Robots, Cyborgs, and Architecture

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This paper seeks to examine the robot cyborg paradigm in relation to architecture and artificial intelligence. It asks, what knowledge might arise from the cross disciplinary study of the historical narrative of the robot and cyborg? Referencing the birth of the robot and cyborg and exploring their significance from past to present, this paper strives to point out how these figures could help us question the status quo or reveal something to us about the world. Through the suggestion of a collective non-human form of intelligence in architecture we can ask, what might the machine have to offer that we haven't considered or weren't even capable of considering? How might machines actively collaborate in the design process? How might our relationship with technology enhance our creative capacities? The response to these questions begins with a comparative investigation of approaches to architecture and AI.

INTRODUCTION

In the 1921 play, R.U.R (Rossum's Universal Robots), by Karel Capek, the word robot was first introduced to the public. On July 2, 1924, the British newspaper, The Evening Standard, quotes Capek describing his initial ideas for the play and the term:

> Robots were a result of my traveling by tram. One day I had to go to Prague by a suburban tram and it was uncomfortably full. I was astonished with how modern conditions made people unobservant of the common comforts of life. They were stuffed inside as well on as on stairs, not as sheep but as machines. I started to think about humans not as individuals but as machines and on my way home I was thinking about an expression that would refer to humans capable of work but not of thinking. This idea is expressed by a Czech word, robot. [1]

With the advent of this play and the coining of word, the robot emerges from several overlapping dichotomies: man vs. machine, organic vs. mechanical, freedom vs. restraint. The robot's birth was a homogenous response to these debates. The cyborg is also a figure born from these dichotomies; however, it emerged not homogenously, but as a hybrid. Thus, the robot and the cyborg are not contrasting figures but are one in the same, one more machine and the other more man.

This paper seeks to further examine this robot cyborg paradigm in relation to architecture and artificial intelligence. It asks, what knowledge might arise from the cross disciplinary study of the historical narrative of the robot and cyborg? The intent is to gain a broader knowledge of the technological evolution in architecture and provide a frame for designers and specialist in AI to understand these fields in a wider context. The robot and cyborg represent two approaches for machine emancipation: the collaborative method and the connected method. In the collaborative method, machines are working with us instead of for us. Here the robot is a key figure and is a super machine or a machine who thinks. In the connected method, machines are a part of us or rather engaged as extensions of the body. In this method, the cyborg is the key figure and is a super human or a machine who helps us think and understand our surrounding environment.

MACHINE EMANCIPATION

Beginning with the narrative of Capek's play, there is a formal introduction of the robot and an underlying thematic relationship to man and machine. The term robot has become a neologism originating from the Czech words robota, meaning servitude, and robotnik, meaning peasant or serf. [2] In both the etymological origin of its name and character traits from R.U.R, the robot makes its first appearance as a slave to man, or a machine capable only of production and not of intelligent behavior. Capek further articulates this notion of the robot as servant by comparing its ability to recall information and make calculations with its inability to be creatively or independently engaged. [3] Here, Capek begins to form a definition of intelligence, as involving creativity and independence, by contrasting it with the mundane processing abilities of the robot.

Today, however, the robot has grown to suggest an automated or computer controlled machine and gained a connotative meaning suggesting it is human-like or intelligent. While a robot's appearance in film and literature has become ubiquitous, its present appearance in architecture has surfaced throughout many design schools and in

