The Ergonomic Frame: Humans, Nonhumans, and their Spatial Ontologies

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Any notion or definition of architecture is preceded by an understanding of ourselves as the predominant spatial referent. The human antecedent from its physiological composition to its cognitive capacities is already embedded in any process of creation, structure of experience, or body of knowledge we engage. From the virtualization of proportion to the actualized qualities of material bodies, human definitions form a foundation for architectural history. It is a history of spatial assemblies between humans and nonhumans, the relationships between them, and the processes that form them. And yet, with the current decentering of humanity as the sole subjective lens through which spatial organizations and material constructions find relevance and define value, what is meant when we say "human" and its a priori status in designing the built environment is called into question.

Ergonomics and Human Factors (E/HF), which emerged as titular terms through regional and lexiconical preferences, refer to the same overarching body of research, set of practices and modes of application.1 Both emerged as organized disciplines in the 1950s based in large part to post-WWII investigations into issues of safety and performance between humans and mechanical systems carried out simultaneously in the US, Russia and throughout Europe.2 Despite current connotations among design professionals and the general public that ergonomics and human factors is concerned with the fitness of objects to bodies, neither term nor their subsequent codification into research objectives, practices and industries are limited to or defined by this narrow reading. More appropriate would be an understanding of both terms as "primarily concerned with how human beings interact with technological systems in all their various forms".3 This turn in definition, away from objects and toward systems/relations, allows E/HF to escape the artifice of industrial practice and fully embrace the relational aspects of the anthropo-technological assemblages and the human and non-human actants that comprise them.⁴

This paper examines six frames through which architectural discourse is able to appropriate ergonomics to analyze its own statements on humans, nonhumans, and their spatial ontologies: the Mereological, the Bio-Mechanical, the Ecological, the Computational, the Sensorial, and the Epiphyolgenic.Through an analysis of spatial artefacts and cultural practices both impacting and impacted by design, each frame is explored through its preeminent status in design thinking and discourse. It will be argued that this analysis reveals both evolutionary and incongruent approaches to building spatial ontologies within architectural and extra-architectural practices.

HUMANS & NONHUMANS

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Figure 01: Anthopometric devices designed to measure and record specific body regions.

And yet, with the decentering of humanity as the sole subjective lens through which spatial organizations and material constructions find relevance and define value, what is meant when we say "human" and its a priori status in designing the built environment is called into question. Whether by global environmental issues of climate and ecology, the increased technological entanglements of the human condition, or the epiphyologenic nature of biological and cultural bodies, spatial practices are finding the stability of humanness eroding. Or, perhaps more precisely, the relationship between humans and nonhumans are becoming increasingly salient concerns for designers.

Within the historical discourse on the human-nonhuman there lies a question of the malleability of the structure and composition of *humanity*, as Michel Foucault writes,

"The critical ontology of ourselves has to be considered not, certainly, as a theory, a doctrine, nor even as a permanent body of knowledge that is accumulating; it has to be conceived as an attitude, an ethos, a philosophical life in which the critique of what we are, is at one and the same time the historical analysis of the limits that are imposed on us and an experiment with the possibility of going beyond them"⁵

It is within this question of ontology that the moderns first explored a philosophy of technology and the relation of technology specifically and nonhumans generally, to humans. This is most apparent in Martin Heidegger's analysis of tools in *Being and Time*, which spawned a wide range of responses the most current of which, Object Oriented Ontologies, seeks to do away with human contingency. But here my focus is not on the ontology of humans, or even nonhumans, rather it is on the multiple ontologies that form our understanding and utilization of space as it relates to humannonhuman relationship might be framed. Annemarie Mol whose work examines the relationships between disease and the body notes that, "In practice the body and its diseases are more than one." The body is when viewed from the point of view of medical practice a "body multiple".⁶ Echoing Foucault's assessment of the continually unfolding and constructed ontologies of the body, Mol's premise begins with the assertion that an individual contains or inversely, can be re-made within more than one ontology. And, that these ontologies are both generated and revealed through practices.

