Enacting Cybernetics

# Composing Systems for Advancing Advancing

INSIGHTS

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CYBERNETICS SOCIETY


## ABSTRACT

This paper was developed from the Ranulph Glanville Memorial Lecture given during the conference of the International Society for Systems Sciences, July 7–11, 2022. It includes information related to neosentience research, and the Insight Engine 2.0 which is more contemporary in nature (August 17, 2024). Glanville in his many papers and presentations explored a series of systematic cybernetic methods. He employed these as a means to advance a set of approaches to design, various forms of creative production, his pedagogy, and sometimes to approach highly complex problem sets that were more didactic in nature, relating to aspects of cybernetics and second-order cybernetics. A series of these methods will be discussed. Additionally, Seaman's methods explored in a project related to developing a new form of AI will be outlined. Both Glanville's and Seaman's approaches, influenced in part by Glanville, seek to explore "advancing advancing."



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The work presented in this article begins with a specific set of ideas and concepts that were central to Glanville. Advancing knowledge production through differing forms of conversation was highly important to Glanville. This includes an approach to holism and ethics that Glanville articulated and undertook. Central to Glanville's late theory and practice was the shift from using the term "observer" to the perhaps more poetic term "composer." My text points to an interest in transdisciplinarity in the pursuit of composing systems for advancing advancing. One of Glanville's contrarian creative research methods took him outside of the normal definition of control, extending early cybernetics definitions. Among other things, the ideas included here initially outline a central set of processes distilled from Glanville's theory and practice, as well as Glanville's perspective on reciprocality as it relates to interaction. The value of these methodologies is that they can potentially be used to advance a systematic set of approaches to highly complex problem sets.

The second section of this paper unpacks neosentience, a new form of AI based on the actual functionality of the body. I lay out a pragmatic list of benchmarks for neosentient articulation as defined initially by Seaman and Rössler (2011, p. 26). Defining a model for neosentience production exemplifies an extremely complex problem set. In particular, I point to the future potentials of advancing advancing through biomimetics and bio-abstraction. I discuss the importance of John von Neumann's notion of the psycho-physical parallelism. I bring to light a novel approach to defining intelligence that Glanville articulated.

The third section of this paper explores Insight Engine 2.0, a dynamic search engine and database linked via a game engine to empower a number of different expanded forms of "conversation" within a constructed database/visualization environment. I discuss this system and salient aspects of its functionality. This includes research areas that will populate the relational database, and novel visualization interfaces and computational platforms (rethinking the use of game engines), as well as long-term goals of the system in particular in relation to new forms of AI—large language models. This section of the paper discusses new potentials of current forms of artificial intelligence working in the service of defining a set of approaches to neosentience research. I discuss a generative approach to informatics that is empowered by the Insight Engine 2.0, which I call recombinant informatics. I discuss the importance of defining entailment structures relevant to the human body, sentience, and sapience production as related to goals of the Insight Engine 2.0.

In the last section of this document, I point out that the entire paper presents a multi-perspective approach to composing systems, specifically addressing an ecology of concepts and methods relevant to cybernetics and systems science. This paper points, in part, to the creation and interfacing of networks of differing generative systems for the advancement of knowledge production. Can one "compose" a set of creative approaches to intelligent generative systems? Is it possible to explore meta-meaning systems, systems that that enable one to address introspection in a mindful manner, such that it points to human intelligence working in concert with AI, to advance the fields of both human and artificial intelligence? One long-term goal is the creation of an even higher-order intelligent system of systems, a model for neosentience. Central are the following questions: Can this initial Insight Engine generative system become relevant for each differing interactant through use? Can this system enable sets of different varieties of conversation both human and machine-related, to contribute to growth and change by continually learning from its interactants?

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# RANULPH GLANVILLE

Ranulph Glanville was a mentor for me for many years when I was doing my PhD with artist and cybernetician Roy Ascott at the Centre for Advanced Inquiry in Interactive Art, University of Wales. I came to know Glanville quite well later in his life, as the President of the American Society for Cybernetics, as a colleague and a friend. Through conversation, publications, works of art, design, music, modes of teaching, and, in particular, his manner of addressing problem solving and creativity, Glanville helped generate a cybernetic way of coming to understand and compose the world.

Glanville was among other things a contrarian. Ted Krueger (2022) provided an interesting text for *The Architecture of Ideas: The Life and Work of Ranulph Glanville, Cybernetician*, entitled "On the Contrary." In it, Krueger (2022) stated:

> A contrarian asserts undecidability as a distinct position rather than as something that is able to, hopefully someday, be decided with additional information, better arguments, or larger explosives. It also keeps open the possibility that there are other, potentially viable propositions not contained within the opposition that might be, or become, available. (pp. 190–191)

In *The Architecture of Ideas*, I point to how Glanville decided late in his life to change his use of the term observer, to the poetic term composer (Seaman, 2022, p. 223; Glanville, 2015). Humans are the composers of thoughts that similarly lead to a constructivist composition of the world (von Glasersfeld, 1991). Composing arises in part as a folding together of lived experience, introspection, interaction with others, intellectual framing, our participation in a large and diverse language community that we experience in many forms, and now also through interacting with computational systems and large language models. Glanville also expressed this point more formally in a late text about parts and wholes, his last contribution to his long series of columns in the *Cybernetics and Human Knowing* journal, entitled *A (Cybernetic) Musing: Wholes and Parts, Chapter 1*:

1. parts are themselves wholes, to be treated as such;
2. their "part-ness" comes from what in second order cybernetics has been for more than 40 years called "observing by an observer," but which I shall, in the course of the column, reword as "composing by a composer." Wholes are composed into the roles of parts in relation to other wholes. (Glanville, 2015, pp. 81–92)

In Glanville's own footnote to this quote, he wrote: "In changing observe to compose, I hope to move away from what some see as the quasi-objectiveness associated with observing" (Glanville, 2015, footnote 2, p. 81). Along with constructivist positionings, this statement points to how creativity might become enfolded with other concepts more central to cybernetics: feedback, the black box, variety, the study of circular causal systems, and so forth.

Glanville sought to empower advances in cybernetics, and relatedly to other fields like the system sciences, as well as the arts and design, functioning as one of the creators and designers of second-order cybernetics. He sought to define advances in approaches to design by articulating a cybernetic set of systematic concepts and ways of *Living in Cybernetic Circles* (Glanville, 2014)—researching and knowing the world through creative cybernetic design practices.

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My research agenda related to neosentience, a new embodied form of AI (which I discuss later in this text), is in part arising out of a rich set of cybernetic and second-order cybernetic histories, which were in part informed by Glanville's ideas, and those of other cyberneticians like Norbert Wiener, Gordon Pask, Heinz von Foerster, Ross Ashby, Margaret Mead, Bernard Scott, and Gregory Bateson, among others. I have also been particularly interested in the Biological Computer Laboratory (BCL) and its very important early research agendas (Müller & Müller, 2007; Seaman, 2018). The BCL was headed by Heinz von Foerster, one of the examiners for Glanville's first PhD.

My text entitled "Composing Composing" from *The Architecture of Ideas* (Seaman, 2022, pp. 221–281) is a focused conversation with some of the salient artifacts of thought that Glanville has provided. It is derived in part from a close reading of *The Black B∞x*, a three-volume series of Glanville's texts (Glanville, 2009, 2012, 2014), and other of his conversations and writings. Volume 3 of *The Black B∞x* (Glanville, 2009) brought together many of the columns Glanville authored for the journal *Cybernetics and Human Knowing*. "Composing Composing" contains succinct definitions provided by Glanville to converse with, drawn from the wonder and inspiration of The Black B∞x, and Volume 3 in particular.

It must be noted that in observing the definition of design through the lens of Glanville's ideas related to composing, as discussed in his writings and through his ongoing thought and conversation, he suggests that one composes everything via thought, including the practice of design. On one important level, this also includes the practice of designing science and other areas of knowledge production. Conversation with the self and others, as well as computational systems and embodied material practices, are central to this process of composing. Interestingly, in this way, design functions as part of an active procedural methodology central to the scientific method. One goes through a second-order cybernetic process with the self related to a set of conversations of differing circular causal forms. This kind of process is used to design experiments, and perhaps helps researchers to develop new ways to systematically approach new forms of knowledge production. In part, this can be explored though the design and authorship of new computational systems as I am seeking to do with the Insight Engine 2.0 as discussed later in this text.

After a very long conversation in *The Architecture of Ideas* book about his practice, where Glanville's multi-perspective approach to knowledge production is unpacked, I came to call this set of foci the architecture of ideas—hence the title of the book. Although Glanville didn't himself like certain kinds of lists, he pointed to the fact that Pask did like them (personal communication, August 1, 2014). In the book, he stated "What I don't like is lists that are constructed as arguments" (Seaman, 2022, p. 81). I have included my own special list related to the breadth of Glanville's work in Appendix 1 (reproduced from Seaman, 2022, p. 277). This list was an extended form of punning on the term "architecture". It is a list that points to a series of different preoccupations that we would circle back to in the discussion of Glanville's rich trajectory of theory and practice.

