

# Conversations With, Among, and About Machines

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## Science in the Forest, Science in the Past V

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*Though I speak with the tongues of men and of angels, and have not charity, I am become as sounding brass, or a tinkling cymbal.*

*1 Corinthians 13:1 (KJV)*

*If the triumph of a revolution is to be measured in the profundity of the social revisions it entrained, then there has been no computer revolution.*

*Joseph Weizenbaum 1976, 32*

## Introduction

In 1875 the eminent kinematician Franz Reuleaux, in his masterwork *Theoretische Kinematik*<sup>1</sup>, proposed a system of kinematic notation that he considered greatly superior to the notation advocated by Charles Babbage in a pamphlet for the Great Exhibition of 1851. Reuleaux observed that after two decades, "[Babbage's method had] never been used. No notice was taken of it by those practically interested in machinery, and by this want of attention they added unconsciously to the great irritation which displayed itself in the work which Babbage published shortly before his death. In this he struck about him most vehemently, like Timon of Athens with his spade, accusing his contemporaries of their want of comprehension and appreciation of his work. Without in the least depreciating, however, his most important labours in other directions, it must be said that the cause of the non-acceptance of his system of notation was due to its own defects, and not to those of the public." (Reuleaux, tr. Kennedy 1876, p.250)

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<sup>1</sup> The translator's preface states "The greater part of the *Theoretische Kinematik* of Prof. Reuleaux, which I have now the pleasure of presenting to English and American readers, was originally published in chapters in the *Berliner Verhandlungen*, under the title of *Kinematische Mittheilungen*. These papers, revised and enlarged, and with the addition of a chapter on Kinematic Synthesis, were published collectively in 1874–5 in the work of which the present is a translation."

I will return soon to Babbage and his notation. The computing machinery he envisaged has since transformed the question of notation itself, especially as revealed in our contemporary anxieties about computation and artificial intelligence (AI). But I will start with material concerns that the engineer Reuleaux considered imminent. In a chapter exploring *The Relation of Machinery to Social Life*, Reuleaux regretted that large factories were breaking up home-life, as the artisans of previous generations left their families to operate machines that did not require their craft skills. Reuleaux's solution, suggesting parallels to our own digital era, was the invention of small machines that could be deployed in the home (the sewing machine was already well-established), so that all kinds of artisan could return to working among their families. The only obstacle was the availability of suitable motive force. Steam engines and water mills would be infeasible, but Reuleaux imagined personal machines powered by "the gas-engine, which has lately been brought into practical shape, and perhaps also for small hydraulic motors and hot-air engines."<sup>2</sup>

Like Reuleaux, I am an engineer concerned about the material requirements of interactions among machines, and their social consequences when they disrupt the conversation of friends and families. Also like Reuleaux, I wish to draw attention to the value of notation. The core of his theory was symbolic decomposition of the machine into a relational network of kinematic pairs, each a geometric constraint between two rigid bodies, determining how the whole assembly marshals motive power to act on some material. The mathematical geometry by which force is expressed in action was intended as the basis for a system of invention, allowing many possible mechanisms to be analysed without the cost of building each one. Those advances were essential to automation, or as Reuleaux described it "machinofacture".

## Mechanical 'conversations'

The dynamic interactions of systems and their components can be considered as a conversation *among* machines. For Reuleaux, the 'conversation' involves the transfer of motive power between components, the mechanical forces acting between them, and the constraints that organise those. In today's digital systems, the physical quantities being transferred and exchanged are formalised in Claude Shannon's information theory. The principles of information theory are less familiar to schoolchildren than Newton's equations

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<sup>2</sup> Historians of technology are familiar with the events by which electricity, rather than gas or hot air, became the basis for home machines, including digital computers (Cowan 1985). We might pause at the irony of gas powering computation, now that Babbage's more industrial vision of a 'manufactory for numbers' (Schaffer 1994) has evolved into the 'hyper-scale' data centres whose massive environmental cost is broadcast by the jet-engine roar of the gas turbines with which Elon Musk's xAI data centre horrifies its Mississippi neighbours. Critical AI scholars such as Kate Crawford, in her *Atlas of AI* (2021), draw attention to the real material costs of these conversational systems, and the social consequences of their deployment. When we converse with machines, that conversation acquires a markedly material aspect.

of motion, but are no more complex, just as fundamental, and already anticipated by Babbage and others.