The bodies seen by the human eye is a different one than bodies "seen" by MRI machines, pyrometers, hemodynamic sensors, or even the human hands of others. These multiple bodies are accessed through artefactual, behavioral and spatial technologies. Which in turn produce ways of capturing, knowing, and reconstructing a body through the conditions of practice, or to adopt Maurice Merleau-Ponty's phenomenologist refrain, they produce the "fields" through which distinct and defined bodies may emerge.⁷

While this would point to the agency of instrumentation even as it refers to aspects of our own bodies, it is the broader notion of technology, beyond devices, that collude in the formation of "persons" that is of interest here.⁸ Specifically, the ways in which spatial and spatialized technologies, which includes architecture but also other constructed environments, are given entry into the discourse on human - nonhuman relationships, and why there are a multitude of ontologies to be explored upon entry. In other words, and to invert the foundational statement of Graham Harmon's Object Oriented Ontologies project, humans are not exhausted by technologies.⁹

ERGONOMICS

But, what is the nature of these relationships and how do they find quarter in architectural discourse? To answer that I would like to



Figure 02: Alignment exercises between digital body scans and TIN mannequins

shift the question or architectural inquiry toward the ways in which anthropo-technological assemblages - constellations of humans and nonhumans operating within specific relationships - define spatial ontologies through practices. This certainly draws on a number of prominent text in the philosophy of technology including Heidegger's analysis of tools, Bruno Latour's concept of "actants" within his Actor Network Theory and Don Ihde's formulation of our technologically mediated experience, the latter of which we will return to. But, for the purposes of this paper it will suffice to say that anthropo-technological assemblies are the purveyors of practices and by extension propagate a multitude of ontologies.

Here is where ergonomics fits into the discussion of human, nonhumans, and their ontological relationships. It would be worth noting an abandonment of two predominate assumptions surrounding the term ergonomics. The first assumption is that artefacts, or more broadly, objects are the only focus of design inquiry. The second assumption is that ergonomics, as a mode of design inquiry, has a single directionality. That is to say, non-humans are directed to fit human metrics, and not the other way around. Or, to extend this line of thinking, that both directions are in play simultaneously, that both are interdependent and contingent, or finally and perhaps most importantly, that directionality is even possible.

Ergonomics from its inception seeks to deal with the relations between humans and nonhumans, the measure of which could be general stated as fitness as it pertains to some intention. This means that in both theoretical and practical terms both humans and nonhumans are sites for design inquiry and intervention. Wellness, within this formulation would be a type and degree of fitness - a measure of an anthropo-technological assemblage's relationships, and as such, open to the incorporation of nonhumans, including spaces, into its overall framework. The term "ergonomics" itself was coined by Wojciech Jastrzebowski in his 1857 article "Rys ergonomji czyli nauki o pracy, opartej na prawdach poczerpniętych z Nauki Przyrody", translated as "The Outline of Ergonomics; i.e. Science of Work, Based on the Truths Taken from the Natural Sciences". Jastrzebowski identifies a number of components that equally define ergonomics. These include philosophy, design, technologies and practices.¹⁰ For Jastrzebowski, the concept of work, or activity of production, was one that could only be conceived of through multiple authors which work in concert and are interdependent.

In "About the Hospital" from 460 - 370 BC the following section, often cited among ergonomists as the earliest record of this concept, Hippocrates give equal weight to both humans and nonhumans as components in the establishment of good practices:

"... the following is required: patient, surgeon, assistants, tools, and lighting; the surgeon must attend to all of the above, as regards their positioning, their use and their number; he should also attend to the patient's position and the surgical instruments; finally, attention should be paid to the time, the method and the place."

Hippocrates speaks of the surgeon, their instruments, the subject of the procedure, and the space of activity. This falls in line with an expansive and more historically consistent view of ergonomics. A view that enjoyed adoption across many disciplines prior to its establishment as a discrete, silo-ed and increasingly compressed course of study in post-world war II Europe and the US.¹¹

Despite the contemporary, mainly commercial and industrial focus on the physical correspondence between normative bodies and designed objects, ergonomics is a question of relationships and the fitness of all the constituent components of that relationship regardless of ontological status. That is to say that ergonomics asks; how are human-nonhuman relationships within an intentional anthropo-technological assembly examined, strategized, designed and evaluated; and, what is the fitness of this relationship when



Figure 03: Student Spatial Devices, modeled by group memebers.