At this point, I point to the title of this paper (repetition intended). Glanville, von Foerster, and other cyberneticists enjoyed playful language use in their titles. "Composing systems" and "advancing advancing", used in my title, play with Glanville's notion of composing—having a kind of doubling in the title. *Composing* systems points to his replacement of the word "compose" with "observing", which takes on a different meaning when the emphasis is shifted to composing *systems*

(or creating systems) for advancing advancing. This doubling in the term "advancing advancing" in my title is associated with a title like *Understanding Understanding*, von Foerster's (2003) collection of papers, a linguistic embodiment of the circular causality inherent to second-order cybernetics. It is also about the potential of exploring different branches of designing in the service of meaning production.

Glanville (2009) elucidated his favorite set of definitions related to design, drawing from Vitruvius:

- Design, according to Vitruvius, deals with three qualities: firmitas, utilitas, and venustas.
- Conversation is essentially constructivist: each participant constructs his/her own meaning and value (therefore, each is responsible for this).
- Design is a conversation held primarily with the self (but also others): self conversation emphasizes the significance of listening/being receptive.
- Designers develop and amplify ideas, make the new from differences in meanings—when difference in expression is welcomed, not hidden.
- The process of design is circular, iterative, unknowing (including rejecting and restarting), constructive: explanations are post-rationalized.
- The new is beyond prediction.

  Implicit in conversation (and thus design) are many ethical qualities we think of as deeply human and desirable. (p. 435)

This passage also points to the emergent nature of design as it participates in seeking to be part of a holistic approach to knowing.

As discussed above, among other processes, if researchers and individuals take on extended roles for conversation, it can take many forms that bring advances to knowledge production. This includes many different forms of conversation, some perhaps inspired by Glanville's work with Gordon Pask, known for conversation theory (Pask, 1975a, 1975b) as well as work in interactive arts, new approaches to architecture, research through electrochemical experiments (Carianni, 1993) (embodied conversation), and the development of new forms of computational systems (Glanville & Müller, 2007). Yet, I would suggest how Glanville put these approaches to conversation into practice became his own, and were entirely Glanvillian.

## MODES OF CONVERSATION

Glanville was known to shift conferences toward conversation, discussion, and learning, as opposed to just listening to paper presentations. His concept of conversation might take a number of modes, embodying second-order cybernetic circular causal forms and including physical conversations with conceptual material as well as material processes, such as sharing and discussing an experiment; thinking through a process, like exploring ideas iteratively via pencil and paper; conversation with the self (possibly in combination with a physical iterative processes); conversations with others both organized and unorganized; and conversations with the constructed artifacts of others, such as Glanville's constructed conversation with Pask addressing aspects of Pask's (1961) book *An Approach to Cybernetics* (Glanville & Müller, 2007, pp. 13–27). In a sense, my conversation with Glanville in "Composing Composing" is a related approach to conversations after the fact. Many of the

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quotes I have chosen for "Composing Composing" came from Glanville's writings and in particular from *Cybernetics and Human Knowing* articles. One can also have a conversation with interactive systems: relational databases, elements of AI, search engines in general, interactive artworks such as Recombinant Poetics (Seaman, 1999b, 2010; Seaman & Rössler, 2011), blogs, and listservs, etc. All of these forms of conversation can contribute to advancing advancing. I will loop back later in the article to my Insight Engine 2.0 project (Seaman, 2022a, 2022b), a self-organizing relational database and visualization system that explores a multi-perspective approach to potential insight and knowledge production (Seaman, 2014), incorporating new forms of AI functioning as collaborators along with a set of potential international individuals and human collaborators. This system of systems is still a work in progress.

## CONVERSATIONS—WHAT IS THE QUESTION? WHAT IS A QUESTION? AND WHAT IS A CONTEXT?

In the famous text *Man-Computer Symbiosis*, J. C. R. Licklider (1960) states:

> Poincaré anticipated the frustration of an important group of would-be computer users when he said, "The question is not, 'What is the answer?' The question is, 'What is the question?'" One of the main aims of man-computer symbiosis is to bring the computing machine effectively into the formulative parts of technical problems. (p. 5)

Here human thought and intuition can potentially find new relationalities between disparate areas of research via new computational potentials working toward the creation of higher-order systems. It has been many years since the Licklider text. Huge technological potentials have opened up, especially in terms of intelligent natural language systems, analysis and focused creation across multiple disciplines, and the development of scientific experiments brought about through AI exploration. Researchers and system designers can also project future potentials. Perhaps we can create a computational system that deeply understands embodied notions of context and might also be introspective about that context. There is perhaps much to work on in relation to this conversational question, where the computational system is in conversation with itself.

In *Philosophical Investigations*, Wittgenstein (1958, para. 24) asked a very special pithy question—What is a question? Notice above that Licklider asks what is *the* question? Also, in this book, Wittgenstein (1958, para. 43) discussed "the meaning of a word is its use in the language." Here, I ask a different but related question: What is a context? There is something very special about the human ability to quickly and effectively discern context as well as observe contexts from a meta-level of introspection. Here contexts define the use and meaning in terms of differing forms of language, as well as through human interaction with the environment and each other—through both embodied and textual means.

Sometimes this difference in terms of learning through embodied interaction with environments is not fully appreciated given the success of textually derived AI systems comprised of large language models. Yet there are now many people interested in exploring the enacted, embodied, embedded, extended paradigm as a means for understanding aspects of cognition (Ward & Stapleton, 2012). Glanville was interested in how conversations and language communities help to articulate notions of shared meaning, albeit unique for each individual. People should become more aware of the fact, if they haven't already, that humans are embodied beings that in

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part use senses to build up accretive contextual knowledge over time. Knowledge is never fixed but enfolds new knowledge in an ongoing manner. Texts are of course a large part of learning, but what does this say about AIs that learn from text only? How does a computer's sense of context differ from that of the human, which in part understands via an embodied, multi-sensed interaction with the world? Alternately, what happens to context when a human programs a computer? Do they still draw on embodied historical learning? I would say yes. What happens when a computer programs a computer? Do computational systems have a very different sense of context or no meta-level (introspective cognition of context) understanding at all? To what degree does human knowledge production draw on embodied interactions that enfold multi-modal sense understandings of the world with textual understandings (Pfeifer & Bongard, 2007)? One of my goals for neosentience production is to develop new intelligent systems that draw on an embodied sense of understanding context through sensing systems that are mixed with language-based AI—large language models. There are some new examples of AI that include elements of multimodal sensing (Mollick, 2023).

Glanville was interested in how mindsets help to determine ongoing understandings of context production. He wanted to point to how this difference might be better articulated in terms of new conversational contexts. Glanville (2012) states:

> My work might be thought of as a generalisation of the work of the others. My major initial concern was to develop a set of concepts that might explain how, while we all observe and know differently, we behave as if we were observing the same "thing". What structure might support this?... My contribution was a structure developed to accommodate observation and difference. This was achieved by arguing mutualism, here glossed as "the reciprocal arrangement by which what may be of one may be of the other". When drawing a distinction that which can be assumed for one side must in principle at least be possible for the other. This I have called the "Principle of Mutual Reciprocity". (p. 192)

I will return to this concept in terms of the definition of intelligence, later in this document.

## VARIETY

Along with conversation, Glanville was very interested in increasing variety. He was enamored of the writings of Ross Ashby on this subject and explored the increasing of variety as one approach to enhancing creativity in a general sense. In "A (Cybernetic) Musing: Variety and Creativity," Glanville (2009) states:

> I argue for the benefits of sharing and co-operation in design (common practice) as a way of increasing available variety, and for us to learn to use computers not so that we control them as tools that carry out our will, but so that they both facilitate sharing and are used to generate surprise, thus also increasing the variety available to the designer.
>
> Behind this a more important concept lurks. It has to do with how we treat an imbalance in variety, when we find that we have less than the system we are interacting with and which we have, traditionally, handled by closing down the variety of the system to be regulated, so that we can control it. (p. 145)

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In particular, Glanville was interested in expanding ideas of design in relation to cybernetics and expanding cybernetics in relation to ideas of design. Interestingly, part of Glanville's contrarian modus operandi explored the temporary loss of control as a way of increasing variety. This was unlike the historical positioning of cybernetics in terms of "steersmanship" as articulated in Nobert Wiener's (1948/1961) seminal book *Cybernetics: Or, Control and Communication in the Animal and the Machine*. Glanville (2009) states:

> Normally, cybernetics is interested in systems which conform to its one universally accepted law, Ashby's law of requisite variety, thus being manageable. In contrast, I propose we should develop an interest in the unmanageable: a form of anti-cybernetics. (p. 434)

This concept, exploring unmanageability, can become actuated in different contexts. The "unmanageability" that Glanville points at is normally encountered in certain stages of learning and growth processes, especially learning that takes people outside of their comfort zone of knowledge production in relation to crossing the boundaries of differing intellectual domains. Negotiating unmanageability is not something to be shunned. To my mind, it is perhaps the price one pays for making some of the greatest advances in knowledge production. For many people this means doing double duty—studying both their discipline but also obtaining a strong working knowledge of new disciplines. Central to this concept is becoming aware of computational tools that potentially help articulate ecologies of relationality between these differing disciplines to promote intelligent conversations across disciplinary domains. This might be achieved by exploring new forms of AI (Hern, 2023). We hope to also explore and test open-source large language models Llama 3.1 and Mistral-NeMo in terms of building new forms or relationality between disciplines—new forms of conversation. One goal is to explore open source focused large language model systems in our search engine/visualization system Insight Engine 2.0.