Technical notation is not simply a mathematical format in which to specify a construction, but also a language of thought, with which engineers explore their ideas, discuss and debate them, consider alternatives and so on. Every notation, in every domain, has this dual character – both the mundane specification of details to be implemented, and also a medium for ideation and discourse among skilled practitioners. We might describe the first as a conversation *with* machines, and the second as a conversation *about* machines.

In the remainder of this paper, I examine the kinds of conversation afforded by different notational alternatives, and in particular the ways that computational machines can themselves manipulate notation, playing the role of scribes, clerical assistants or interlocutors in those conversations. There is increasing awareness that some forms of computation, and especially those required to emulate human conversation with large language models (LLM), are extravagantly material, to an extent that threatens environmental harm from large-scale computational machinery. However, it also introduces the problem that ‘natural resources’ of the social domain may be at risk of extraction or depletion. To anticipate my later conclusion, the natural resources that most concern me are the foundations of conversation as (individually) conscious and (relationally) intersubjective.

The inadequacy of Babbage’s notation, in the view of Reuleaux, was that it had nothing to say of Newtonian forces and power, considering only symbolic interpretation of the parts. Babbage was not much interested in motive power or crude geometry. Notoriously, he left such questions to his engineer Joseph Clement, who made clear his belief that he, rather than Babbage, deserved the credit of invention (Schaffer 1994). In modern terms, we might describe Babbage’s immaterial specification as ‘software’, although it was Ada Lovelace who most clearly communicated this, credited for creating the first computer program in her note explaining how to implement a Bernoulli algorithm. Critically, where Reuleaux and Babbage’s notations used mathematical algebra, Lovelace described the representation of her algorithm as a “diagram” whose typographic layout corresponded to the time order of the operations to be executed. Most importantly, rather than mechanism or numerical quantities, the diagram defined the manipulation of *symbols*, which could as easily correspond to words or musical notes as to calculations. Her diagram could specify any “process which alters the mutual relation of two or more things” (Pasquinelli p.70)

The universality that Lovelace recognised in arranging symbols of different types can be compared to Diderot’s Encyclopaedia, which in its great technical variety juxtaposed representations of text and music with pictorial tableaux and the parts of machines. Bender and Marrinan (2010), in their close reading of the encyclopaedia, describe it as establishing

a culture of diagram where systems of visual representation become *working objects*. They take this term from Daston and Galison as reflecting the materials “from which concepts are formed and to which they are applied.”

For the designers of computer systems that manipulate new kinds of representational diagram, encompassing all possible symbolic elements and relations between them, the invention of new programming languages reflects the ancient philosophical ambition to create a ‘perfect language’ (Eco 1997) from which true statements and their combinations can be generated algorithmically. The predecessor of Lovelace and Diderot’s diagrams can be seen in the ‘great instrument of reason’ proposed by Leibniz – described by Rutherford (2006) as a rational calculus whose elements are “signs which possess a determinate content and exactly correspond in their structure to the analysis of thoughts.” Anticipating the Boolean propositional logic of symbolic AI, Leibniz’s experiments described relations between entities with sufficient precision to make it clear that the validity of the resulting inferences would depend on sufficiently precise definition of the entity itself. This semiotic problem has been central to AI ever since, described by Harnad and Searle as the ‘symbol grounding problem’: how do we know that the symbol being manipulated by the computer does correspond to an object in the world?<sup>3</sup>.

