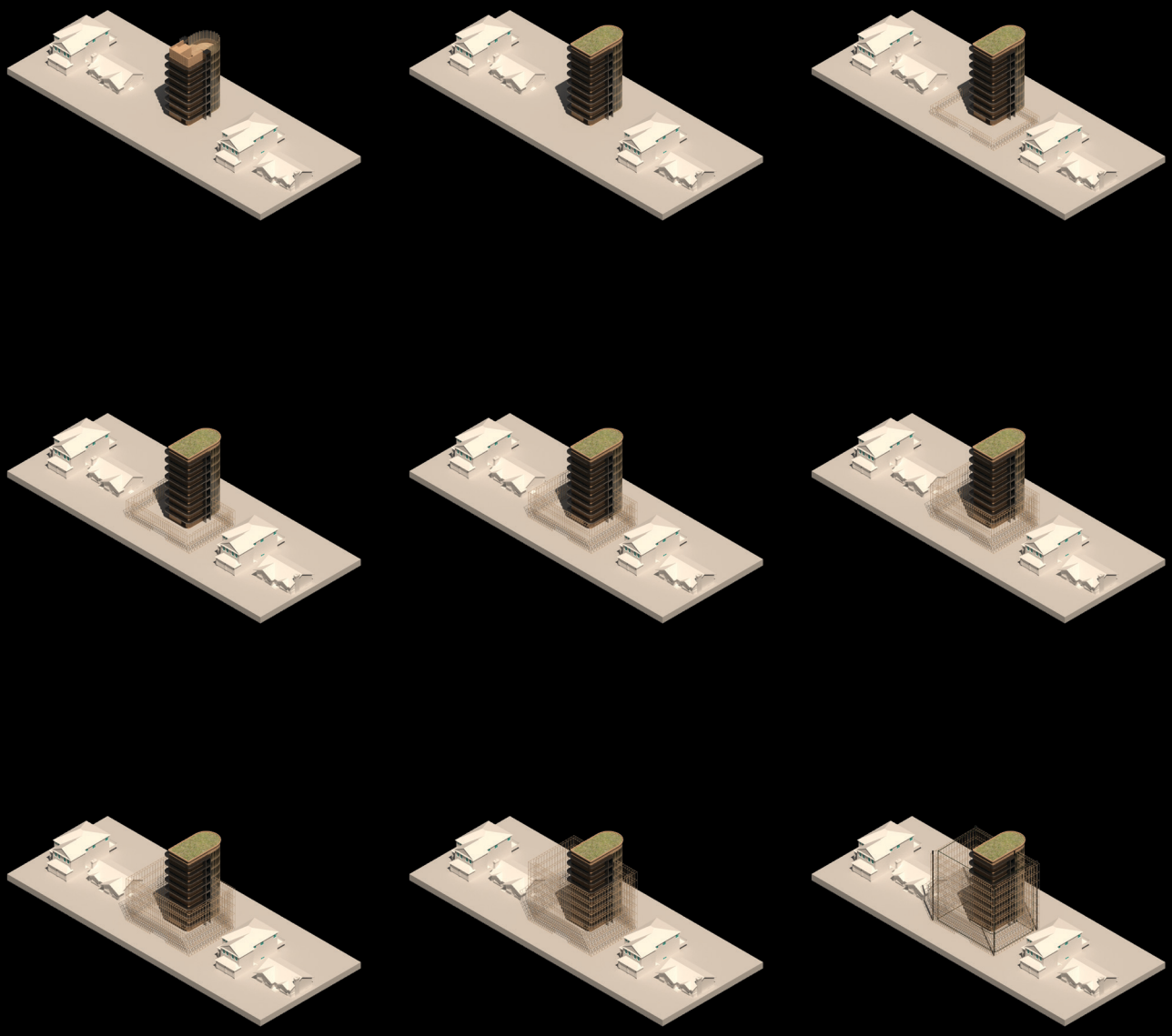
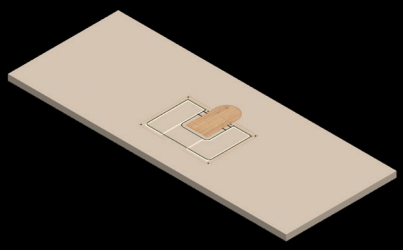
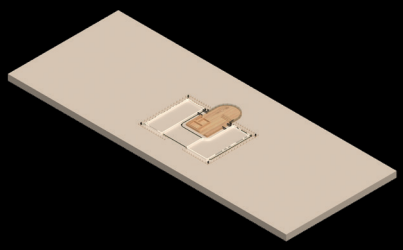
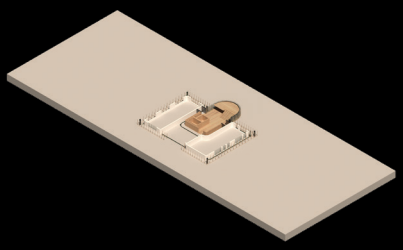
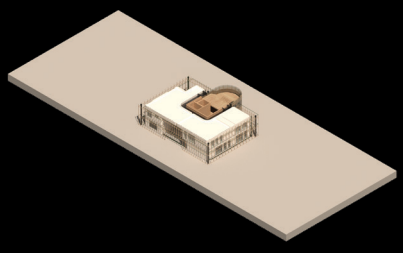
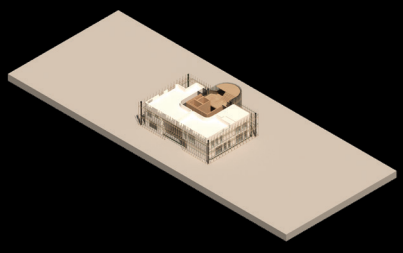
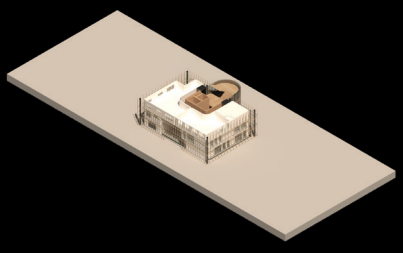
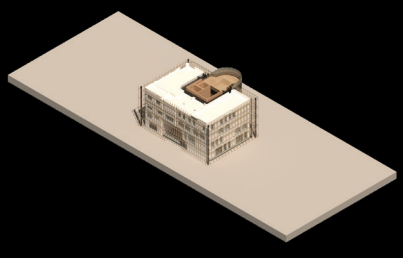
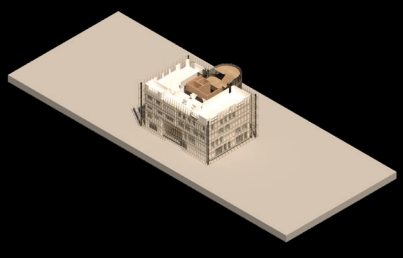
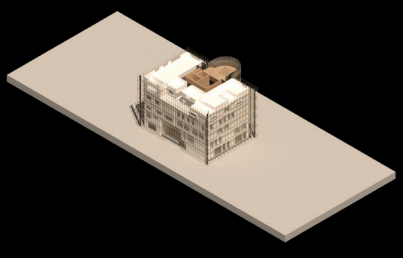