To advance advancing one may need to explore new forms of computation to help elucidate different forms of relationality, especially relationality that embodies concepts related to biomimetics and bio-abstraction, to human/machine relationality. Glanville believed that unmanageability could increase variety, and thus promote instances of potential growth, particularly in relation to aspects of iterative design processes. In terms of the steersmanship and navigating the circular causal wheel of second order cybernetics related to conversations with the self and others, Insight Engine 2.0 seeks to include conversations with an intelligent computational system of systems by diverse human interactants with different levels of science and branches of intellectual exchange. Glanville pointed to a form of learning that explored allowing oneself to enter into unmanageable conversations that might initially start outside of one's current abilities. Such strategies loop back to the beginnings of cybernetics in terms of exploring conversations between humans representing differing disciplines, yet perhaps shines a light on potential new forms of conversation, like conversations with an AI. Norbert Wiener talks about this kind of cross-disciplinary talk in *Cybernetics*. Speaking about defining early relations between computation and thinking, Wiener (1948/1961) stated "Everywhere we met with a sympathetic hearing, and the vocabulary of the engineers soon became contaminated with the terms of the neurophysiologist and the psychologist" (p. 15).

How can this disciplinary boundary crossing best be facilitated? In each case participants may potentially need to learn to apply aspects of knowledge production

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across differing domains, domains that are often historically isolated. This kind of disciplinary boundary crossing can in part be achieved by defining relevant ecologies of relations and functional biomimetic abstractions. Historically, this often meant taking initiative related to learning about a different discipline, understanding its vocabulary and gaining a grasp of certain of the central concepts relevant to that other discipline to help define and build this relevant ecology of relationalities. It may also be highly significant to include a team member or members that have deep knowledge of both or multiple domains, working on complex research problems.

One of the most important early texts discussing what has come to be called boundary objects is *Sorting Things Out: Classification and Its Consequences* (Bowker & Star, 2000). Here, a process is developed for exploring differing disciplinary perspectives in an articulate way. In the text they discuss the concept of boundary objects, defining them as representational forms that can be shared between different communities. In a related text, Star and Griesemer (1989) state: "Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (p. 393)

Glanville (2009) states the following in "A (Cybernetic) Musing: Design and Cybernetics":

> Describing the central act of design through the metaphor of conversing with oneself connects to the idea that different personae don't see the world in the same way, from the same understandings, or know the same things. We can reconstrue this: The variety of any one persona cannot equal the variety of all (other) personae. (p. 433)

Thus, designing systems that help model, design, and build new pluralistic understandings of contexts by including conversations exploring many different disciplinary perspectives is central in helping us articulate relevant networks of biofunctionality and its abstraction through biomimetics.

Unmanageability leading to growth in knowledge enables humans to fall outside of their comfort zones to increase variety, and often to take in knowledge derived from other personae, which might potentially also fall outside of one's current mind-set. These kinds of conversations can help define systems that point in the right direction related to solving certain sets of complex problems. Undertaking this aspect of unmanageability is a circular accretive process. In such contexts the unknown becomes the known via process and iterative change brought about through conversations with the self and others, with papers and books, with systems and new computational methodologies to advance study and research. As discussed above, the other with whom one converses might increasingly include AI collaborators, working in concert with huge relational databases and eventually through differing means of visualization, sonification, and hapticization. Such interdisciplinary and transdisciplinary undertakings may also mean creating special systems that help define context-relevant jargon, so that computational linguistic processes enabling the articulate bridging of research domains can be as accurate as possible. Glanville (2012) states:

> *Control is circular, not linear. It exists between the controlling and the controlled systems.* ...

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> *If systems are of such variety and such complexity that it is inconceivable that we can satisfy the Law of Requisite Variety and thus properly control them, we must consider them unmanageable. …*
>
> *When a system is unmanageable, we have three options: to reduce complexity, to change the organizational structure (how control operates), and to alter our attitude to unmanageability. …*
>
> *Unmanageability lives between the (nominally) controlling and controlled systems as interaction. …*
>
> *Unmanageability is unavoidable. In unmanageable systems, the communication needed for control cannot be coded: an alternative form for communication is the conversation, with its personal meanings. …*
>
> *Unmanageability is not bad. It can give us many options and opens up possibilities for us, if we listen carefully and keep an open mind.*
> (pp. 523–527)

One of my goals is to define and design new conceptual approaches to draw on, enabling better access to certain articulate ecologies of relational concepts that embody aspects of temporary unmanageability. Another approach is to form a team of individuals to tackle together, through conversation, aspects of complexity. In discussing Glanville's change from observer to composer above, Glanville provided a very broad definition of design. In one instance, Glanville discussed how design related to science in terms of composing. How does one come to design or better compose the ideas that form an experiment or an approach to a problem set? This points to the difference between the scientific method which seeks to keep the observer at bay, and the second-order cybernetic set of process that go on in the scientist via the conversations they have with themselves about how to design experiments. This puts design in an extremely important light, in terms of knowledge building processes. One designs science, and in particular scientific experiments and new approaches to knowledge production, as well as new approaches to highly complex linguistic and human-sense related embodied computational systems.

With AI, such approaches can touch on the nature of the uncanny, as machines exhibit what seems like human intelligence and/or addresses the abstraction of human intelligence. Of course, there is an ethics and responsibility attached to the design and use of such new systems. Many people fear the nature of unmanageability when it comes to conversing with machine intelligence.

## NEOSENTIENCE

In my "Composing Composing" text in *The Architecture of Ideas* (Seaman, 2022, p. 221), where I conversed with a series of Glanville's historical quotes, I asked him: How would you articulate computational intelligence? Glanville stated (as drawn by myself from an earlier text):

> I examine the relationship between human and computer through a consideration of intelligence, suggesting intelligence as we experience it is neither a (genetic) property of an object, nor an attributed quality (a la Turing, 1950) but comes about in the interaction between me and it. Thus, intelligence is shared, and sharing implies an essential equality.

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> This is remarkably similar to Bateson's view of where the creativity is when a human is using a computer: it is in their sharing, within a particular context. (Glanville, 2014, p. 88)

For me this speaks to the potential of sharing knowledge across disciplinary domains—building a network of relevant relationships to inform new forms of intelligent systems, but also working in conversation with others. Glanville describes his principle of mutual reciprocity in relation to his definitions surrounding artificial intelligence. Glanville (2009) states:

> The Principle (or Law) of Mutual Reciprocity states that, if through drawing a distinction we are willing to give a certain quality to that (which) we distinguish on one side of the distinction, we must also permit the possibility of the same quality being given to that which we distinguish on the other side of the distinction. If I distinguish myself from you and I consider I am intelligent, I must consider that you (which I distinguish from I) might also be intelligent. (pp. 399–400)

This understanding of intelligence as defined in a reciprocal manner is quite different from the Turing test because the system is bi-directional. AI researchers perhaps need some new forms of systematic contextual intelligence tests.

## UNPACKING HUMAN SENTIENCE

One very long-term question that interests me is to what degree is it possible to unpack human sentience from multiple perspectives? I am here collapsing sentience and sapience as is often done by computer researchers. How can this process be valuable to knowledge production in general, especially in terms of defining new computational tools and approaches to knowledge production? Researchers can potentially create self-organizing computational systems to help in unpacking and elucidating this extremely complex network of enfolded processes which contribute to sentience/sapience arising. If scientists, researchers, and lay people never reach a full understanding via such systems, I feel that it is still important to chip away at this highly complex problem set over the span of a human lifetime, and beyond.

I have sought to enfold a series of differing foci though the development of generative systems, empowering disciplinary and transdisciplinary cross-pollination. In particular, neosentience (Seaman & Rössler, 2011) is a potential new form of AI that is inspired by mind/brain/body/environment, enfolding shared language use and self-observation, as well as employing meta-level systems.

I am thus seeking to explore composing systems for advancing transdisciplinary insight through conversation with the self and the knowledge of others, enfolding the focused employment of intelligent machine-based systems in this distributed network of conversations. The ecology of goals includes composing systems for advancing transdisciplinary insights (outlined in the next chapter: The Insight Engine 2.0: Advancing Advancing—Toward a Neosentient Model), and, in particular, authoring systems that point toward composing higher order intelligent systems.

Rössler and I defined a unique approach to articulating neosentience. In our book, *Neosentience|The Benevolence Engine*, we discuss a set of neosentient pragmatic benchmarks ("it" in the list below being a potentially neosentient entity):

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- It can learn.
- It can intelligently navigate.
- It can interact via natural language.
- It can generate simulations of behavior (it can "think" about potential behaviors) before acting in physical space.
- It can function in a creative manner.
- It can come to have a deep situated knowledge of context through multimodal sensing.
- It can display mirror competence.
- It can function in a benevolent manner.

Synthetic emotions would become operative within the system. The neosentient entity is potentially brought up (brought to life) in a social and cultural sphere of reciprocal inter and intra-actions contributing to language and knowledge acquisition. This is achieved through embodied relations to the environment, self, and others.