Leibniz’s system of mathematical logic was intended to be rigorously universal, anticipating the diagrammatic *Alpha System* of C.S. Peirce, Frege’s *Begriffsschrift* and Shannon’s adoption of Boolean logic operators as digital switches underpinning the propositional logic of digital computing and symbolic AI. However, as Leibniz himself emphasised, all such combinatorial systems are accurate only to the extent that the elements being combined are precisely defined. Perhaps this is why the Haskell programming language favoured by theoretical computer scientists has adopted Leibniz’s term “monad” as a core construct for immutable deduction, although their desire for an immutable referent might also be compared to Ramon Llull’s *Ars Magna*, able to generate all true relations among perfect and eternal qualities.

In all of these diagrams, the construction of syntactically valid combinations according to geometric constraints between the represented parts can be considered as a mechanical “conversation” in which the rearrangement of signs causes information to be transferred. However, as described by Peter Damerow, the activity of manipulating them means that these notational systems become the material tools of mental labour, a socioeconomic foundation of abstraction itself. Just as with Reuleaux’s notation for the engineering analysis of kinematic pairs and Lovelace’s algorithm, all such representations encode and support intellectual work. Whether or not the product being specified is concrete or symbolic,

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<sup>3</sup> One might also note the concern raised by Philip Agre, that AI researchers use philosophical terms without reference to their established definitions and familiar debates.

Damerow reminds us that the diagrammatic notation is itself a material system whose manipulation requires embodied labour.

Conversation *among* machines may be relatively straightforward, requiring only that the entities and relations are equivalently defined by the sending and receiving machine. The machinofacture anticipated by Reuleaux followed his observation of the benefits of part standardisation in gun manufacture, where the parts being combined could be precisely associated with their mathematical specification. In software networks, the exchange of diagrammed algorithms allows one machine to specify the future behaviour of another, as when a digital music file is treated as a musical score, received by a machine that will render it in performance. As observed by Bender and Marrinan, musical notations render the abstraction of time itself as a relation between parts (2010 p.46), along lines that allow Tim Ingold to see conversation encoded as music, and to understand any text as a score to be performed in its reading.

Bringing this lineage to contemporary visual representations such as the screen of a mobile phone, or the graphical 'desktop' of a laptop computer, with their diverse symbolic icons and coloured regions bordering textual captions, we can see these as wholly diagrammatic. Manipulating these material tools of mental labour, as we 'converse' with the machines to express our will, renders us concurrently as engineers arranging parts, mathematicians understanding patterns, and performers of a score. The philosophers whose work across the centuries has led us to this juncture, including Lull, Leibniz and Lovelace, would surely have recognised this realisation of their semiotic ambitions.

The enterprise of professional software engineering relies on programming languages to precisely specify parts that might be incorporated into larger assemblies having desirable engineering properties. This reflects a tension between the temporal performance of the algorithm, described in computer science as an "imperative" language specifying the ordering of actions in time, and logical derivations whose outcome might be mathematically proven, described as a "declarative" language. I suggest that the implication of these conflicting ambitions, in addition to being fundamental to software engineering, also runs through any conversation that a person might have with such a linguistic, diagrammatic, notational, machine.

## The Attention Economy of Conversation

In the sections above, I have described conversations among and about machines as essentially diagrammatic, involving symbolic representation of material parts or abstract entities and the relations between them. All this was already apparent to Lull, Leibniz and Lovelace. It should also be clear that the conversational "chat" of ChatGPT is very different

in kind to the engineering and epistemological foundations of computing I have discussed so far. A diagram, as a mental tool, offers many different conversational uses, from retrieving a specific detail, to diagnosing a fault, instructing a student, or perhaps exploring rearrangement of its structure in a new invention. The diagrammatic personal computer desktop was created for precisely this purpose, to allow freedom of exploration and application by users for many different purposes relating to their own goals.

As users of earlier generations of computer will remember, the previous paradigm of interaction with computers was the 'command line' dialog, where instructions were issued from a keyboard, taking conversational turns to which the machine would respond with acknowledgement or further information. When considering the supposedly transformative potential of a new generation of conversational AI, many have suggested that the future of interaction with computers will revert to this dialog form, with instructions being given to an AI 'agent' that will act on the user's behalf. The engineering precision of diagrammatic notation, it is suggested, is unnecessarily arduous for those who would prefer to speak 'naturally' or 'intuitively' to machines as if they were people.