Fig. 32 - The erection of a seven-storey circulation core (left to right then down), with an exterior scaffolding to define a 3D printing bed limit

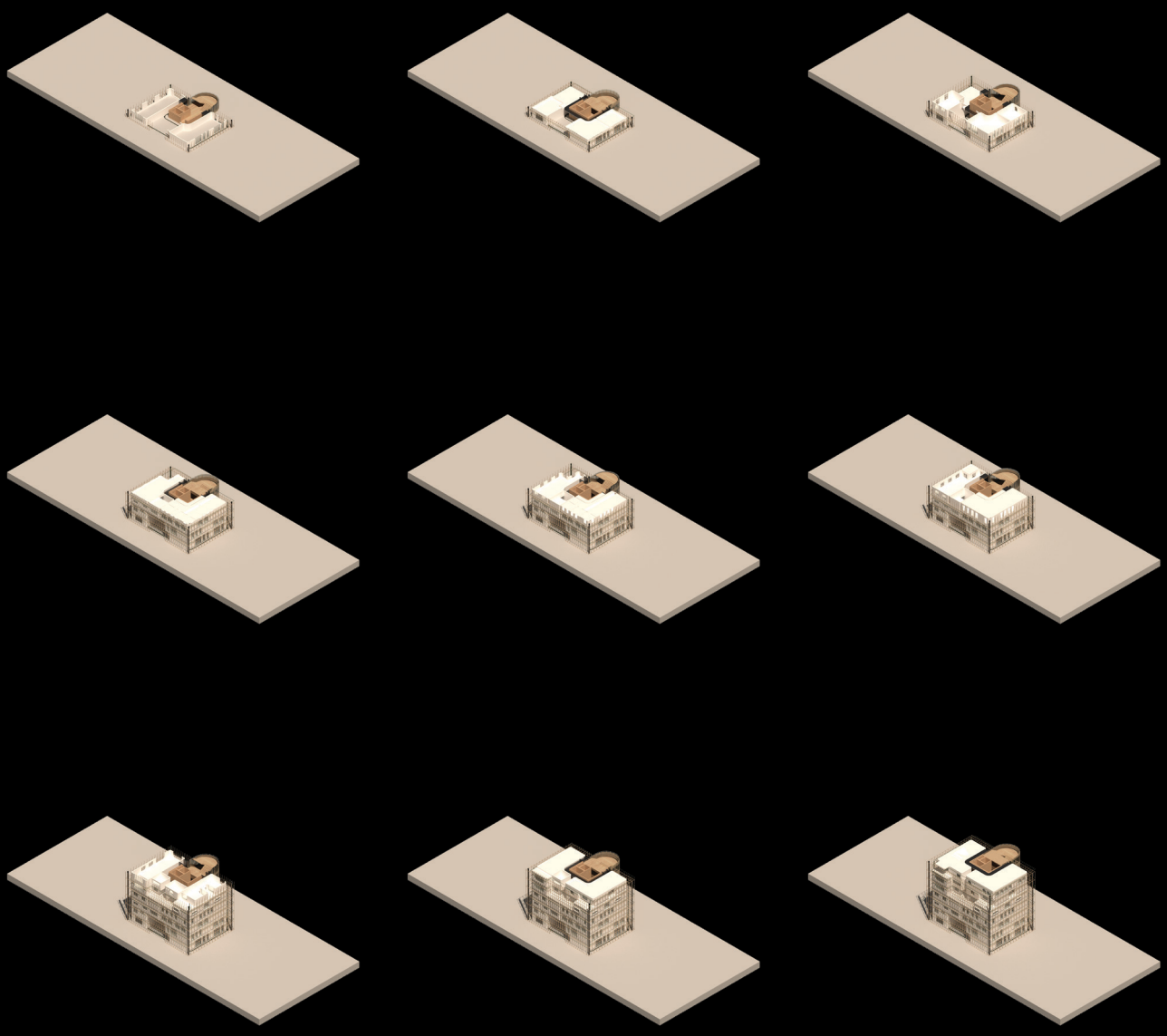
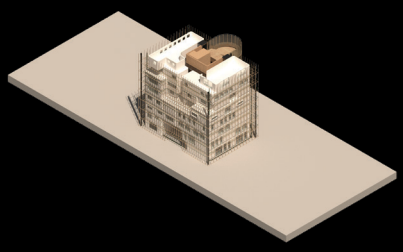
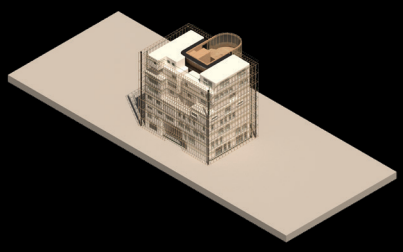


Fig. 33 - The printing bed then prints the units based on the designed developed through collaboration with the client, architect, and most importantly user.