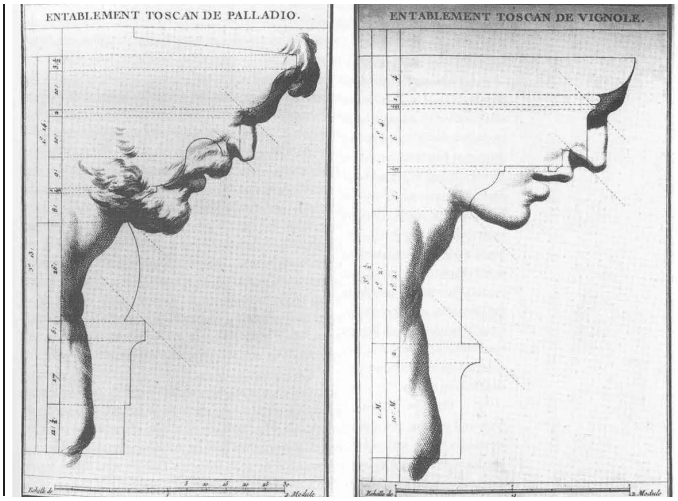

Figure 1: Face profile imposed on Palladio's Tuscan cornice

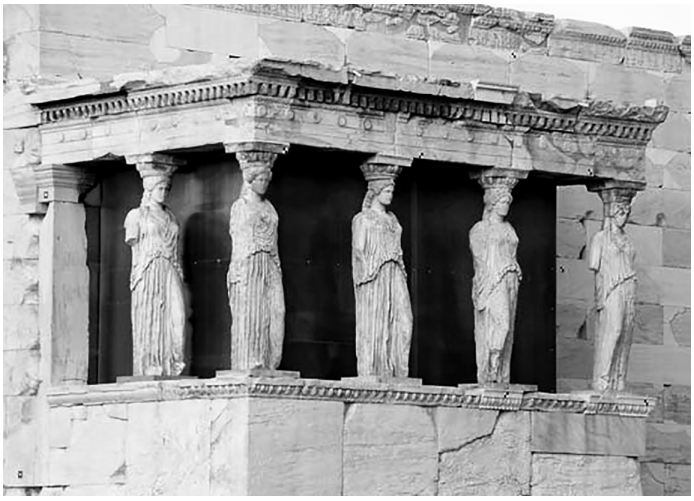

Figure 2: Caryatids at the Acropolis.

architectural research of advanced manufacturing and construction strategies. Today robots in architecture act, as their origins suggest, as servants or slaves to the automation procedures of the architect. In the 1970's Nicholas Negroponte, founder of the Architecture Machine Group, had envisioned a much different relationship between architects and intelligent machines suggesting participatory conversations with machines, who would be active collaborators in the design process.[4] Antoine Picon points out, "Robotic fabrication may confront us for the first time directly with the need to cooperate with our technological auxiliaries rather than simply use them."[5] Looking beyond material and tooling methods, Picon draws upon Negroponte's ideas and opportunistically calls for the emancipation of the robot, no longer acting as a workforce, but as a contributor to discourse of design.

SELF REPLICATION

In the collaborative method, we have sought to emancipate the machine through self-replication or by making machines more like us. Within both architecture and AI, the quest for recreation of human-like qualities lies in both building and in machine. Within the reference to human life, the architect has used the body as a reference for beauty and proportion, while the AI specialist has historically used the human mind a reference for defined intelligence. In both cases, there is a reliance on unquantifiable and subjectively evaluated criteria. However, in the attempt to systematize the ideas in each discipline, both have at some point turned to the human figure as a guideline and reference.

The quest for mechanical self-replication has a long history. Even Leonardo Da Vinci's sketchbook from 1495 shows early ideas for a full scale human-like machine.[6] Later in 1664 René Descartes first introduced the theory that the body was similar to a machine and the idea that animals are a complex aggregation of machine like systems. Drawing upon Decartes theory, the 18th century holds many attempts to mechanically automate human and animal-like qualities. Jacques de Vaucanson's mechanical duck, developed in 1739, was one of the more infamous devices. The device was capable of eating and digesting grain by containing a system which imitated an animal's digestive process using both mechanical and chemical means.[7] Later Von-Kempelen developed an automaton chess player made to look like a black bearded Turkish man, wearing robes, a turban, and smoking a pipe. The device would move chess pieces and often won games, including one over Napoleon Bonaparte in 1809.[8]