Whose interests are best served, when replacing the precise reference and freedom of reading in diagrammatic notations with the ambiguous referents and linear temporal constraints of verbal conversation? Huge commercial investments are being made toward the promise of conversational 'artificial general intelligence' – deploying software systems in place of, or as if they were, humans. These investments can be placed in the context of changing economic dynamics, because the manufacturing industries of the 19<sup>th</sup> and 20<sup>th</sup> centuries, and the nation-states that traded in their products, are being replaced by the software infrastructure platforms of companies such as Amazon, Apple, Google and Microsoft who aim capture the attention of their user-citizens in a new global economy of technofeudalism (Varoufakis 2023).

When placed in this commercial context, we can consider the alternatives of conversation and notation from an attention-economic perspective. Herbert Simon classically foresaw that the excess of information in the digital era would result in a shortage of that which information consumes – human attention (Simon 1971). From the 19<sup>th</sup> century perspective of manufacturing economies and material goods, it would have seemed surprising that the richest company of the 21<sup>st</sup> would make no material goods, serving only as an advertising agency that promotes the products made by others, through its capacity to track and manipulate the 'eyeballs' of consumers.

James Williams, in his critical assessment of the attention economy, notes that Adam Smith claimed the purpose of wealth is to be attended to (2018, p.60). If the technofeudalists really resemble feudal lords, perhaps the trading of human attention could be satirised in the style of Gogol, whose novel *Dead Souls* describes a macabre accountancy along those

lines. Nobody accuses Google (as distinct from Gogol) of literally trading lives. But Google's platform services do consume our lives, one second at a time. Each of us may have a billion or so seconds of conscious attention in our time on Earth. One second of attention is one billionth of a conscious soul. The attention economy of eyeballs and clicks could be quantified as an aggregation of "nanosouls", vampirically extracting the traces of human consciousness through the infrastructure that Zuboff (2015) described as *Surveillance Capitalism*.

There is considerable irony in the professed ambition of so many AI researchers to create a *machine consciousness*, as the promised outcome of their technical programme that has proceeded by monitoring, extracting and imitating actual human conversations. Whether framed as speculative philosophy, in which they hope to reveal the mysterious essence of the conscious soul, or as a business investment hoping for a new philosopher's stone of artificial general intelligence (alchemically transmuting the base metal of social media into the gold of eternal wealth and leisure for us all) these are cruel misdirections from the reality of the consciousness-degrading business models that fund their projects.

A suggestion that we pay closer attention to conversation in terms of nanosouls - apparently trivial blinks of conscious time - may seem overwrought when most of us, after all, use computers for only a few hours a day. Surely the nurture of the human soul rests firmly in the material world, in homes and communities, among families, friends and companions, enjoying (if we are lucky) good food, warm clothes, music and dancing, restful sleep and invigorating exercise? Despite the ominous drumbeat of warnings from politicians and media commentators about the perils of AI and social media, is there really any danger to the soul itself? This word is not fashionable in the secular West, although it might reasonably be observed that all the metaphysical commentary on the presence (or not) of 'consciousness' in AI machines is simply a circumlocution where the word soul would have been used quite precisely by the renaissance philosophers I've discussed above.

We can relate these economic dynamics via the neo-Marxian history of AI by Matteo Pasquinelli (2023), in which he draws on Damerow's (1995) account of the material tools of mental labour. Analyses of computation in the light of Marx are justified, given the extent to which Marx himself understood the economic foundations of computing in the work of Babbage (Schaffer 1994). But is labour an adequate category within which to account for the nanosouls of human life? Conversation with computers can certainly be arduous, and Pasquinelli quotes Jonathan Beller "To look is to labour" (Pasquinelli p.233).