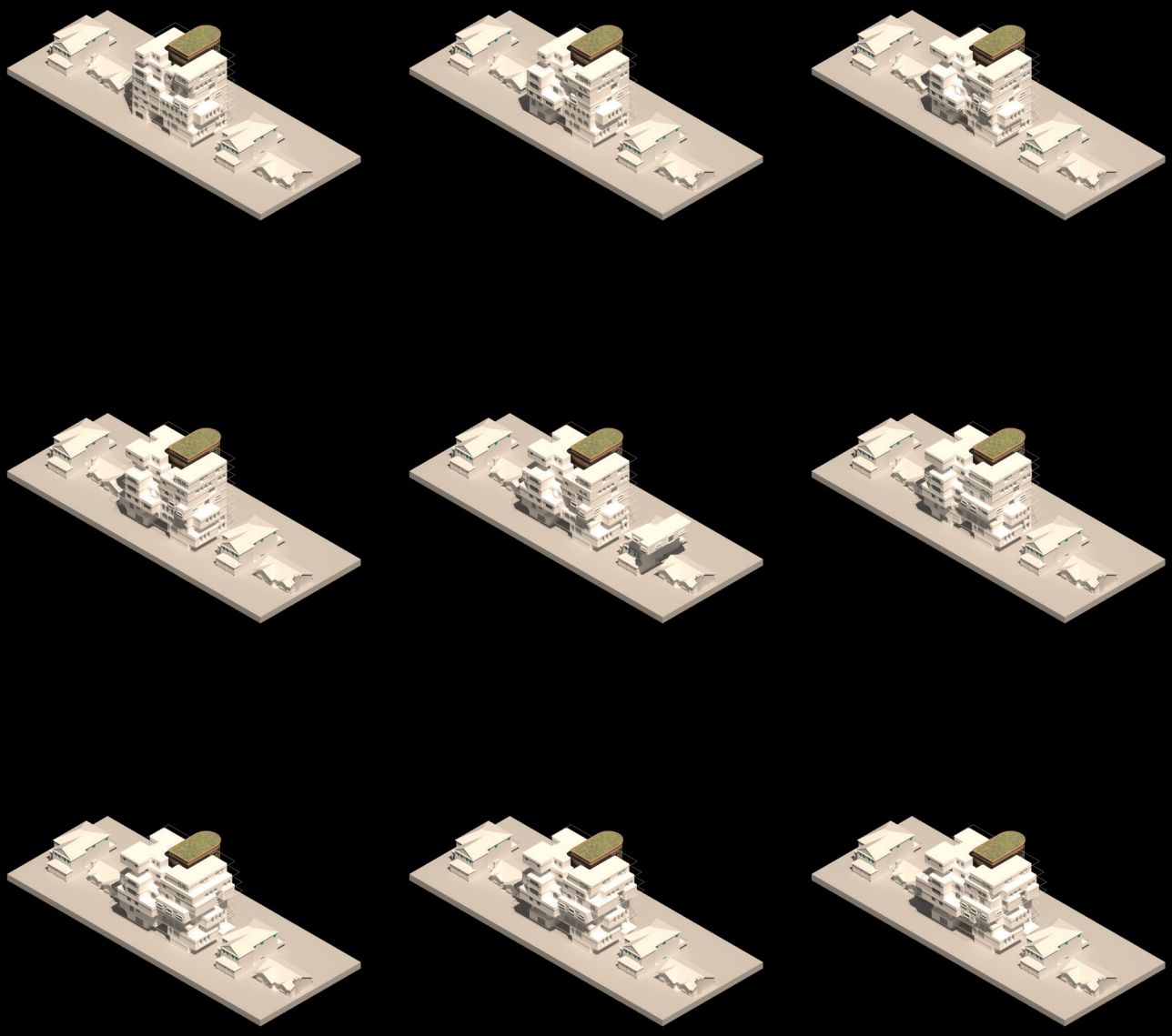


Fig. 34 - Once the printer finishes the last level of printing, the scaffolding is removed and robot tracks are added at each level along the outer edge so the building can adapt to its users needs over time.

Fig. 35 - Year one render
Fig. 36 - Years one to two transition

Fig. 37 - Narrative 1 - Year 1 (top left), Year 8 (top right)
Fig. 38 - Narrative 2 - Year 2 (mid left), Year 6 (mid right)
Fig. 39 - Narrative 3 - Year 1 (bottom left), Year 7 (bottom right)

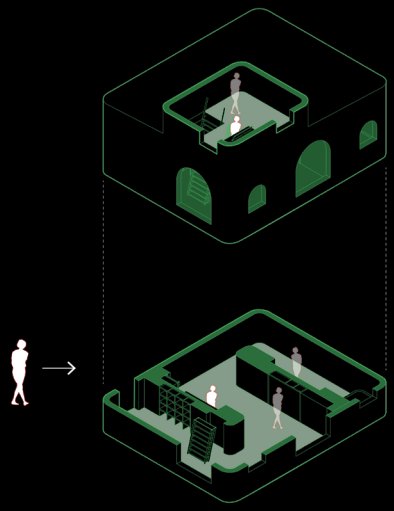
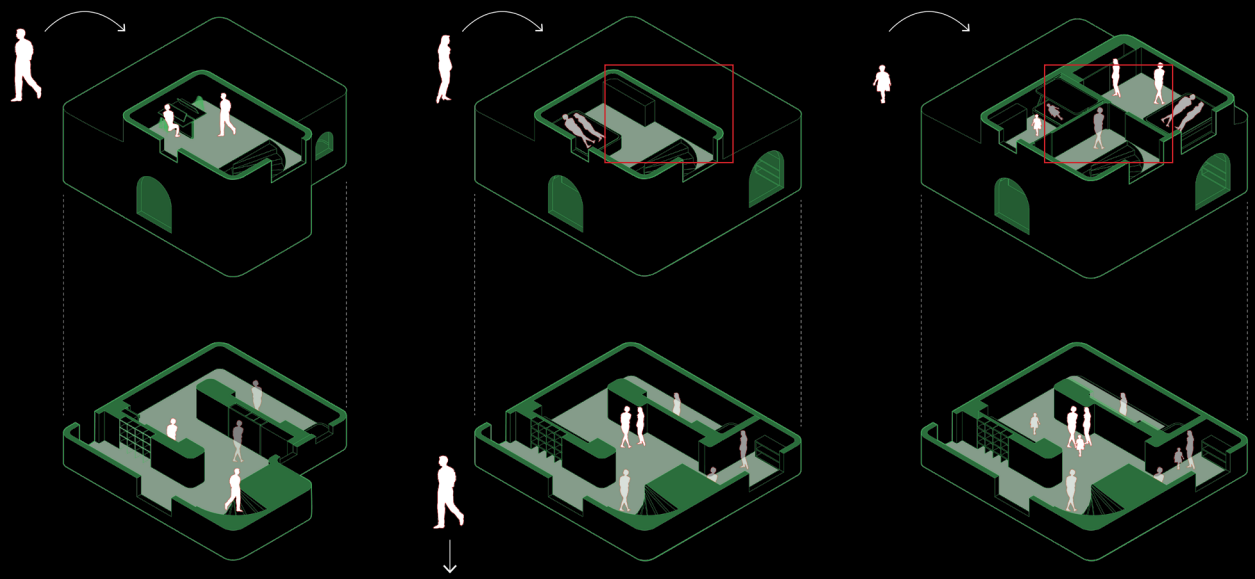