## COMPOSING SYSTEMS FOR ADVANCING ADVANCING

Given the interest in holistic thinking as being central to second-order cybernetics and systems thinking, a question arises when seeking to articulate models that employ aspects of highly complex biological processes. Ludwig von Bertalanffy (1968), in his book *General Systems Theory*, discusses wholeness:

> In the past, science tried to explain observable phenomena by reducing them to an interplay of elementary units, conceptions appear in contemporary science with what is somewhat vaguely termed "wholeness," i.e. problems of organization, phenomena not resolvable into local events, dynamic interactions manifest in the difference of behavior of parts when isolated or in a higher configuration, etc.: in short "systems" of various orders not understandable by investigation of their respective parts in isolation. (pp. 36–37)

The human body is an extremely complex system of systems. In "A (Cybernetic) Musing: In the Animal and the Machine," Glanville made some interesting observations about the relationality between the animal and the machine—pointing at the beginnings of cybernetics and then articulating how those ideas changed over time. Glanville (2009) states:

> In this column I argue…that the early cyberneticians lived in an era where mechanism reigned supreme. …I capture this through two reciprocal metaphors. The early cyberneticians treated the animal through the metaphor of the machine, yet understood that this was reductive of some aspects of human experience.
>
> These understandings of mechanism and wholism, can be seen as leading to the development of second-order cybernetics, which I propose, we can understand through the idea that the machine can be treated through the metaphor of the animal. (pp. 107–108)

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Neosentience research is driven in part by the latter approach, thinking of the interactive system as being organism-like and adaptive. Roy Ascott, an artist, discussed this in his text "Behaviourist Art and the Cybernetic Vision" (Ascott, 1966). I consider neosentience research, explored via the Insight Engine 2.0, to be the enfolding of conceptual art, design, science, the humanities, and cybernetics.

## ADVANCING ADVANCING AS RELATED TO NEOSENTIENCE RESEARCH

I am deeply interested in biomimetics and bio-abstraction as they are applied to new forms of robotics and computation. The goal is to best design systems enabling the examination of multiple of the above topics to help diverse interactants explore this ever-expanding ecology of relationalities. I am using a game engine for the front end of this interaction, as well as a website. Both are still under development. It came to me that if I substitute the interfacing of complex processes for "parts" when defining new models of highly complex environments, and seek to define how each process interfaces with the others in order to enable emergence, that perhaps I could potentially transcend aspects of the problem of using machine-oriented parts as a means to address biomimetics based on human biological systems. I thought that this might be productive, drawing on both metaphors and analogies related to the animal and the machine. Previously, I have referred to the body as "a not yet fully entailed ultra-complex bio-machine" (Seaman, 2013, p. 63). I will provide a short definition here: The human could be considered to be an ultracomplex bio-machine made up of an ecology of relations that relate to processes and interfaces that interact with other processes and interfaces within an autopoietic system.

One likes to circle back to Gordon Pask now and again, whose definition of cybernetics seems quite quotable here: "Cybernetics is the science or the art of manipulating defensible metaphors; showing how they may be constructed and what can be inferred as a result of their existence" (Pask, 1975a, p. 13). In particular, "the idea that the machine can be treated through the metaphor of the animal" (Glanville, 2009, p. 108) becomes highly relevant in neosentience research. Yet, I am still enfolding metaphors related to a very new kind of machine—the bio-machine.

Concerning cognition, from the thought of von Foerster, a multiplicity of processes are enfolded in contributing to interactions and conversations with the world. Foerster (1981) begins the introduction to *Observing Systems* with a recursive loop (Figure 1).

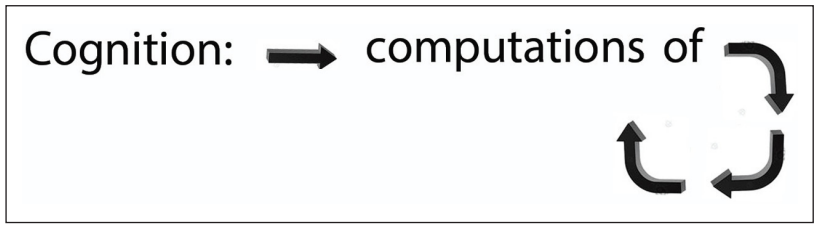


**Figure 1** Rendition by Seaman of von Foerster's (1981) diagram.

This diagram points to the overarching recursive computational complexity of human steering (read cognition, sensing, emergence, and human volition) and also points to the internal loops that contribute to the cybernetic steersmanship brought about through human holisticness.

Here, von Foerster simplifies cognition into one overarching recursive approach to computation in the brain/mind. In relation to this, von Foerster provided a definition

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for what he called a non-trivial machine. Sheena Calvert (2019), in a section of her text titled "The Trivial Machine vs. The Non-Trivial Machine" discussed the difference between these two varieties of machine:

> Within the context of mid-20th century writing on cybernetics, Heinz von Foerster proposed the notion of the "Non-Trivial Machine", referring to it as possessing the "well-defined properties of an abstract entity", and in so doing, posed a machine as not necessarily something with "wheels and cogs". Instead, a machine is "how a certain state is transformed into a different state". (para. 7)

Here, instead of "wheels and cogs" we can discuss processes that become interfunctional through differing forms of interface in the body, and their biomimetic abstraction. Calvert (2019) continues:

> The important aspect of a "Non-Trivial Machine", for von Foerster, is that its "input-output relationship is not invariant, but is determined by the machine's previous output." In other words, its previous steps determine its present reactions and so it is reactive, variant, and dynamic. In contrast, a "Trivial Machine" would be one in which the input creates an invariant output. This kind of machine is inherently stable, and produces no fluctuations or errors: it's predictable. As such, by definition, a 'Non-Trivial Machine' would be one in which the output cannot be predicted from its input. (para. 7)

Where Calvert was discussing aspects of human language production as well as new forms of machine-oriented language use, we can also discuss the non-trivial machine in another higher-order manner. It is interesting to note that Søren Brier (2008, p. 340) in his book *Cybersemiotics,* points to von Foerster discussing humans as non-trivial machines. Brier quotes von Foerster: "Let us only make note of the fact that non-trivial machines are dependent on their own history, cannot be analytically determined, and are unpredictable" (von Foerster and Poerksen 2002, p. 58).

The idea of studying the mind as related to a set of physical processes at operation in the brain and the body was suggested very early on by von Neumann (1955):

> It is a fundamental requirement of the scientific viewpoint — the so-called principle of the psycho-physical parallelism — that it must be possible so to describe the extra-physical process of the subjective perception as if it were in reality in the physical world — i.e., to assign to its parts equivalent physical processes in the objective environment, in ordinary space. (p. 418–419)

The paradox of biomimetics relates to the following concept—we must better come to know the workings of the body in order to holistically abstract those complex functionalities into new forms of intelligent systems. The big push behind the interest in neosentience research for me is in designing an intelligent system that is closely aligned with the study of human sentience and sapience, and our own personal enactment of that sentience/sapience as explored through self-examination as well as across the understandings of a plethora of differing related research domains. Also, as I have explored intelligent systems over time, in each case these have helped me better come to understand my own interests in sentience—in observing and experiencing the world, in exploring creativity, in observing knowledge production and creating meta-level systems exploring meaning production.

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## ANOTHER FORM OF COMPLEMENTARITY

I came across an old but very important article recently that seems to suggest a new set of perspectives related to von Neumann's psycho-physical parallelism. In 1979, H. H. Pattee wrote a paper entitled "The Complementarity Principle and the Origin of Macromolecular Information." Pattee's (1979) conclusion points to an interesting set of ideas related to the articulation of such complex bio-systems:

> There is general agreement that biological systems need both structural and informational concepts for their description. However, whether these concepts are related in a reductionist sense or a complementary sense is not yet resolved. We may as practical biologists agree, with Delbrück, that "This riddle of life has been solved," but we cannot as critical physicists say, "This riddle of physics has been solved." If biological information originates only by measurement processes, then we need a much clearer epistemological idea of measurement before we can interpret our mathematical theories as explanations of life. A valid mathematical model that usefully describes certain structural features of a biological information system may indeed, by analogy with the classical paradigm of physical models, make us feel that information is just another physical variable; but until we can agree on what we mean by an explanation of the measurement process, we have little reason to claim that life has been reduced to the laws of physics. (p. 225)

A relevant book discussing approaches to mathematical biology is *Integral Biomathics: Tracing The Road to Reality* (Simeonov, Smith, & Ehresmann, 2012). In the chapter entitled "Processes and Problems That May Define the New BioMathematics Field," Robert S. Root-Bernstein (2012) provides the following:

> Historically, mathematics developed hand-in-hand with the physical sciences. While biological processes must obey the laws of physics, biology is not reducible to physics (otherwise we would not be able to distinguish one set of phenomena from the other!), and therefore mathematics that have been adequate for describing physical processes are often inadequate to describe biological ones. In consequence, I argue that a new phase of scientific development is required in which mathematicians turn to biological processes for inspiration in creating novel forms of mathematics appropriate to describe biological functions in a more useful manner than has been done so far. (p. 6)

My text in the same volume is entitled "The Engine of Engines – Toward a Computational Ecology." In it, I discuss the following:

> When we study the body we can consider it to function incorporating the architecture of different computational processes that are currently not fully understood, especially in terms of the interrelation of those processes over time functioning in concert with other biological functionalities. From this overarching perspective we can study the body as an ultra-complex time-dependent computational ecology. (Seaman, 2012, p. 298)

As mentioned above, I think of the body as an ultracomplex bio-machine that has not as yet been fully articulated in terms of the complexity of its relational entailment structures (Seaman, 2013, p. 63).