measured through practices? To co-opt Latour's concept of actants, (or perhaps the other way around) all humans and nonhumans in so much as they are actors within an intentional relationship are within the purview of ergonomics. This turn in definition, away from objects and toward the relational aspects of anthropo-technological assemblages opens ergonomics as a frame for spatial design inquiry. An ergonomic frame then includes all of "technics" which Don Ihde philosopher of technology, defines as "the symbiosis of artifact and user within a human action".¹²

FRAMES

"it is less epistemologically, politically, and emotionally powerful to see that that there are startling hybrids of the human and nonhuman in technoscience... than to ask for whom and how these hybrids work" - Donna Haraway¹³

For Ihde, it is within this "symbiosis" that human-nonhuman technological relationships lie. He proposes four modes of technologically mediated relationships humans have with the world: *Embodied*, *Hermeneutic*, *Alterior*, and *Background*. These relationships create other accessibilities to the world through technologies¹⁴. In each case technologies are positioned between our innate abilities to experience, and the world to be experienced. The distinction between the four mediations frames the relationship between human and nonhuman, and creates new world ontologically.

Peter-Paul Verbeek writing on Idhe's post-phenomenological approach to the philosophy of technologies sees and intrinsic gradient or "continuum" between the embodied, hermeneutic, and alterior modes of technological mediation.¹⁵ The gradient marks levels of technological entanglement in which a technological assemblage becomes ever more entrenched through practices. Verbeek leaves background relations on the outside, both figuratively, (it is incompatible with the previous three in that it's presence recedes into the conditions of experience rather than an active participant in them), and literally, (in that background relations do not operate within the interior of the assemblage itself, but within the world). However, background relations may in fact allude to ways in which architecture has historically been characterized in discourses on technology and the arts.¹⁶

These four types of human-nonhuman relationships are where the course Post-Human Factors begins. Post-Human Factors is a cross disciplinary course taught in the Interior Architecture / Adaptive Reuse program within the division of Architecture and Design at the Rhode Island School of Design. This seminar examines the changing definitions of "human" and "nonhuman" in the manifestation of Anthropo-technological conditions through artefactual, techno-factual, and spatio-factual production. Though our primary interest focused on the implications on architectural design, our exploration comes at more traditionally ergonomic spatial scales. The goal is to position spatial design within the discourse on human/nonhuman relations; and philosophies of technology by engaging practices. As such the course operates within two domains of inquiry: Theoria (Theories) and Praxis (Practices). We explore these two domains simultaneously through a discussion of critical texts and the application of ergonomics practices in course assignments with the intent that theory opens up possibilities for practice, and practices produces new territory for theory.

Using Ihde's four typologies of technological mediation as the bases of a design approach we work backward through design practice to examine six spatial ontologies rooted in anthropo-technological assemblages. Through an analysis of spatial artifacts and the cultural practices both impacting and reflexively impacted by design, each frame is explored through its preeminent status in practice and discourse. These are loosely defined as:

THE MEREOLOGICAL

The Mereological frames the part to whole relationships as they define humans and nonhumans within spatial relationships.







Figure 04: Spatial behavior mapping.

THE BIO-MECHANICAL:

The Bio-mechanical frames the formal and structural relationships between physiological, and kinesthetic qualities, and the ways in which these impact the formation and understanding of spatial relationships.

THE ECOLOGICAL:

The Ecological frames the systems/environmental relationships between humans and nonhumans, specifically as it relates to constructing, intervening in, and sustaining these as spatial relationships.

THE COMPUTATIONAL:

The Computational frames the relationship between humans and nonhumans as collaborative entities of thought, formulation, and calculation in the formation of spatial relationships.

THE SENSORIAL:

The Sensorial frames the spatial extension of the physical and phenomenological body through spatio-technological relationships

THE EPIPHYOLGENIC

The Epiphylogenical frames the co-evolutionary nature of humans and spatial technologies and their inverse as spatial relationships.