Fig. 40 - Years two to three transition
Fig. 41 - Years three to four transition



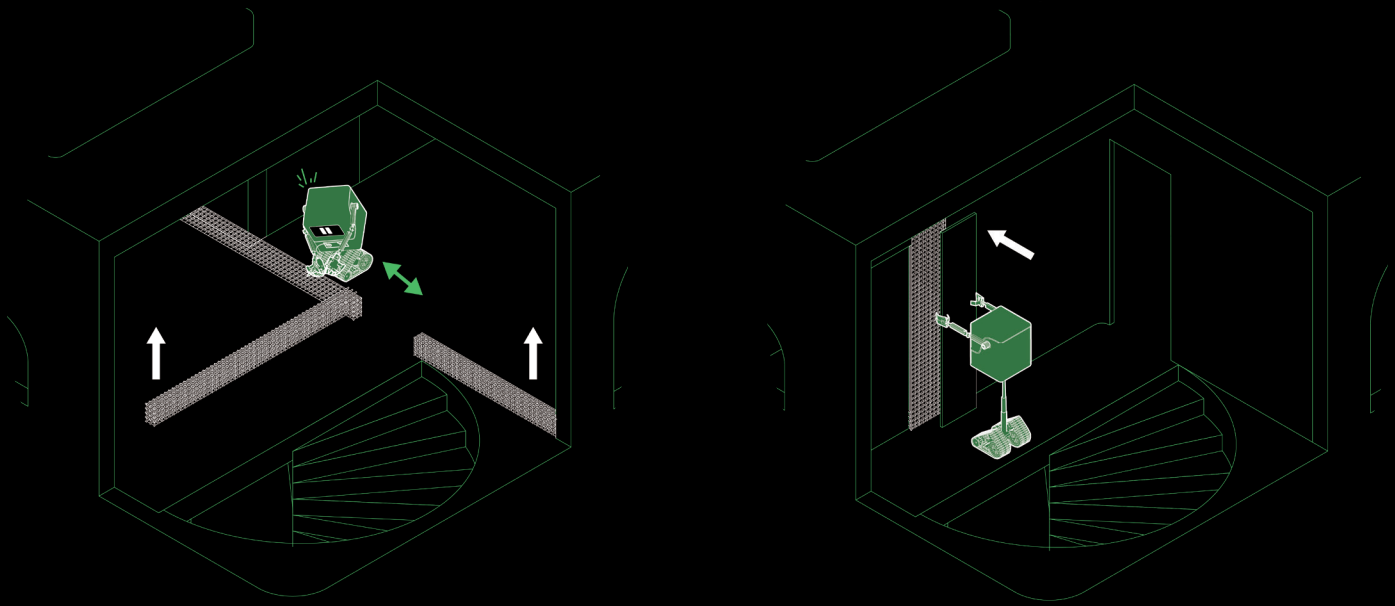
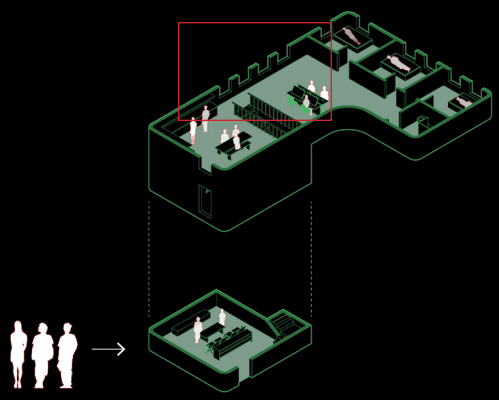


Fig. 42 - Formal changes to narrative 1 over the decade span
Fig. 43 - Showing the use of Jack to print interior walls for its occupants, located in red from Fig. 42