## THE INSIGHT ENGINE 2.0: ADVANCING ADVANCING—TOWARD A NEOSENTIENT MODEL

Neosentience is a new form of AI based on the functionality of the body. The Insight Engine 2.0 is an extensive ecology of interfaces housed in the unreal game engine, and a massive database which is still under construction. A version was originally created that, in small portion, used AI as part of the system. The Insight Engine 2.0 is to be an updated version of the system. The human body/brain/mind as it interacts with the larger environment is perhaps one of the most complex living systems. The Insight Engine 2.0 seeks to design and explore a set of computational approaches and related research methodologies to work toward defining a model of neosentience production, eventually articulating a new form of something like artificial consciousness. It will employ a new transdisciplinary relational database, search engine, and visualization system.

Given the incredible complexity of neosentience research, I am now developing a methodology (with other team members—see Appendix 2 related to historical team members) where many people could add to the research from their own perspectives and undertake multiple forms of conversation with the differing forms of interactive interfaces, visualization system and database, driven by their own interests. Working with teams on the project, we have been seeking to design a self-organizing system, where each different interactant might find a relevant set of perspectives that relates to them, either as a reader/composer or as a researcher (or both).

At the center of neosentience study is human research about what it is to be a sentient/sapient being, which is now intimately tied into the creation of a new form of AI based on this research. I find this to be an exciting paradox to embrace; to develop this new form of AI, one must first better understand sentience/sapience production in the human. Additionally, I also feel that illuminating pieces of how consciousness comes to be operational in the body will lead to new knowledge, and new forms of computational application.

### UNMANAGEABILITY IN NEOSENTIENCE RESEARCH

My approach was initially to ask myself what is it that I do when I try to solve a complex problem that includes one or more domains that are currently outside of my knowledge base? How have others historically explored such problems? In using the Insight Engine 2.0 system interactants might ask themselves what aspects of sentience/sapience production have they as individuals been most interested in? Are interactants interested in approaching these questions though poetics, philosophy, history, the study of cognition, ethics, etc.? What would you as an individual define as the overarching categories to research, and how might these change over time through interaction with the system, reflecting on both human sentience/sapience and the potentials of neosentience? I apologize for the breadth of topics in this text but, in a sense, I want to point out how many individuals might contribute and/or explore the system in their own way, or suggest new categories for relevant inclusion. So, as you are reading this article, take a moment to reflect on what your perspectives related to a contribution might be, and how this branch of research into human sentience/sapience might be put in conversation with others. You can explore the existing categories of research in the list below entitled Insight Engine 2.0 Research Categories—Neosentience.

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One can focus on developing a team of collaborators to work on difficult problems, breaking up aspects of the potential solution in logical ways. One can also ask the more difficult question—how and where in the body does emergence take place contributing to human sentience/sapience? This question may be an impossible one to fully answer. One can also develop multiple ways to promote conversation across disciplinary domains. This also suggests the potential of opening up new transdisciplinary approaches to complex problems. This kind of conversation across varying foci explored by differing individuals was central to Glanville's sense of the design process writ large.

The Insight Engine 2.0 seeks to draw on my long history as a media and AI researcher designing new forms of interfaces, generative environments exploring emergence and meta-meaning (Seaman, 1999b, 2010), as well as new qualities of interactivity, and to expand this research via a strong interdisciplinary/transdisciplinary collaboration that bridges neuroscience, computer science, mathematics, as well as the arts and humanities at Duke, as well as through international collaborations, still to be determined.

This research seeks to work toward the computational authorship of a tool to empower insight production—disciplinary, interdisciplinary, crossdisciplinary, and transdisciplinary individual and team-based research, and to potentially enable bisociational processes as discussed by Koestler in *The Act of Creation*, bringing disparate conceptual potentials into relevant juxtapositions through focused interaction. Koestler states (1964):

> I have coined the term "bisociation" in order to make a distinction between the routine skills of thinking on a single "plane", as it were, and the creative act, which, as I shall try to show, always operates on more than one plane. (pp. 35–36)

Koestler (1964) continues:

> We learn by assimilating experiences and grouping them into ordered schemata, into stable patterns of unity in variety. They enable us to come to grips with events and situations by applying the rules of the game appropriate to them. The matrices which pattern our perceptions, thoughts, and activities are condensations of learning into habit. …The bisociative act connects previously unconnected matrices of experience. (pp. 44–45)

Extending this is my concept of poly-association, which, like employing bisociation, enables intelligent database searches that bring multiple concepts from quite different disciplinary contexts into juxtaposition through AI vector data textual analysis.

The *Neosentience* book (Seaman & Rössler, 2011) has hundreds of short micro-chapters. In the book I discuss my concept of recombinant informatics (influenced by Koestler's bisociation). Take the ideas in any two micro-chapters and build a cogent bridge between them to define a new area of research. Here the creative thought of the individual exploring generated contexts through bisociation and/or poly-association comes into play.

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The goal of my current work is to author a new interactive computational system of systems which will aid in knowledge production through pointed concept juxtaposition that is user-driven, as well as informed via conversation with AI. Additionally, the goal is to define systems that help us articulate meaningful connections and relational patterns between these disciplines. In the past interplay between disciplines has often been restricted because of particular publishing hegemonies and the limits of historical conceptual arenas.

Again, the goal is to compose a set of creative approaches to intelligent generative systems—meta-meaning systems that explore human intelligence working in concert with artificial intelligence, to advance the fields of both human and artificial intelligence, in the creation of an even higher-order intelligent system of systems. The overarching goal of Insight Engine 2.0 is to enable an international community of researchers, as well as interested individuals, to explore extremely complex problem sets via accessing relevant data.

In the operation of Insight Engine 2.0, a transdisciplinary database and unique set of visualization modes enable researchers from differing disciplines and advanced exploratory research domains to peruse data which may not normally be found in the papers and books related to a specific disciplinary domain. New knowledge and insight potentially arise via the intelligent juxtaposition of one or more such domains. No single discipline of science, the humanities, or the arts can tackle such a difficult information-related problem set—the defining of a model for neosentience production.

A special transdisciplinary distributed international team of teams will potentially arise out of the use of the Insight Engine 2.0, and the variety of forms of conversation it enacts. The Insight Engine 2.0 information system is being designed to support researchers, to empower them to access relevant transdisciplinary data from the database and to contribute to the higher order goal over time of articulating a functional neosentient model as an extended approach to open source knowledge production, in part, accessible via the internet as well as the Unreal game engine. Such a model is to be informed from many intellectual perspectives and transdisciplinary conversations facilitated by the Insight Engine 2.0 system, including a list-serve (still to be set up) and future information-oriented gatherings and relevant links. I often call this kind of approach a multi-perspective approach to knowledge production and, in this case, to neosentience production.

## AN ULTRACOMPLEX BIO-MACHINE

Robert Rosen (1999) saw the limitations of the machine metaphor in relation to biological research, yet, later in his book, changed his mind in relation to future research. In *Essays on Life Itself*, Rosen (1999) points to a particular limit, and later discusses a thought about the future in terms of approaching complexity:

> I have attempted to introduce, and to motivate, a concept of complexity. A system is called complex if it has a nonsimulable model. The science of such complex systems is very different from the science we have become used to over the past three centuries. Above all, complex systems cannot be completely characterized in terms of any reductionistic scheme based on simple systems. Since the science is different, so too are technologies based on it, as well as any craft pertaining to the systems with which that science deals. (p. 306)

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Given the time that has past, perhaps researchers can continue to seek to devise a set of ultra-complex simulable models that are interfaced with each other, given the potentials of new computational systems and the development of new conceptual approaches. Additionally, researchers can work toward building a system to articulate new approaches exploring complex mathematics and multi-value logic that seeks to explore new forms of modeling ultra-complex systems, enabling the development of new methodologies to work in tandem with sophisticated high-resolution technologies to explore and map entailment structures. Perhaps the computers and linked advanced scanning technologies we need to render such observational systems operable are still off in the future. The articulation of entailment structures is one of the richest goals of the neosentience project, as is their biomimetic abstraction. Later in *Essays on Life Itself*, Rosen (1999) questions his initial assumptions and suggests:

> It is too early to tell how such ideas will develop in the future. My purpose here has been to introduce some of the flavors of the concept of complexity, how it pertains to basic biological issues, and how it may force a complete reevaluation, not only of our science, but of our concepts of art and of craft as well. Indeed, it may turn out, as it has before, that the pursuit of craft may provide the best kind of probe to guide our science itself. (p. 307)

The Insight Engine 2.0 seeks in part to provide a technological platform to aid in the research of such ideas and concepts that elucidate future approaches to unpacking biological complexity.

## ENTAILMENT STRUCTURES

Is writing code a craft? The last couple of years have been a very exciting time in terms of how AI code has altered the arts, humanities, and sciences through ChatGPT (Wolfram, 2023) and other OpenAI related systems, as well as a plethora of new AI-based applications (Biswal, 2024) and, in particular, applications exploring creative production in the arts (Zhou & Lee, 2024). The Insight Engine 2.0 project seeks to provide a technological platform to aid in the research of future ideas related to unpacking complexity, defining new forms of mathematics, and articulating methodologies to best map the entailment structures that enable sentience to arise, as well as to explore the development of new forms of code and machinic systems to re-embody the functionality of these processes and entailment structures via biomimetics and bio-abstraction (Seaman, 1999a, pp. 175–176). The full entailment (the study of relevant structures at operation in the body) and the later potential emulation of the body's functionality, especially related to what I have called the creation of an ultra-complex entailment network in response to Rosen's thoughts presented above, has to my knowledge not been achieved at this time. This is due in part to the distributed, highly complex nature of the mind/brain, as it falls in relation to the operation of the body, and the environment the body is nested within, where a small event in one part of the brain might not be picked up in terms of the resolution of a technological scan or other contemporary technological methodology as related to multi-modal sensing, yet this might shift elements of thought and in turn lived interaction.