The six frames, as much as they can be thought of as different human-nonhuman ontologies, are only so in practice. Meaning that not only are these terms and the systems they represent provisional, but that they are in flux, they overlapping and they fold into one another. They act as the title suggests, frames through which questions of human-nonhuman relationships manifest in space. They provide a way of deconstructing the built environment, and gravity to a design endeavor. This is most evident when they are used to choreograph course work. In the course design projects, which operate within Ihde's four fold techno-mediation, students are asked to engage in one of the six ergonomic frames, to contextualize the application of ergonomic practices to complete a series of design problems. These projects bridge the more conceptual discussions of the class with the practical and pedagogical formation of "spatial ergonomics"

Students begin by recording the physical limits of areas of their own bodies. This information has been gather in a number of ways including the design and construction of their own measuring devices, and the modification of existing analogue and digital devices, software, and datum. (fig. 01) This information is used to create a virtual or percentile model that represents a mean extensive body based on the class. Again this has been done in different ways, most recently by 3D scanning students and overlaying that information on to a readymade Triangulated Irregular Network model, and modifying it.(fig. 02) Students are then tasked with creating a wearable apparatuses that disrupts or modifies their understanding, perception, or use of space. These are built, tested, and modified in an iterative and partially automated manufacturing process.(fig. 03) Disruptions and modifications are recorded and mapped to communicate how these nonhuman components become embodied and spatialized. (fig. 04) Finally, students are asked to generate versions of their devices which can be worn by a certain percentage of the class. These too are manufactured and distributed for testing. (fig. 05)

The entire course lasts six intensive weeks. The process leverages many commercial software and hardware systems used in medical, industrial design, and architecture disciplines. The course itself welcomes designers and non-designers alike, with most work done in teams. The challenge in this course is combining the theoretical and practical modes of exploration, which traditional occupy separate courses in any design curricula. This difficulty has been tempered by creation of the six provisional frames which are continually reformed each year this course is taught, allowing students to be part of the conversation on how design thinking and design production are bridged through practices.

ENDNOTES

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- 2. Meister, David. *The History of Human Factors and Ergonomics*. (Mahwah, NJ: Lawrence Erlbaum Associates, 1999)
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- Foucault, Michel. "What is Enlightenment" in *The Foucault Reader*. ed. P. (Rabinow. New York Pantheon. 1984), 50
- 6. Mol, Annemarie. *The Body Multiple: Ontology in Medical Practice* (Durham & London: Duke University Press, 2002.) viii
- 7. Merleau-Ponty, Maurice. *Phenomenology of perception*. Trans. Colin Smith (London and New York: Routledge 1962). passim
- Wolfe, Cary. What is Post Humanism? (Minneapolis & London University of Minneapolis Press, 2010) 60 – 61.

Cary Wolfe discusses the "ungrounding" of what we mean when we speak of persons as strain of post-humanist discourse that examines the ontological position of other species, or biomedically modified humans. The line between person-ness and non-person-ness is one that may shift through various social, ethical, moral, and scientific frames of practice.

9. Harman, Graham (2002). *Tool-Being: Heidegger and the Metaphysics of Objects*. Peru, IL: p. 1

My reading of Graham Harman's development of Object Oriented Ontology (OOO) proposes that (among many other things) the ontology of objects is only partially accessible to humans - Objects are withdrawn from us in that an object's totality is not "exhausted" by human perception.

 Jastrzebowski, Wojciech. "Rys ergonomji czyli nauki o pracy, opartej na prawdach poczerpniętych z Nauki Przyrody" in Przyroda i Przemysł. (Warsaw 1857)

The Polish natural scientists and polymath Wojciech Jastrzębowski coined the term "Ergonomics", a combination of the Greek words ergon (work) and nomos (principle or law). Jastrzebowski translated "ergonomics" as "the Science of Work" in his article in "Przyroda i Przemysł (Nature and Industry)"

- For more on the history of Ergonomics and Human Factors see: Hancock, P.a. "Human Factors/Ergonomics." 358-63 (2012). &, Meister, David. The History of Human Factors and Ergonomics. (1999)
- 12. Ihde, Don. Technology and the Lifeworld: From Garden to Earth (Bloomington & Indianapolis: Indiana University Press, 1990) 73
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- See Walter Benjamin's critic of architecture and technology in: Benjamin, Walter. "The Work of Art in the Age of Mechanical Reproduction". in *Illumination*. Ed. H. Arendt (Cape 1970) 219-226.



Figure 05: Final spatio-technical device