Nevertheless, many wisdom traditions persist in attending to the transcendental – subjective experiences that transcend the objective material conditions of the body. As technological education veers from the natural sciences that were understood in the Victorian era to govern the physical world of machinery, to Herb Simon's (1969) *Sciences of*

*the Artificial*, we may need to reflect more phenomenologically on the human origins of computing. In particular, these developments return to perennial concerns with the subjective, with consciousness, with affect (in “emotional AI”) and with the necessary intersubjectivity of “social media” seem to demand an alternative moral-economic framing of computation, not simply an epiphenomenon of material culture in which computational representations may serve as the abstract tools of mental labour.

To return to my comparison between ChatGPT’s “conversation” on one hand, and the diagrammatic representations that were anticipated by Leibniz, Lovelace, and others, do the considerations of conscious attention – consuming human subjectivity by the nanosoul – offer any new perspective on the options that we might choose? Alert commentators ask why the latest conversational AI products so often make tasks *less* efficient than the simpler search engines and graphical interfaces that preceded them. They note that, just as with Spotify playlists and YouTube algorithms, the goal of search companies is to keep the customer engaged, not to improve their lives (Doctorow 2025). When a simulated ‘conversation’ might detain each of a billion users for a few nanosoul-seconds longer than a diagrammatic alternative, the investment dividend that fuels the neofeudal attention economy ought surely to be measured in conscious lives.

## Designing Alternative Conversations

At a previous SFSP, I posed the speculative question of what AI would look like if it were invented in Africa (Blackwell 2021). I was later able to make extended visits to Ethiopia and to the Namibian Kalahari, collaborating with local computer scientists and traditional communities to investigate other ways of framing this sociotechnical imaginary, at a relatively mutable moment, yet to be reified in the product releases of ChatGPT and the commercial revolution of generative AI.

Having set out a theoretical position with regard to machines and conversation, I now return to this methodological strategy to investigate alternatives. What might conversation with machines look like, from outside of this Western genealogy? Are abstractions from the material tools of mental labour inevitably diagrammatic? What future technologies might be imagined, from a concern with epistemic justice for all those who have conscious bodies?

I am particularly interested, given the supposedly inevitable trajectory toward an AI future that promises to entrench current inequities, how perspectives from outside the Western ‘past’ that I have outlined might suggest alternatives from the ‘forest’, which is to say other cultures and environments (perhaps even the subjectivities or consciousnesses of other species beyond the human). Shannon Vallor’s classically-informed ethical critique of AI draws our attention to the tragedy of Narcissus, arguing that we have fallen in love with the

reflection of our own conversations, as statistically mirrored in the models trained to reproduce patterns of our own behaviour (Vallor 2024).

Geoff Bowker imagines *sustainable knowledge infrastructures*, resembling my own advocacy of diagrammatic notations in challenging the reification of the written word with alternative nonlexical representations that may be more open and extensible than scholarly text. He admits, however “A quintessential tension surrounds the deployment of standards and ontologies in knowledge infrastructures. Fundamentally, it consists in the opposition between the desire for universality and the need for change.” (Bowker 2018, p.217). This echoes Vallor’s concern with an artificial imitation of human intelligence that is constructed entirely from the amalgamated data of humanity’s past. She warns that “dependence on these mirrors for self-knowledge risks leaving us captive like Narcissus, unwilling to move forward and leave behind what the mirror shows”. In particular, where habits from the past have led us into global crises of society and its environment, might we need other kinds of wisdom (Vallor suggests that of phronesis) to re-describe or redefine our futures?

The ‘natural language’ of large language models (as it is described by computer scientists and AI researchers) is *natural* only from the perspective of certain people and their communities – the literate, the educated, the wealthy, the able, the conventionally gendered, probably WEIRD people (Henrich 2010). The natural conversations through which humans represent and transfer information is certainly not natural to mice or insects or trees or mushrooms. Whenever conversation is mechanically specified, there are consequences for political economy - David Golumbia, in his cultural critique of computation (Golumbia 2009), suggests that the reification of human language through mechanical computation reflects a corporate control of natural speech through normative application of Chomsky’s generative theories.