This inability to precisely define highly detailed entailment structures in the brain and body, is also potentially due to data processing strategies. One goal of neosentience research is to track the development of new high-resolution still and time-based

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scanning technologies. These high-end technological systems will have to be developed to undertake scanning tasks that perhaps will successfully encompass the biological functionality of the entire body. It is exciting to note that a huge breakthrough has just been made here at the Duke Institute for Brain Sciences. Reporting on recent advancements, Dan Vahaba (2023) states that "the refined MRI provides an important new way to visualize the connectivity of the entire brain at record-breaking resolution" (para. 5).

Researchers must come to know the human body better from many different perspectives to elucidate its functional abstraction. This includes researching the potential social and cultural ramifications as well as the ethics surrounding such study. It is the interfacing and concomitant interfunctionality of all of the systems in the body leading to sentience/sapience production that that I and partners are seeking to research and better understand in the service of defining a model for neosentience production.

## THE ENACTED, EMBODIED, EMBEDDED, EXTENDED APPROACH

Central to neosentience is research into embodiment and how it relates to knowledge production and language use. Ward and Stapleton (2012) state that "when we say that cognition depends on 'our activity', or upon 'bearing relations to an environment', the phrases within the quotation marks can be cashed out in many different ways" (p. 90). In terms of the enacted, embodied, embedded, extended approach, Ward and Stapleton suggest that "to be a cognizer, in the sense which interests the enactivist, is to manifest an appropriate degree of attunement to the objects, features, threats and opportunities present in the immediate environment" (p. 91). Ward and Stapleton (2012) continue: "The features of the environment to which the system is attuned are not inert and independent of the system, but dependent upon, and specified at least partly in terms of, the system's activity and capacities" (p. 91).

One set of neosentient-related goals is to research the embodied, embedded, enactive, and extended approaches to understanding cognition in the human, and then seek to articulate the entailment structures that enable this set of dynamic interrelations to function. This understanding means extending current modalities of AI through multi-modal machine-based sensing and articulating a different set of modalities for defining context, and introspection about context, partly through embodied interactions and synthetic memories of pattern flows of robotic experiences. This embodied approach is quite different from current language driven models of AI, which at this moment, in terms of systems like ChatGPT, are highly successful. Yet, perhaps such language driven approaches still have a distance to travel given the qualities that are operative in terms of human sentience/sapience as exemplified by deep contextual awareness and its abstraction in thought. This in part also plays out via the meta-level of introspection.

## THE INSIGHT ENGINE 2.0—FOCUSING ON A MODEL FOR THE PRODUCTION OF NEOSENTIENCE

The pragmatic goal is to make the Insight Engine 2.0 function in such a way as to point to, and enfold, new research data across disciplinary boundaries by using advanced information processing, computational linguistics, a natural language API, new open source forms of AI like Llama and Mistral and additional forms of AI acting as Micropeers (AI collaborators to enable the development of ecologies of

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intelligent relationalities in terms of specific research questions and related prompts). Additionally, the development of new informational paradigms through bisociation (Koestler, 1964, pp. 35–36) and poly-association are explored. Such research is about promoting new forms of connection and juxtaposition that transcend traditional boundaries of knowledge production. This research explores mutually beneficial articulated relational structures between disciplines that may have not been historically defined or as yet codified. It is my goal as a computational media and AI theorist to make systems that can help play midwife to new thoughts related to the future of AI. I seek to author interactive generative systems, working with my team, that enables new forms of academic border crossing in the service of new knowledge, perhaps bringing ideas into juxtaposition that historically have been held at a distance due in part to the hegemonies of differing research publications.

I seek, with an advanced team, to create AI-driven insight-oriented systems that bring disparate aspects of knowledge production into play (into juxtaposition) where new fields of relational understanding need to be negotiated and discussed. Concepts and potentials will additionally be suggested by conversations with new forms of AI, as well as through individual search mechanisms. Thus, my take on this has been to research and author systems that promote the cogent generative relational bridging of disciplinary practices through new forms of creative code authorship, as well as through stimulated conversation between human interactants. This kind of system promotes differing varieties of conversation including conversations with the self after reading papers as well as exploring conversation that becomes illuminated by exploiting the natural language potentials of AI. Central is the exploration of nested high-end systems that enable elements of AI, large language models, and machine learning to become operative as part of this system of systems—Insight Engine 2.0.

There are many new interface-related areas to be explored. Imagine employing a form of gravity used in game engines to be repurposed to enable specific foci to be repositioned in virtual space via a repurposed physics engine, where relevant ideas might become attracted to each other given appropriate meta-data, interactively reconfiguring a spatial textual environment. Additionally, conversations with material systems could be facilitated that the Insight Engine links to—i.e., exploring models for new forms of biomimetic computation. This might empower the navigation of a biological model juxtaposed with a code-based model enabling the perusal of elements of human functionality as related to the computer code that is mimicking it artificially. Such a system may also enable the exploration of new linked databases, external to the system, mapping the body and its functionalities. The researcher/interactant could potentially explore new forms of data generated by scanning that, once made operative in the system, could be navigated and at any point could be queried for related relational information. An individual could navigate to exact locations in the body and the brain, and access relevant linked papers or other differing scale models related to that aspect of human biofunctionality. One might also have conversations with relevant historical artifacts, exploring quotes from researchers and relevant papers driven by individuals' interaction and navigation.

Call this a set of advanced conversations surrounding the perusal of ideas empowered via user-driven navigations of this self-organizing transdisciplinary search engine and visualization system. This Insight Engine 2.0's functionality will in part incorporate moments of chosen chance processes as part of a menu system. Central is ongoing navigation leading to focused human and computationally articulated relationality, with new ideas driven by pointed queries via open-source large language model

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prompts as well as simple human queries of the relational database, and playful explorations of flying through 3D models and data; ideas that relevantly cross non-traditional disciplinary domains using the natural language AI and the navigable computational environment to help connect and articulate relationalities between domains; this includes the navigation of 3D worlds; ideas where visualization and in the future sonification and haptics-oriented interfaces are potentially explored enabling new means to examine datasets and related information annotations. Such a system seeks to provide a novel sense of interaction in terms of where to navigate in a spatial ecology of knowledge-production-approaches. These interfaces literally present a new set of perspectives that are providing an alternative to many traditional search methodologies. Yet, traditional approaches are also part of the menu system. One can move back and forth as needed from 3D models and visualizations (presented in 2d or 3d) to specific forms of datasets and to purely textual articulations and searches accessed in a more traditionally viewed dashboard.

## RESEARCH AREAS THAT WILL POPULATE THE RELATIONAL DATABASE AND VISUALIZATION INTERFACES

Although Glanville in conversation with Seaman did not like certain forms of lists, as discussed above, I have explored a very broad set of initial research areas to be included in the database. In particular, this summer (2024) the list became highly articulated. As you read this very long list of foci, please consider writing to me with your ideas about any improvements. These different research areas forming the overarching database, explored through many different interface forms, include the following (although new research areas will continuously be added as they are defined):

### Insight Engine 2.0 Research Categories—Neosentience

- consciousness studies
    - attention schema theory
    - autonomous adaptive intelligence
    - bodily entailment structures (and related research)
    - brain modules
    - cognitive architectures
    - conscious machines
    - consciousness and complexity
    - diffusion, structural, and functional neuroimaging methods
    - embodied cognition
    - introspection, mindful awareness/self-observation
    - old and new problems and theories
    - reinforcement learning
    - scanning and imaging technologies
    - sentience and sapience
    - spike timing networks
    - structures in the human nervous system
    - the effects of emotion on consciousness

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- disciplines
  - android linguistics (Donahue, 2022)
  - discipline related jargon and interdisciplinary and transdisciplinary approaches
  - ecologies of knowledge
  - neuroscience and computational neuroscience
  - neuroscience and computational neuroscience: emotions
  - neuroscience and the arts, neuroaesthetics
  - related new forms of mathematics
  - synthetic biology
- governance and oversight
  - ethics
  - explainable AI
  - governance
- AI
  - conversation theory, etc.
  - AI and ethics
  - artificial general intelligence
  - bionics
  - deep learning and human biomimetics
  - embodied computation
  - natural language processing
  - neural networks
  - philosophy of AI
  - supervised deep learning
  - unsupervised deep learning
  - testing for intelligence
  - testing for consciousness
  - the history of AI
- computation
  - agents and machine consciousness
  - AI and the arts—computational creativity
  - AI and the environment
  - bio-abstraction
  - biomimetics
  - complex engineering systems
  - computation and intuition
  - exploring neuromorphic chip architectures
  - extended intelligence
  - history of computation
  - human biomimetic multimodal sensing

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    - machine learning
    - natural computing
    - neural nets—adaptive resonance theory (ART)
    - pattern recognition to study the nervous system
    - quantum computing via neuromorphic systems and other
    - semantic computing
    - the connectome
    - themes in education and learning
    - conventional computing
- Robotics
    - biomimetic approaches to humanoid robotics
    - ethical and social implications of AI and robotics
    - human-robotic interaction
    - robotics and situated knowledge production
    - robots and emotion
- Social and Cultural Ramifications
    - AI and cultural bias
    - AI and the environment
    - artificial consciousness, algorithms and culture
    - conscious AI in science fiction
    - ethics and AI
    - feminism and AI
    - racial bias and AI
    - shared human values
    - social bias and AI
    - indigenous thought and AI
- Systems Thinking
    - biological systems theory and consciousness
    - building structures of relationality between disciplines
    - emergence
    - explainable AI
    - information—new relevant approaches
    - mechanistic interpretability for AI safety
    - models
    - philosophical foundations of artificial consciousness
    - transdisciplinary computational neuroscience
- Energy consumption and large language models [under development]
- Cybernetics and AI history (Individuals) [under development]
- Boundary objects [under development]

Currently thousands of papers and publications are being analyzed in terms of defining textual vector relationalities across the above topics via AI.