Critical moments in machine intelligence also emerge in the 19th century, such as with the development of Charles Babbage's Difference Engine and Analytical Engine, which could assist in complex calculations. The difference engine was the earliest advent to the contemporary computer. Ada Countless Lovelace published her analysis on the analytical engine and described it as having the potential to operate as a "thinking, reasoning machine."[9] Architects, Charles and Ray Eames would later produce a video documentary on the Difference Engine as part an exhibition for IBM on the origins of the computer, content from which was published in their illustrated history of the computer entitled *A Computer Perspective*.[10]

While it wasn't until 1968 that artificial intelligence laid a major claim in architecture with the work of Negroponte, as early on as ancient Greece, architects were engaging in ideas of self-replication. With the Caryatids at the Acropolis, architecture engages the body as structure, where the figure of a woman's body is literally translated to column. The notion of replicating and referencing the human body as a means for exploring form and ornamentation continually reoccurs and is referenced by Vitruvius, Albert, and Borromini. Vitruvius referenced the "well-proportioned human figure" as a model for building.[11] Francesco di Giorgio Martini furthered articulated this idea in his treatise illustrating the relationship of the proportions and profiles of cornices to the face.

Today, examples of self-replication are taken to an extreme where now the robot has a role in recreating itself. In a 2015 Popular Mechanics article, describes the production of robots capable of making other robots at University of Cambridge. The research team programed a robot to design smaller robots, where it would examine and evaluate the results in order to "design future generations which incorporate certain traits over others."[12] Interestingly, this work is not only engaging in ideas of self-replication, but also involves a design process where the robot is

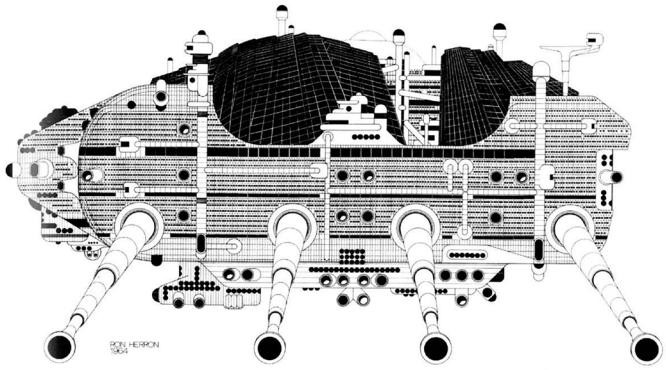

Figure 3: Ron Herron of Archigam, Walking-City 1964.

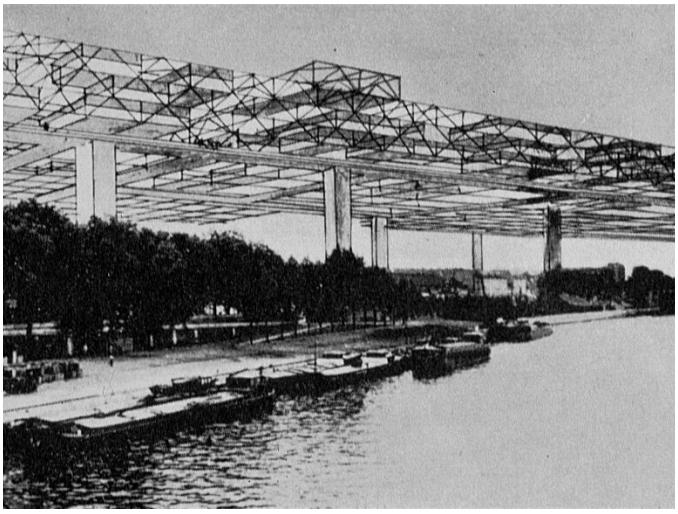

Figure 4: Yona Friedman, Ville Spatiale 1964.

being tasked to make a robot, evaluate it, and them iterate and improve the next generations.