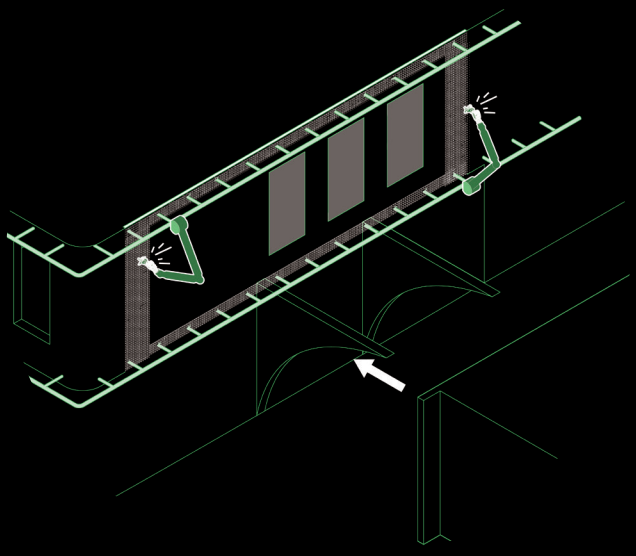
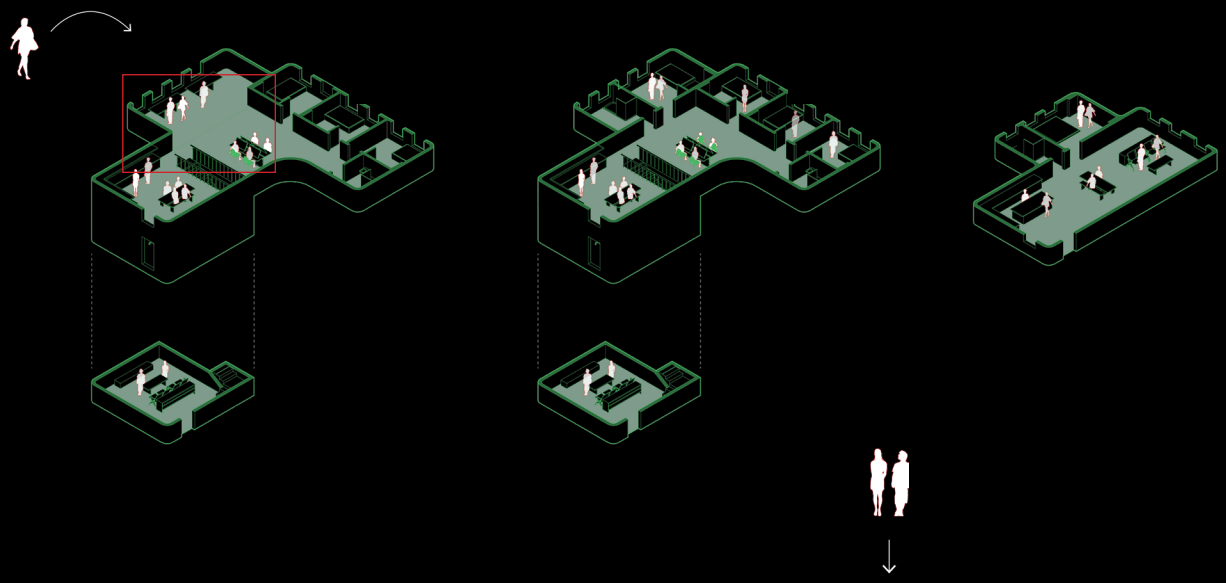


Fig. 44 - Years four to five transition
Fig. 45 - Years five to six transition



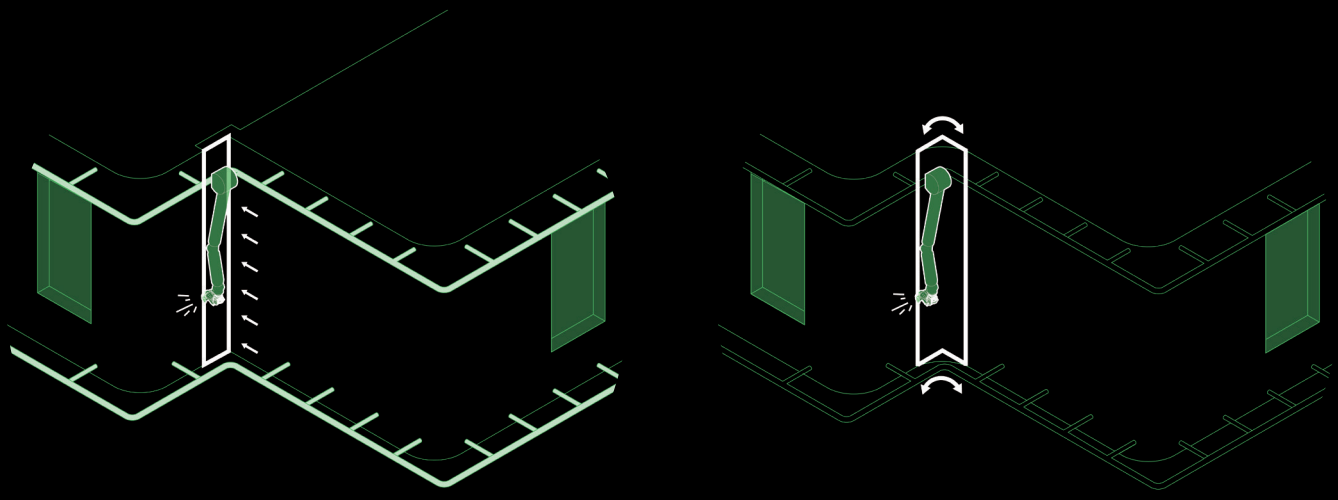
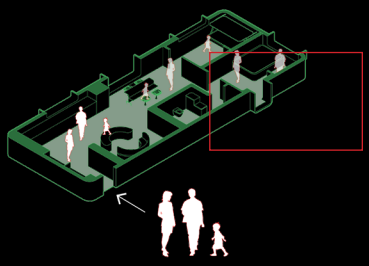


Fig. 46 - Formal changes to narrative 2 over the decade span
Fig. 47 - Showing the use of a prefabricated room that is attached to the existing structure for its occupants, located in red from Fig. 46