As a computer engineer responding to Bowker’s call for new systems of representation, how might I proceed to build knowledge systems beyond the Western history of Leibniz, Lovelace et al, potentially as a route toward more equitable and inclusive forms? What design criteria might be invoked, guided by what moral principles? As Bowker observes, a theory of design is needed.

The history of computer programming languages provides one source of relevant experience, despite the fact that its intellectual origins are derived almost wholly from the Western rationalist tradition. For example, Richard Gabriel is a pioneer recognised for his contributions to the human-centric design of programming systems who drew on the pattern language of architect Christopher Alexander to describe these representational systems as a metaphorical space that is inhabited by the engineers who work there (Gabriel 1993).

My own contributions in this phenomenological tradition have systematised the patterns in user experience that may be encouraged or afforded by alternative design options for new notations (Blackwell & Fincher 2010, Brazauskas & Blackwell 2024, Blackwell forthcoming). Importantly, critical understanding of computer programming extends beyond the business automation of mental labour as documented by Damerow and Golumbia, to include playful tools for creative and artistic exploration, live coding notations for improvised music or dance (Blackwell, Cocker et al 2022), and the esoteric languages – esolangs – that often resemble jokes or thought experiments rather than practical business tools (Temkin 2025). These artistic and conceptual threads are often brought together as a basis for political critique, for example in Geoff Cox's *Speaking Code* (2013), and potentially responding to David Graeber's advocacy of the arts in response to the infrastructures of technocracy (2015).

An understanding of the patterns of human experience in use of notations seems relevant, for the project of reframing conversation with machines. And the moral hazards of the technofeudal attention economy offer an *antipattern*, for a designer who aspires to construct more equitable and just foundations. How does one navigate the available options, if the objective in conversing with and about machines is to enhance human consciousness rather than degrade it?

A critical early stage in my own project will be serious engagement with alternative knowledge traditions, emphasising elements of human experience and knowledge that have been de-emphasised in the Western project of abstract representation. I expect such knowledge to be culturally situated and grounded, requiring fieldwork to properly engage with those recognised or their traditional wisdom (considering the Sage Philosophy of Henry Odera Oruka (1990)) alongside the cultural innovators who resist colonial legacies (attending to the warnings offered by Linda Tuhiwai Smith in *Decolonising Methodology*). I am making provisional plans to work with philosophers and artists based in a Yorùbá-speaking cultural organisation in Nigeria and a Māori-speaking institution in New Zealand.

The most important metaphysical foundations are unlikely to be straightforwardly rendered in English, posing a challenge that is only too familiar to the professional anthropologist, but further complicating the application of established engineering design and human-centric user research methods.

The guiding questions that I hope to bring to this design research project (and for which I will be grateful to receive corrections or advice from SFSP participants) include:

1. How could one study subjective and inter-subjective conscious attention as a basis for understanding novel computational formalisms in non-Western notations?

2. Are there phenomenological methods suited to investigating the subjective experiences of interacting with such notations?
3. How could one determine whether anticipated novel experiences with computational notations would be more, or less, nourishing of the conscious subject, by comparison to technologies that reduce the subject to a machine?
4. What varieties of novel experience are intersubjectively constitutive of a collective consciousness, in a manner that social media and AI products often seem not to be?
5. Is it possible for the material exercise of intersubjective consciousness to be persistent and generative, perhaps beyond the embodied lifespan of the individual subject?

Although slightly tortuous in their phrasing, these questions are designed to directly address the challenges of the Western social media / AI / surveillance capitalist / technofeudal economy, while not presuming the conventional Western critiques, whether Marxist, anarchist, or libertarian. They also pertain directly to the gauntlet thrown down by Bowker, and the unsettling conclusions of my own paper at SFSP IV, asking whether recent developments may require a post-text academy. Finally, whether effective or not, they are at least commensurable with my own expertise and make use of my technical skills in the design of programming languages. As in each of my previous contributions to these workshops, I continue to work in the rigorous tradition of Philip Agre's critical technical practice (1997), committed to building things in the hope of understanding them.

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