I was involved in exploring some of these areas of research in a large on-line conference in 2021 entitled *Theoretical and Foundational Problems (TFP) in Information Studies* (Burgin et al., 2021; Seaman, 2022a, 2022b).

## COMPOSING SYSTEMS

An overarching set of the systematic processes incorporated in Insight Engine 2.0 seeks to inform the composing of relevant systems. My goal for the Insight Engine 2.0 system is to empower high level conversations of many different forms. In particular, the system is designed to promote differing forms of interaction to help define various potential functionalities relevant to neosentient production. I am seeking to have these computational functionalities embodied in a future neosentient model arising out of the research. In so doing, they could help articulate a future approach to AI. Part of this process is to keep the system open and continuously growing in a computationally articulate manner. This means refining the overarching set of goals and related sub-goals as an ongoing process via research and conversation between the interactants. The complexity of the problem necessitates articulating an overarching model and set of sub-systems to define biomimetic relationalities from different disciplinary perspectives, keeping in mind an overall holistic approach.

The Insight Engine 2.0, the computational vehicle of my (and others) research, seeks to help unpack and map the entailment structures of bodily functions in relation to the mind/brain/body/environment set of relationalities, as opposed to the just the mind/brain. Part of this relates to how humans articulate advanced notions of context through sensing, memory, and the history of embodied actions and interactions. This has much to do with multi-modal sensing. In human knowledge production, these processes intermingle human embodied functions with both document-driven and AI exploration of large language model-driven knowledge production. I am quite interested in how such systems might address the ability to be self-reflective about knowledge production processes and human learning, necessitating a meta-level of self-observation contributing to knowledge production, which is not currently part of most aspects of AI.

Additionally, such an approach also points to the building of articulate relationalities between domains that do not usually talk to each other, i.e., the study of entailment structures in the body and biomimetic approaches to articulating them in a neosentient humanoid robot. Thus, one must develop shared languages to frame and discuss problem solving. In particular, different research domains employ different jargon definitions that span such areas as computer science, mathematics, big data, new forms of computer code, as well as the bodily processes that are at operation in the production of human sentience. A field in physics is not the same thing as walking in an embodied manner across a physical field.

To explore such a broad set of complex questions this will mean learning new language to enable discussion across these intellectual domains. In terms of this broad set of tactics, can researchers and individuals explore new systems that enable multiple perspectives related to meta-level approaches, in part by incorporating boundary objects discussed above?

One of my goals for the modelling of neosentience is to explore the following question: Can computers become highly introspective around a particular topic? Some people find this to be a problematic idea because they do not like thinking about

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the notion that machines might begin to develop qualities that are deeply related to consciousness. In terms of studying this network of complex problem sets, how can we best define relevant metaphors and analogies to draw on, to elucidate our conversations that bridge from the human to the machine and exemplify this ecology of emergent processes that need to intelligently intercommunicate? There is a vast ecology of processes at operation in the human that facilitates the employment of creative thinking and intuitive jumps. How do we define new forms of system in the Insight Engine 2.0 that empower such approaches—that enhance human leaning along with machine learning?

Such learning systems may in part need to learn in a highly contextual fashion from choices, mistakes, and failures (Glanville, 2007) as an ongoing system that enfolds new contextual knowledge. How does a system decide if it made a mistake? For example, one might say a corpus of texts or database of works creates a context, but it does not necessarily enable deep knowledge about how that context has arrived and what knowledge should or should not be left or applied to a particular context. Here, we plan to embed particular textual information. Alternately, how can chosen knowledge best be enfolded to help elucidate the parameters of such a complex information space, informed by embodied knowledge production, leading to new intelligent approaches to human and computational modalities?

Studying the history of tool building, historical observation witnesses the creation of a set of tools to enable the creation of higher-level systems and better tools. We might look back and see the beginning of computing where the concepts driving the potential of the systems were arrived at long before the tools that enabled the first computer's physical embodiment. Can individual and disparate researchers define a set of goals related to knowledge generation, exploring a form of ongoing tool-based hierarchy to be employed in generating new forms of relevant technologies? Or, alternately, should this be a dynamic heterarchy rather than a hierarchy? Part of this means defining new complex forms of relational mathematics, enabling and informing new interdisciplinary and transdisciplinary domain conversation. Many have suggested that category theory already does this, yet I believe we need additional approaches. It is interesting to note that Stephen Wolfram (2023) is working with ChatGPT to help define new mathematical systems that enfold new forms of operative AI.

## CONCLUSION

Ranulph Glanville provided a rich set of conceptual perspectives related to a series of different fields over his lifetime in terms of his interest in living in cybernetic circles. Glanville did this through his series of columns in *Cybernetics and Human Knowing*, publications, conferences, and mentorship of a generation of students internationally. He also did this through his leadership of the American Society of Cybernetics, and in part through the design of multiple conversation-based conferences. His greatest contributions were perhaps reflected in being one of the developers of second order cybernetics as well as articulating a series of ideas surrounding the definition and articulation of design in all of its potential functionalities and processes. His interest in conversation, broadly defined as a means to interact and achieve new forms of knowledge, was central. Glanville's extension of Gordon Pask's articulation of how conversation might be played out on different levels and with different media, as well as through interaction with intelligent machines and physical processes, is also noted, particularly in relation to design processes. Glanville was a polymath and his

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final shift and rearticulation of the term "observer" to "composer" was a meaningful one for both my artwork and research. As I came to know him over many years of conversation and through the writing of my book, *The Architecture of Ideas*, about his life and work, I developed an elaborate pun which had many forks relating the term "architecture" (Appendix 1) as a way to point at the many perspectives his thought explored over a lifetime.

I have sought to re-embody multiple of Glanville's perspectives in terms of my own media research and practice methods, as well as follow my own interests. For me, the Insight Engine 2.0 is a system to empower the potentials of many forms of conversation in a disciplinary, interdisciplinary and transdisciplinary manner. This elaborate system of systems seeks to promote a broad set of conceptual conversations, the metaphorical cross-pollination of concepts, the articulation of ecologies of relationalities between the human and the model for a neosentient entity, and provide a technological platform to empower a rich ongoing set of observations related to intersections of ideas which cross many disciplinary domains. An overarching goal of this system of systems is to enable exploration of holistic approaches to extremely complex problem sets related to neosentience production.

## APPENDIX 1: SEAMAN'S POETIC TEXT RELATED TO THE BREADTH OF GLANVILLE'S PRACTICE

The architecture...

- of thought
- of knowing
- of physical properties—physics and biology
- of proportion—art and music
- of sharing concepts—an approach to second-order cybernetics, etc.
- of music
- of space
- of non-standard approaches to knowing and mentorship
- of psychology/behavior
- of language
- of creativity
- of buildings
- of conversation
- of delight
- of inquiry
- of curiosity
- of form and content
- of emergence
- of composing
- of ideas

(Seaman, 2022, p. 277)

## APPENDIX 2: MEMBERS OF THE INSIGHT ENGINE TEAM

Insight Engine Team as of 2014:

- Myself as primary investigator;
- Todd Berreth, design consultant and primary developer (early simplified closed version)
- Oliver Perriquet, early consultant, computational linguistics

Insight Engine 2.0 Team as of 2022:

- Myself as primary investigator
- Hojung (Ashley) Kwon, Computer Science student, Duke (now PhD study, Brown)
- Dev Seth, Computer Science student, Duke
- Mingyong Cheng, PhD researcher, UCSD. (formerly MFAEDA Duke)
- Kelsey Brod, PhD researcher, Computational Media Arts and Cultures, Duke
- Quran Karriem, PhD researcher, Computational Media Arts and Cultures, Duke
- David Zielinski, Office of Information Technology, Duke (consultant)

Insight Engine 2.0 Team as of 2023/2024:

- Gregory Baker, analyst, AI related media arts developer and infrastructure specialist
- Duy Trieu undertook an Independent Study related to developing open source large language models, Mistral and Llama.

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The author has no competing interests to declare.

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## REFERENCES

**Ascott, R.** (1966). Behaviourist art and the cybernetic vision. *Cybernetica: Journal of the International Association for Cybernetics*, *IX*, 247–264.