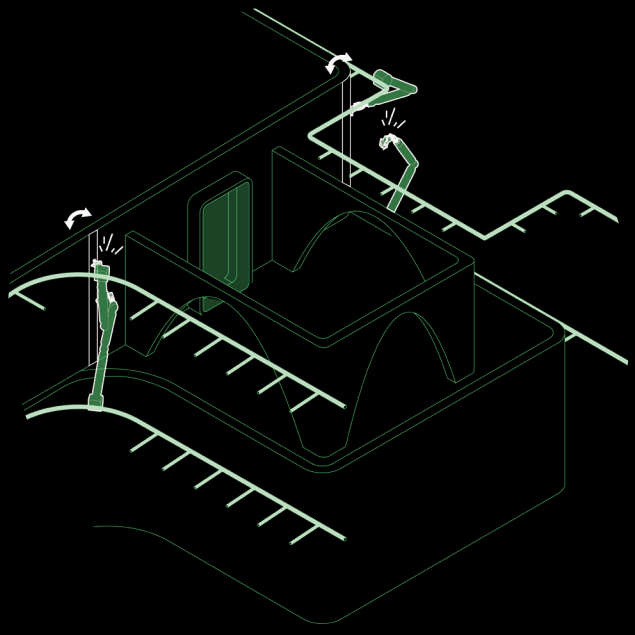
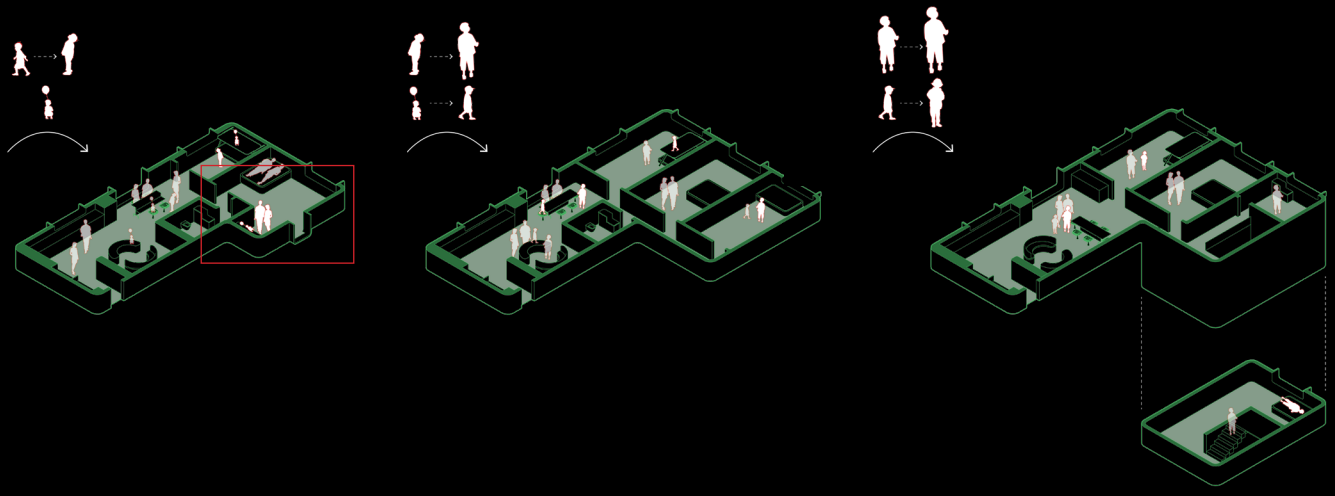


Fig. 48 - Years six to seven transition
Fig. 49 - Years seven to eight transition



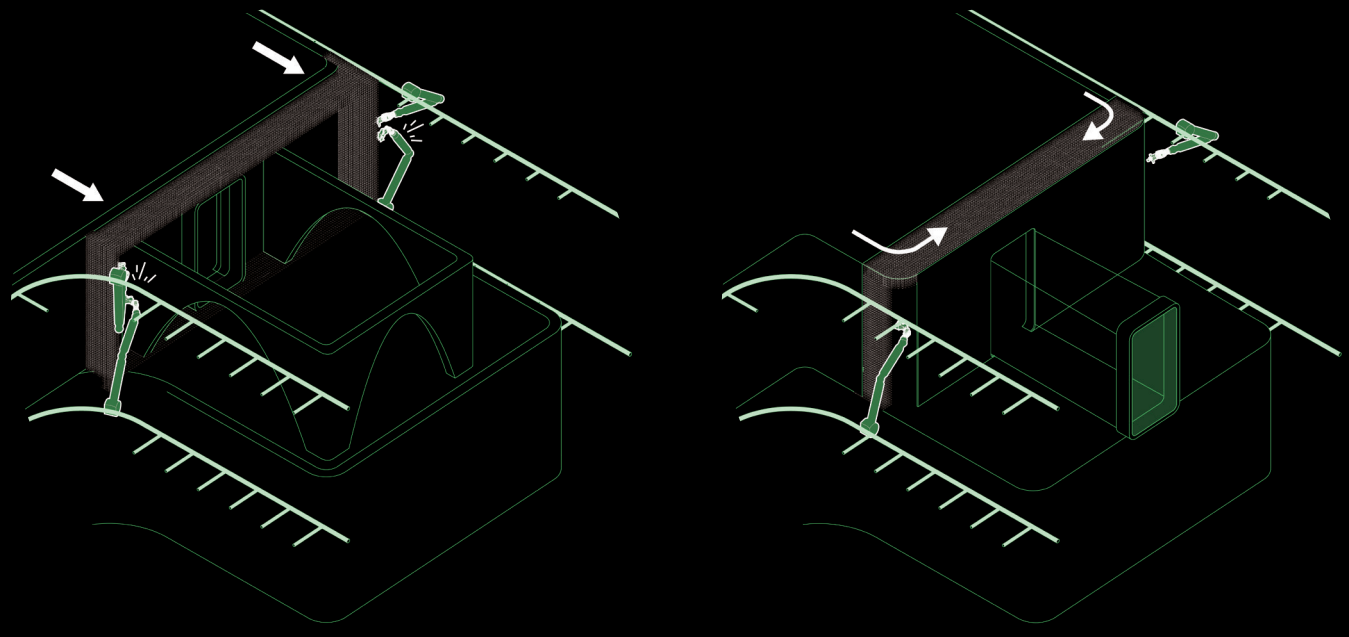


Fig. 50 - Formal changes to narrative 3 over the decade span
Fig. 51 - Showing the real time, in-situ 3D print that is attached to the existing structure for its occupants, located in red from Fig. 51

