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The Ashby Box as Situated Object within Context

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> Abstract • We explore the implications of the design of the hand-held Elementary Non-Trivial Machine, a contemporary reconstruction of the Ashby Box by Thomas Fischer and Hengjie Li. Situating it in conjunction with earlier speculative efforts by Fischer in collaboration with Andrei Cretu, we consider the evolution of early cybernetic concepts and artifacts and their continuation in contemporary socio-techno landscapes. Applying the dynamic framework of Gilbert Simondon's philosophy on the evolution of the technical object, an emphasis is placed on the interplay between machines and their associated milieu as well as the role of material and human intentionality in the development of knowledge-bearing artifacts.

« 1 » The Ashby Box, originally conceived by cybernetician Ross Ashby, is an epistemic object that embodies ideas emerging within cybernetics and systems theory in the mid-20th century. Central to the understanding of the device is Ashby's concept of the black box. Originating from practical challenges faced by engineers working with electronic *black boxes*, the black box problem as a theory, model, tool, and metaphor, permeated various disciplines perpetuated by cybernetic investigations (Petrick 2020). Ashby's black box theory expanded upon earlier technical and engineering usages of the term to embody broader approaches to the study of complex systems and our interaction with the worlds we inhabit (Ashby 1957: 110–113).

« 2 » In their target article, Thomas Fischer and Hengjie Li elaborate on a modern reconstruction of the Ashby Box. Motivated by the recognition that the original historical artifact is inaccessible to a wider audience (§16), Fischer and Li utilize contemporary electronic components and manufacturing methods in designing and producing a hand-held Elementary Non-Trivial Machine (Elementary NTM) that seeks to preserve Ashby's original aims (§30). To fully understand and discuss the Elementary NTM, it is useful to consider the trajectory leading up to this point. Between 2018 and 2019, guided by limited knowledge of its internal workings, Fischer, in collaboration with Andrei Cretu, constructed two "speculative remakes" of the Ashby Box using components common during the time of the original device's creation (Fischer & Cretu 2023: 181–187). These earlier investigations and experiments led to the current microcontroller-based prototypes.

« 3 » In the following, we consider the collection of technological artifacts created within this line of inquiry. Analysing these various remakes in connection to the original Ashby Box reveals a fascinating interplay of tensions between reproduction and reinterpretation strategies. From an ontological perspective, it illuminates the genesis and evolution of a category of cybernetic objects, particularly, the Black Box, from abstract model to concretized artifacts.

« 4 » Before delving into specific discussion and analysis of technical objects, we would like to first address the shapelessness of the black box. Tracing the deep history of the black box metaphor reveals a history that predates cybernetics and modern technical objects. As historian of science Dagmar Schäfer suggests, human interpretation and tangible manifestations of the black box remain consistent throughout history and across geographies as "a useful device and thinking tool" when considering knowledge (Schäfer 2020: 321). Yet the functional relationship between the black box and knowledge shifts and changes throughout the centuries and can be understood from equally optimistic and critical points of view (ibid: 309). In this context, shapelessness can therefore be understood from three aspects: the evolving idea of the black box as a concept; the numerous ways in which it manifests as tangible objects; and the changing context in which it may be perceived and understood. While this all-encompassing concept of the black box parallels the wide-ranging intended applications proposed by Ashby (1957: 86) and other cyberneticians, it presents challenges to its own analysis as a boundary object. Boundary objects exist as communication vessels at intersections of different social worlds (Star & Griesemer 1989: 393), divisible by disciplinary, social, cultural, or temporal borders. They emerge organically out of "information and work requirements" and assist in structuring practices (Star 2010: 602). As a metaphoric object, a technical object, a media archaeology object, a designed object, and an epistemic object, the difference of intentionality situates the black box, and by extension the Ashby Box, in different knowledge and meaning systems. Furthermore, within this context, boundaries, along with boundary objects, are not static, but instead co-evolve throughout time (Leonardi, Bailey & Pierce 2019: 665f). Meaning making becomes a "many-to-many mapping" (Star & Griesemer 1989: 390) of communication flows.

« 5 » To better understand the readings and interpretations that are carried over and further grasp the framework of translation, it is necessary to define and specify the specific boundary and shared structures and spaces in which the Elementary NTM may be situated. When considering the adaptation of cybernetic objects, how does one determine whether the designers' intentionality matches or diverges from that of earlier cyberneticians such as Ross Ashby? Q1

« 6 » In *The Cybernetic Brain: Sketches of Another Future*, Andrew Pickering describes Ashby's Black Box theory as a Black Box ontology, equating it to a cybernetic ontology that is concerned with performance over presentation (Pickering 2010: 20–24). However, he points to a lack of interest in ontological discourse within cybernetic circles, suggesting that a favouring of epistemological approaches may result in the eventual disappearance of "performative materiality" that characterized early cybernetic explorations. Furthermore, Pickering argues for an ontology of cybernetics that may assist in the conception of the field and its research agendas at large (ibid: 25f). Similarly, when considering reconstructions, an ontological analysis of the Black Box and its material embodiment, the Ashby Box, is necessary. It assists in clarifying what is being preserved and re-enacted in subsequent remakes. In the following, we expand upon this point in situating the Black Box and the Ashby Box as technical objects within associated milieus that develop over extended periods of time.