**Biswal, A.** (2024, July 25). 24 cutting edge artificial intelligence applications in 2024. *Simplilearn*. https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/artificial-intelligence-applications

**Bowker, G. C.,** & **Star, S. L.** (2000). *Sorting things out: Classification and its consequences*. MIT Press. https://doi.org/10.7551/mitpress/6352.001.0001

**Brier, S.** (2008). *Cybersemiotics: why information is not enough!* University of Toronto Press. Toronto Buffalo London. https://doi.org/10.3138/9781442687813

**Burgin, M., Mikkilineni, R.,** & **Seaman, W.** (Eds.) (2021). *Theoretical and foundational problems (TFP) in information studies: The book of abstracts*. https://tfpis.com/session-2-neosentience-biomimetics-and-the-insight-engine-2-0/

**Calvert, S.** (2019, October). Language: The non-trivial machine. *Interalia Magazine*. https://www.interaliamag.org/articles/sheena-calvert-the-non-trivial-machine

**Cariani, P.** (1993). To evolve an ear: Epistemological implications of Gordon Pask's electrochemical devices. *Systems Research*, *10*(3), 19–33. https://doi.org/10.1002/sres.3850100305

**Donahue, E.** (2022). Towards an android linguistics: Pragmatics, reflection, and creativity in machine language. *Proceedings*, *81*(1), Article 156. https://doi.org/10.3390/proceedings2022081156

**Glanville, R.** (2007). Try again. Fail again. Fail better: The cybernetics in design and the design in cybernetics. *Kybernetes, 36*(9/10), 1173–1206. https://doi.org/10.1108/03684920710827238

**Glanville, R.** (2009). *The Black B∞x: Vol. 3. 39 steps*. Edition echoraum.

**Glanville, R.** (2012). *The Black B∞x: Vol. 1. Cybernetic circles*. Edition echoraum.

**Glanville, R.** (2014). *The Black B∞x: Vol. 2. Living in cybernetic circles*. Edition echoraum.

**Glanville, R.** (2015). A (cybernetic) musing: Wholes and parts, Chapter 1. *Cybernetics & Human Knowing*, *22*(1), 81–92.

**Glanville, R.,** & **Müller, K.** (Eds.) (2007). *Gordon Pask, philosopher mechanic: An introduction to the cybernetician's cybernetician*. Edition echoraum.

**Hern, A.** (2023, March 15). What is GPT-4 and how does it differ from ChatGPT? *The Guardian*. https://www.theguardian.com/technology/2023/mar/15/what-is-gpt-4-and-how-does-it-differ-from-chatgpt

**Koestler, A.** (1964). *The act of creation*. Macmillan.

**Krueger, T.** (2022). On the contrary. In B. Seaman (Ed.), *The architecture of ideas: The life and work of Ranulph Glanville, cybernetician* (pp. 188–194). Imprint Academic.

**Licklider, J. C. R.** (1960). Man-computer symbiosis. *IRE transactions on human factors in electronics*, *HFE-1*(1), 4–11. https://doi.org/10.1109/THFE2.1960.4503259

**Mollick, E.** (2023, June 23). On giving AI eyes and ears. *One Useful Thing*. https://www.oneusefulthing.org/p/on-giving-ai-eyes-and-ears

**Müller, A.,** & **Müller, K.** (Eds.) (2007). *An Unfinished Revolution? Heinz von Foerster and the Biological Computer Laboratory|BCL 1958–1976*. Edition echoraum.

**Neumann, J.** (1955). *Mathematical Foundations of Quantum Mechanics* (R. Beyer, Trans.). Princeton University Press.

**Pask, G.** (1961). *An approach to cybernetics*. Harper and Brothers.

**Pask, G.** (1975a). *The cybernetics of human learning and performance: A guide to theory and research*. Hutchinson.

**Pask, G.** (1975b). *Conversation, cognition and learning: A cybernetic theory and methodology*. Elsevier.

**Pattee, H. H.** (1979). The complementarity principle and the origin of macromolecular information. *Biosystems*, *11*(2–3), 217–226. https://doi.org/10.1016/0303-2647(79)90013-3

**Pfeifer, R.,** & **Bongard, J.** (2007). *How the body shapes the way we think: A new view of intelligence*. MIT Press. DOI: https://doi.org/10.7551/mitpress/3585.001.0001

**Root-Bernstein, R. S.** (2012). Processes and problems that may define the new biomathematics field. In P. L. Simeonov, L. S. Smith & A. C. Ehresmann (Eds.), *Integral biomathics: Tracing the road to reality* (pp. 5–15). Springer. https://doi.org/10.1007/978-3-642-28111-2_1

**Rosen, R.** (1999). *Essays on Life Itself*. Columbia University Press.

**Seaman, B.** (1999a). Nonsense logic and re-embodied intelligence. In R. Ascott (Ed.), *Reframing Consciousness: Art, Mind and Technology* (pp. 174–179). Intellect. https://monoskop.org/images/8/8a/Ascott_Roy_ed_Reframing_Consciousness_Art_Mind_and_Technology.pdf

**Seaman, W. C.** (1999b). Recombinant poetics: Emergent meaning as examined and explored within a specific generative virtual environment [Doctoral dissertation, Centre for Advanced Inquiry in the Interactive Arts]. Daniel Langlois Foundation Website. https://www.fondation-langlois.org/media/activites/seaman/d00001759.pdf

**Seaman, B.** (2010). *Recombinant poetics: Emergent meaning as examined and explored within a specific generative virtual environment*. VDM.

**Seaman, B.** (2012). The engine of engines – Toward a computational ecology. In P. L. Simeonov, L. S. Smith & A. C. Ehresmann, (Eds.), *Integral biomathics: Tracing the road to reality* (pp. 297–309). Springer. https://doi.org/10.1007/978-3-642-28111-2_29

**Seaman, B.** (2013). Neosentience and the abstraction of abstraction. *Systems: Connecting Matter, life, culture and technology*, *1*(3), 50–67. https://billseaman.com/Papers/Abstraction%20of%20Abstraction_2013.pdf

**Seaman, W.** (2014). A multi-perspective approach to knowledge production. *Kybernetes*, *43*(9/10), 1412–1424. https://doi.org/10.1108/K-07-2014-0145

**Seaman, B.** (2018). Towards a dynamic heterarchical ecology of conversations. *Cybernetics & Human Knowing*, *25*(1), 91–108.

**Seaman, B.** (Ed.) (2022). *The architecture of ideas: The life and work of Ranulph Glanville, cybernetician*. Imprint Academic.

**Seaman, B.** (2022a). Neosentience: Research areas and Insight Engine 2.0 foci. *Proceedings*, *81*(1), Article 14. https://doi.org/10.3390/proceedings2022081014

**Seaman, B.** (2022b). Overview: Neosentience, biomimetics, and Insight Engine 2.0. *Proceedings*, *81*(1), Article 89. https://doi.org/10.3390/proceedings2022081089

**Seaman, B.,** & **Rössler, O. E.** (2011). *Neosentience|The Benevolence Engine*. Intellect. https://doi.org/10.2307/j.ctv36xvrc7

**Simeonov, P. L., Smith, L. S.,** & **Ehresmann, A. C.** (Eds.) (2012). *Integral biomathics: Tracing the road to reality*. Springer. https://doi.org/10.1007/978-3-642-28111-2

**Star, S. L.,** & **Griesemer, J. R.** (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, *19*(3), 387–420. https://doi.org/10.1177/030631289019003001

**Vahaba, D.** (2023, April 17). Brain images just got 64 million times sharper. *Duke Today*. https://today.duke.edu/2023/04/brain-images-just-got-64-million-times-sharper?fbclid=IwAR0DlGqgqPrjHPBtF-j-v

DOI: 10.58695/ec.7

**Von Bertalanffy, L.** (1968). *General system theory: Foundations, development, applications*. George Braziller.

**Von Foerster, H.** (1981). *Observing systems*. Intersystems.

**Von Foerster, H.** (2003). *Understanding understanding: Essays on cybernetics and cognition*. Springer. https://doi.org/10.1007/b97451

**Von Foerster, H.,** & **Poerksen, B.** (2002). *Understanding systems: Conversations on epistemology and ethics* (K. Leube, Trans.). Kluwer Academic/Plenum.

**Von Glasersfeld, E.** (1991). An exposition of constructivism: Why some like it radical. In G. J. Klir (Ed.), *Facets of systems science* (pp. 229–238). Springer. https://doi.org/10.1007/978-1-4899-0718-9_14

**Ward, D.,** & **Stapleton, M.** (2012). Es are good: Cognition as enacted, embodied, embedded, affective and extended. In F. Paglieri (Ed.), *Consciousness in interaction: The role of the natural and social context in shaping consciousness* (pp. 89–104). John Benjamins. https://doi.org/10.1075/aicr.86.06war

**Wiener, N.** (1961). *Cybernetics: Or, control and communication in the animal and the machine* (2nd ed.). MIT Press. (Original work published 1948). https://doi.org/10.1037/13140-000

**Wittgenstein, L.** (1958). *Philosophical investigations* (G. E. M. Anscombe, Trans; 3rd ed). Macmillan.

**Wolfram, S.** (2023, February 14). What is ChatGPT doing…and why does it work? *Stephen Wolfram: Writings*. https://writings.stephenwolfram.com/2023/02/what-is-chatgpt-doing-and-why-does-it-work/

**Zhou, E.,** & **Lee, D.** (2024). Generative artificial intelligence, human creativity, and art. *PNAS Nexus*, *3*(3). https://doi.org/10.1093/pnasnexus/pgae052

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