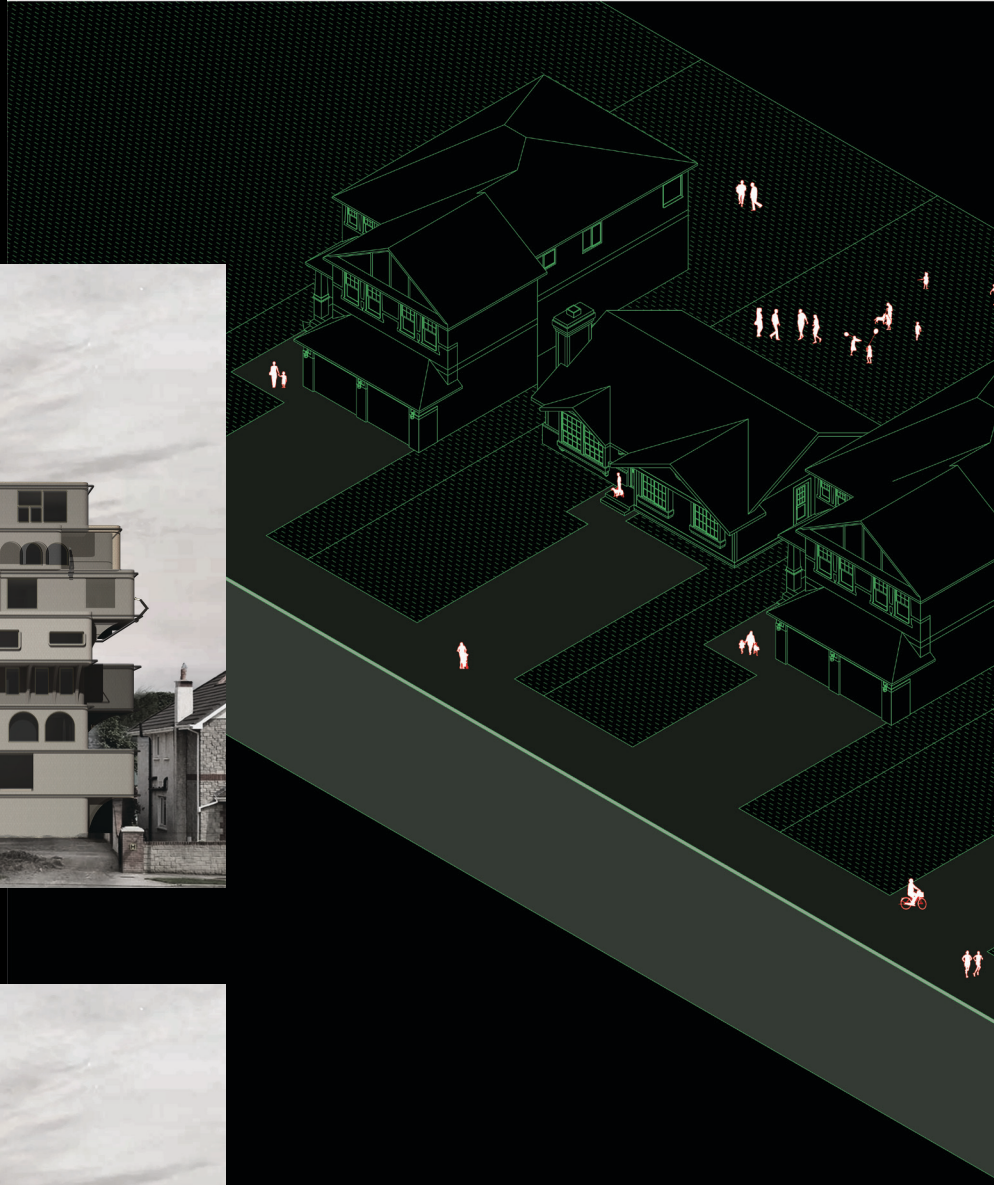
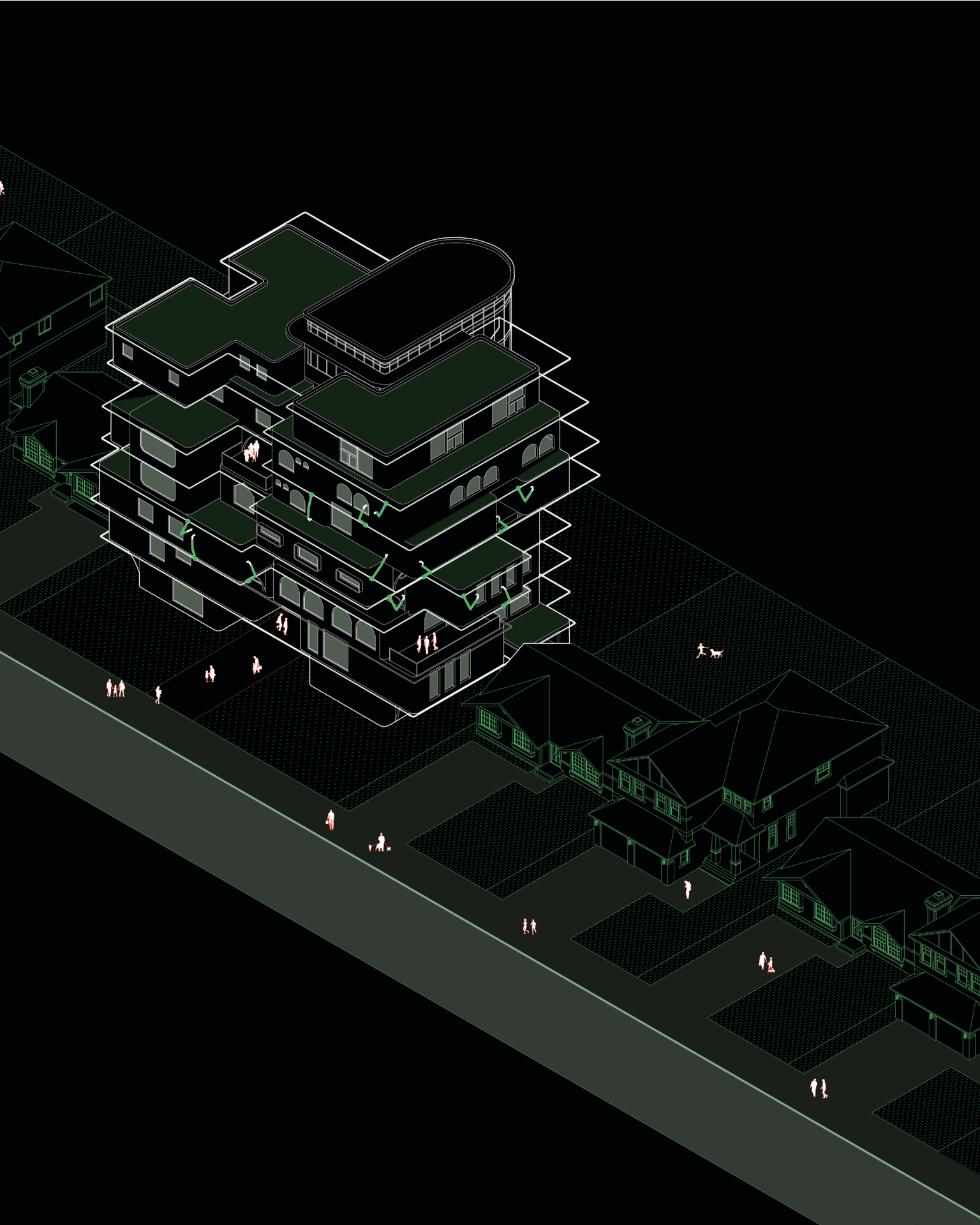
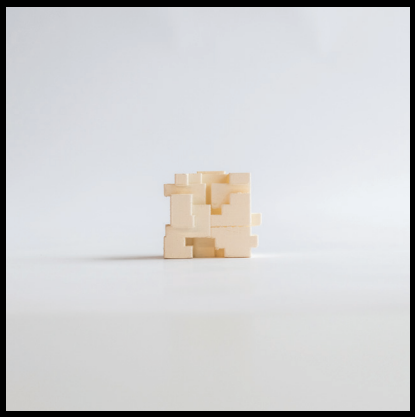