INDETERMINATE SYSTEMS

The discourse of robot histories in architecture would be incomplete without the mention of Cedric Price and Archigram. In 1968 Cedric Price developed a proposal for the *Fun Palace*, a dynamically reconfigurable structure, based on a three dimensional rectilinear grid. Price had worked in collaboration with Gordon Pask, in order to combine ideas from cybernetics into the design of the structure.[13] The proposal could adjust to various programmatic needs and also could recommend other configurations. The Fun Palace was an early attempt to respond to the indeterminacy of human needs and behaviors through variable spatial configurations.

John McCarthy and Patrick Hayes, in their 1969 publication defined a problem with indeterminacy in AI, known as the frame problem. The problem occurs when a program uses a representation of the world as a scene and then responds to that scene in order to make decisions; however, when the scene changes it has to run through extensive data to know if the change is relevant to the situation and determine whether or not to update the scene.[14] Here the frame problem and indeterminism in architecture are both dealing with issues of how to approach issues of change. The frame problem is evaluating a change in scene and trying to determine its relevance. In Cedric Price's scenario, the architecture is able to change according to the needs of the users and suggestions of the intelligent system. In both cases they are only capable of handling a certain degree of change either by a predetermined set of conditions, which are loaded in the database or designed into the tectonic make-up the dynamic structure.

In 60's and 70's to deal with frame problem and relevance question, AI researchers limited their programs to "artificial situations" which they referred to as micro-worlds.[15] Terry Winograd was a leader in developing systems with this type of approach. He developed a micro-world project called SHRDLU which worked in an isolated scenario and "responded to commands in ordinary English instructing a virtual robot arm to move blocks displaced on a computer screen."[16] Similar to working in a vacuum, this research sought to create isolated environments where a significant number of unpredictable aspects would be ignored in order to focus on teaching the machine to move the blocks without interruption. While Winograd's program simulated the manipulation of blocks in a digital environment, architects during this time were using representational strategies to simulate opportunities for dynamic futures, as seen with the work of Archigam's *Walking-City* and Yona Friedman's *Ville Spatiale*.

In the both cases of *Ville Spatiale* and *Walking-City,* the suggestion of indeterminate systems arises through proposals for intelligent giant robots which adjust to accomodate the individual's freedom of choice or operate as a city moving across the globe. These representational proposals for city or infrastructural scale robots suggest alternative ways for appropriating intelligent robots in architecture today outside of automated efficiency in industry production. However, they also suggest similarities in approaches to AI which involved simulating environments; in both scenarios of micro-worlds and large scale indeterminate architectural system, the AI specialist and the architect are simulating environments either digitally or graphically as a means of experimentation and as a way to convey the complexity of ideas. The frame problem, micro-worlds, and giant inhabitable robot proposals represent a crucial moment in time where machines are asked to consider the environment through space and object relations. In these approaches to indeterminate scenarios, lies the larger agenda for exploring design opportunities for appropriating machines who think.

TECHNOLOGICAL PROSTHESES

While the robot signifies a machine who thinks, the cyborg is a symbol for machines who help us think through their connectedness with us. The term cyborg emerged in 1960 when scientist, Manfred Clynes and psychiatrist, Nathan Kline, coined it while working for NASA as a way to describe a machine enhanced human being who is capable of living on other planets.[17] Looking back to Capek's play, there is also a suggestion

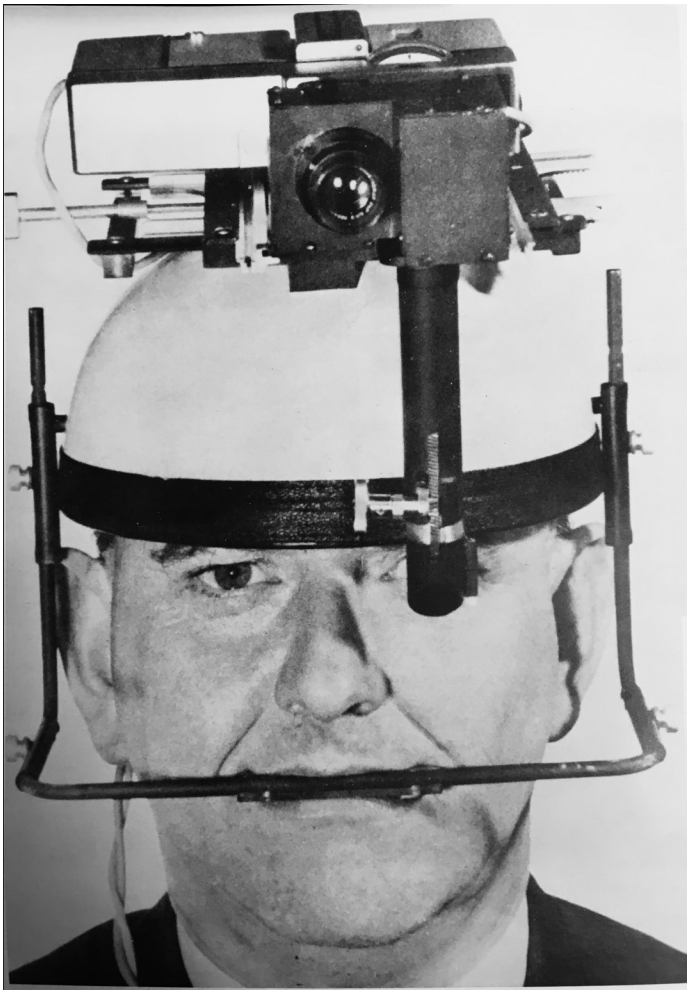

Figure 5: Head-Mounted Eye-Marker Camera, Dunlap and Associates, The Ontario Hospital, New Toronto, Canada, 1961.

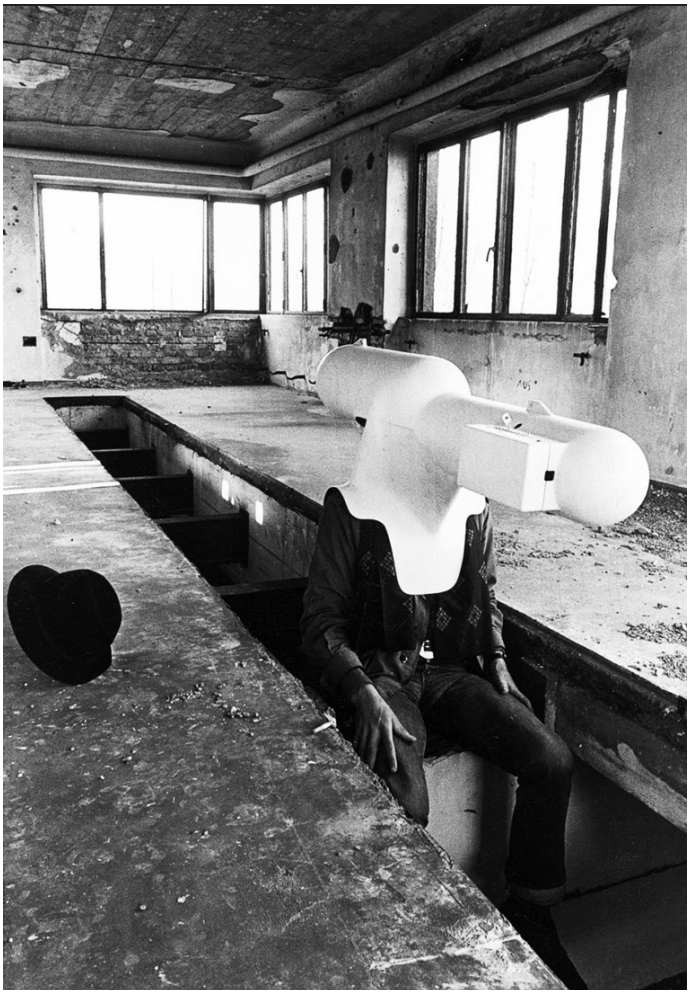

Figure 6: TV-Helmet (Portable Living Room), Walter Pichler, 1967.