Fig. 52 - Years eight to nine transition
Fig. 53 - Years nine to ten transition
Fig. 54 - Isometric drawing showing the relationship between the project and its single family home context





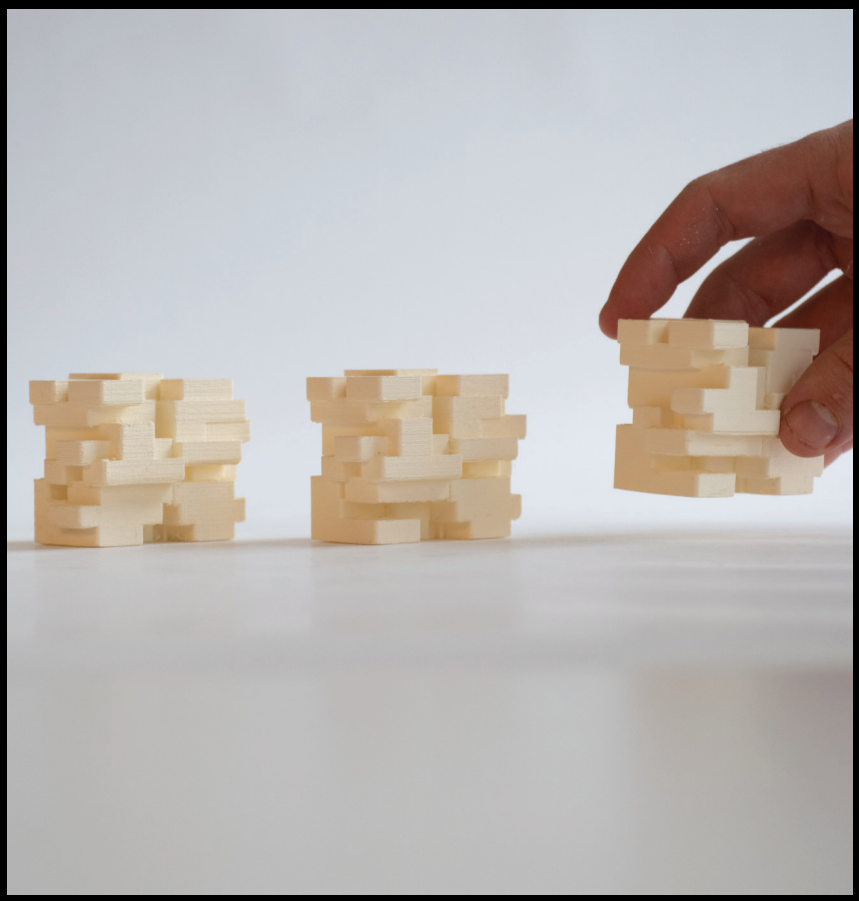


Fig. 55 - (top left) Year 2 1:500 Model
Fig. 56 - (top middle) Year 6 1:500 Model
Fig. 57 - (top right) Year 9 1:500 Model
Fig. 58 - Year 8 1:500 Model frame 1
Fig. 59 - Year 8 1:500 Model frame 2
Fig. 60 - Years 8-10 1:500 Model placement

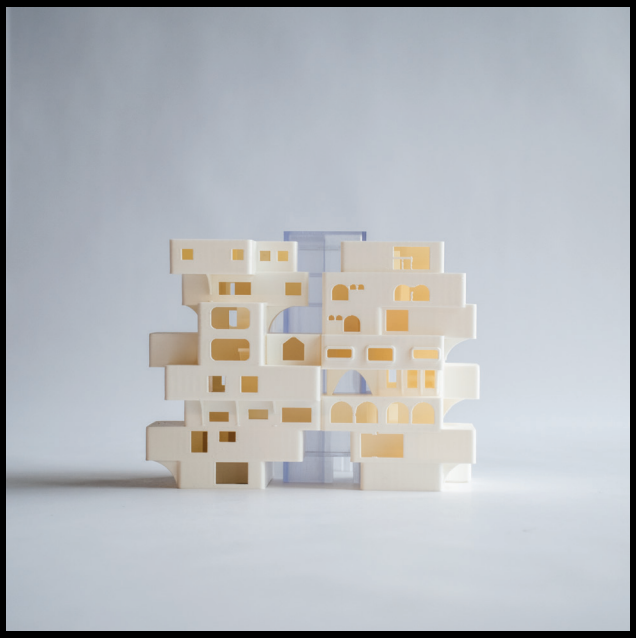


Fig. 61 - (top left) Elevation photo of 1:150 3D printed model
Fig. 62 - (bottom left) Side view of 1:150 model
Fig. 63 - (top right) Left profile view of 1:150 model
Fig. 64 - (mid right) Side view of 1:150 model
Fig. 65 - (bottom right) Right profile view of 1:150 model

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