of the cyborg in its theme. While viewers often interpret the play with techno-pessimism, as an ominous warning of the misappropriation of advanced machines, Capek, intended for the robot to be "a metaphor for workers dehumanized by hard monotonous work."[18] Capek was not suggesting the robot as a machine, which is an opposition to man, but articulated that man and machine are combined and represent two extremes or ends of a spectrum. Thus, RUR introduced the robot for the first time, as a single unit or sameness or an amalgamation in which there was no distinction between machines that behave like humans and humans that behave like machines.[19]

In Georges Teyssot's "The Mutant Body of Architecture", he describes, "The Greeks had only one word, organon, to designate both a corporal organ and a tool. Further the term is very closely related to the word egon, meaning 'labor.'"[20] Within this definition and terminology there is a clear relationship between body and tool not separated, but as part of the same entity. Similarly, he explains, "There is no fundamental ontological separation in our formal knowledge of machine and organism, of technical organic."[21] Within the play and Teyssot's description, the cyborg evolves from the fundamental relationship and connectedness of humans and machines.

The cyborg is a character for understanding human behavior and heightening or isolating the senses. In Norman Mackworth's 1961 *Head-Mounted Eye-Marker Camera*, the wearable camera was produced to understand the wearer's field of gaze. The camera reflects light off the eye in order to visualize the eye position. László Moholy-Nagy also used the body and light as means of experimentation in development of his project, *Vision in Motion*, which uses light sources mounted to parts of the body and photography to capture and represent movement. These devices provide a means for translating human behaviors and movements while also signifying an exploratory approach through man and machine hybrids.

In architecture the cyborg is a figure of design exploration and research. In the 1960's and 70's, avant-garde architects were investigating the role of architecture as mediator between bodies and spaces. Within such studies were the projects of Haus-Rucker-Co and Walter Pichler. Haus-Rucker-Co's project *Environmental Transformer* included a set of architectural prosthetics which explored ideas of perception and sought to enhance sensory experiences of the environment. Also, in their project, *Mind Expander*, a chair becomes a tool or device which confines two users and heightens their experience of listening and seeing each other.[22]

From Clynes's and Kline's conception of the cyborg, as a man capable of inhabiting extraterrestrial environments, the figure emerges as a technologically enhanced human capable of surviving in harsh environments. In the project *TV Helmet* by Walter Pichler, the original concept of the cyborg is further explored through the design of the prostheses, or immediately surrounding devices, which respond to harsh conditions. The *TV Helmet* was a wearable living room consisting of a television at the end of an extruded helmet with elongated ends in the front and back. In photographs of the project, Pichler depicts the wearer of the helmet "happily distracted from a barren post-industrial, seemingly post-nuclear, environment."[23] This project makes a larger commentary on potential nuclear desolation and the willingness for isolation that arises from our relationship with technology. The television in the project becomes a technological cocoon allowing the user to ignore the larger surrounding environment through isolated focus on encompassing machine extensions.

Technology today is prevalently engaged as an extension of the body. Psychologist have realized that we currently view the cell phone as an extension to the body; this is why when a someone accidently forgets their phone they feel like they have forgotten apart of themselves.[24] Teyssot further explains this idea of the technologically extended body and its impact and relevance to architecture, when he writes:

> The first task architecture ought to assume, therefore, is that of defining and imagining an environment not just for "natural" bodies but for bodies projected outside themselves, absent and ecstatic, by means of their technologically extended senses […] We must conceive tool and instrument "like a second sort of body, incorporated into and extending our corporal powers." It then becomes possible and even necessary to logically invert the terms of our proposition on the role of architecture. The incorporation of technology is not effected by "imagining" a new environment, but by reconfiguring the body itself, pushing outward to where its artificial extremities encounter "the world."[25]

Teyssot points out that the cyborg becomes a way for understanding our relationship with our environments. In order for architects to truly understand who they are designing for, they must be aware of the body's technological extensions. Similarly, for bodies to experience the world, the experience at times must filter through its technological auxiliaries. The cyborg, in this case, is a way to envision the self and understand a way of building relative to bodies and their relationship to the world.

Hurbert Dreyfus proposes a contemporary argument for the development of AI in Why Heideggerian AI Failed and How Fixing It Would Require Making It More Heideggerian. In the chapter he explains Heidegger's notion of ready-to-hand and suggests how it could solve the problem of computer sorting relevance and working with unanticipated scenarios. He explains our relationship to objects and our environments is based on "solicitation." For example, we are able to use a hammer to drive a nail by pairing the force of the body with the specificity of the tool; however, Dreyfus points out that the object has a readiness-of-hand not because of its function or the user's ability to engage it, but because of being drawn into the object by a force or allurement.[26] Similarly, he describes we enter and pass through a door with an instant response to it. He writes:

> For Heidegger, the ready-to-hand is not a fixed function, encountered in a predefined type of situation that triggers a predetermined response that either succeeds or fails. Rather, as we have begun to see and will soon see further, readiness-to-hand is experienced as a solicitation that calls forth a flexible response to the significance of the current situation—a response that is experienced as either improving one's situation or making it worse.[27]

This notion of ready-to-hand is fundamental to the ontological state of the cyborg. As Dreyfus, suggests exploration and understanding of this state might lead to the further advancement of artificially intelligent machines.

DEFINING DESIGN INTELLIGENCE

In Pamela McCorduck's book on the extensive history of artificial intelligence, she writes, "Our history is full of attempts--nutty, eerie, comical, earnest, legendary, and real -- to make artificial intelligences, to reproduce what is the essential us, bypassing the ordinary means. Back and forth between myth and reality, our imaginations supplying what our workshops couldn't, we have engaged for a long time in this odd form of self-reproduction."[28] As evident from the examples of architecture's relationship to the robot and cyborg, there is also a play between myth and reality, the qualitative and the quantitative, the immeasurable and the scientific. However, as McCorduck suggests the quest for remaking intelligence requires us to ask what is essential. Herein lies a specific cross disciplinary intersection between AI and architecture relative to philosophical overlaps. Because we inevitably think and we inevitably inhabit space, professionals in both disciplines are tasked with making sense of the essential conditions of the human consciousness, which involves an understanding of oneself and one's surroundings. Both architecture and artificial intelligence ask, what is essential for us, for our communities, and for our survival and both disciplines must respond through design and creative making.

As Dreyfus points out, a solution to problems in AI require us to develop a more Heideggerian approach. Progressing an artificial intelligence agenda in architecture requires one as well. Both architecture and AI rely on an understanding of our "being-in-the-world" and thus permit a more seamless relationship between our bodies and our environments. As Heidegger suggests in his essay "A Question Concerning Technology," in order for us to have a better relationship with technology we must get back its true essence, which he calls techné. He writes, "[Techné] is the name not only for the activities and skills of the craftsman but also for the arts of the mind and the fine arts. Techné belongs to the bringing-forth, to poiesis; it is something poetic […] It reveals whatever does not bring itself forth and does not yet lie here before us."[29] Perhaps through this notion of techné and poeisis, technology could help us question the status quo, reveal something to us about the world, or even address needs we never even knew we had. Through the suggestion of a collective non-human form of intelligence we can ask, what might the machine have to offer that we haven't considered or weren't even capable of considering? How might machines actively collaborate in the design process? How might our relationship with technology enhance our creative capacities? The quest for such artificial design

intelligence requires us to define what is essential for design thinking and what is essential for making a valuable contribution to our field. Within such definitions lie the potential for both human and non-human advancements in intelligent design.

ENDNOTES

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