« 7 » In his seminal 1958 work, *On the Mode of Existence of Technical Objects*, Gilbert Simondon proposes an adaptive view of technical objects that emphasizes the relationship between machine and associated milieu. He argues that the genesis and evolution of technical objects emerge as a necessity through recursive adaptation with the associated milieu, where the milieu provides recursive feedback to the technical object and is "homeostatic" (Simondon 2017: 61). Here, associated milieu simultaneously comprises the geographical and the technical, the former encompassing natural and energetic components that facilitate the functionality of the technical object, and the latter providing the foundation by which technical objects could be conceptualized, produced, and engaged with (ibid: 54f). The technicity of a technical object can thus be examined through the different orders of magnitude from the perspective of technical elements, technical individuals, and ensembles (ibid: 65f).

« 8 » Before considering the Ashby Box within this framework, we must first clarify the definitions of technical elements, technical individuals, and ensembles. The technical element can be understood as a fundamental component that does not function independently but serves as building blocks for more complex systems. These elements have the capacity to be embedded into technical individuals (Simondon 2017: 66). The technical individual is uniquely defined by its associated milieu in that its milieu exists as a condition of its functioning (ibid: 63). Furthermore, technical individuals can assemble and group themselves into ensembles, networks of independent technical objects coupled with their respective associated milieus, yet inter-dependent of each other (ibid: 65f). A contemporary example at the level of technical elements is the microcontroller, a modular component that can be embedded into more complex digital devices. Digital devices, such as the smart phone or laptop, occupy the space of technical individuals. They are more conventionally what we conceive as technical objects. However, it is important to point out here that the scope of these technical individuals expands beyond the physicality of the device to include associated milieus that constitute the functioning of the object (i.e., electricity, wireless connection, etc.). Finally, a smart home network, consisting of smart phones, laptops, sensors, and software, could be understood as an ensemble, in that each device within the network distinguishes itself from other technical individuals, but at the same time co-exists within a shared space, with inter-dependent devices. This demonstrates the complexity of technical objects that deviate from mere material and form considerations towards a multi-layered and dynamic understanding of functionality. This is especially the case when considering modern technologies.

« 9 » Ashby's black box schema materializes through artifacts such as the Ashby Box and its later remakes. Through these individual technical objects, we can more systematically consider the adaptation and translation process of the black box theory and its integration into contemporary contexts and technological cultures. An analysis of the Elementary NTM can thus be made at three levels. Fischer and Cretu's 2018–2019 speculative remakes of the Ashby Box initially sought to replicate the original artifact that prioritized material accuracy. This is seen through the material choices of components such as the Enigma rotor and uniselector employed in the reconstruction (Fischer & Cretu 2023: 185–187). Conceptually, these speculative remakes occupy a liminal space between historical and contemporary material contingencies, which restricted the demonstrative capabilities of the device, and in doing so, obscured the communicative clarity of the technical object. By contrast, Fischer and Li's later redesign shifts the focus from re-presentation to re-enactment (§30). At the elementary level, this translation of components was necessary and crucial in adapting the Ashby Box for a contemporary audience.

« 10 » When considering the Elementary NTM at the level of the technical individual, more complex questions concerning functionality and associated milieu emerge. Beginning with function, the authors' intentions for the Elementary NTM bifurcate into two different subsets of objectives. The first positions the Elementary NTM as an operative media artifact that seeks to re-enact an experience that is similar to the original Ashby Box's interactions (§30). In this case, that is a machine with a two-bit input (two switches) and a two-bit output (two LEDs) that demonstrates a feedback behavior that is governed by a large number of possible state transitions (§18). The second objective goes beyond the specificities of the device and positions the Ashby Box as an epistemic object (§10) that demonstrates the limits of knowledge, specifically, experience-based induction (§14). As Ranulph Glanville points out in his 2009 article "Black boxes," the observer is a key aspect of the black box ontology. Through continued recursive feedback over time, the observer constructs the concept of the black box, and through this process, also defines and redefines the relationship between herself and the black box artifact. This relationship can be dynamic and transcendental (Glanville 2009: 157–165). In this sense, the observer becomes the associated milieu by which the black box artifact may function as an epistemic object. As acknowledged by the authors, a recontextualization of the artifact is necessary (§§30–32). However, before this, a deeper analysis of the observers of the Elementary NTM and the ways in which the observer may engage with this device may be needed to further speculate on the efficacy of the reconstruction. What would the evaluation of the efficacy of the reconstruction entail? How would one conduct a deeper analysis of the observers of the Elementary NTM and the ways in which they may engage with this device? Q2

« 11 » In today's socio-techno landscape, observers are confronted with a multitude of trivial and non-trivial machines ubiquitously embedded in their everyday environment, even reshaping these environments. These ever-increasingly complex ensembles fuelled by vast data streams in multidimensional technical infrastructures challenge conventions of perception, experience, and interaction. Increasingly, the technical milieu overpowers the geographical milieu, in both virtual and concrete ways, for better or for worse. This shift, while driven by technological advancement, is also ideological, socio-political, and cultural. In view of this landscape, what is contributed to contemporary discourse on technology through the Elementary NTM? What new perspectives are introduced? Q3

« 12 » Tracing the historical context from which Ashby's Black Box theory emerged, the mid-20th century marked a paradigm shift from classical mechanistic systems to a general systems theory that embraced complexity, laying the foundation for today's technologically saturated computation age and the complex systems lens by which we understand it. Cybernetics and systems education and discourse are more than ever necessary. Fischer, Cretu, and Li's development of the various Ashby Box remakes reflect the broader challenges of balancing historical preservation with contemporary adaptation. Ultimately, their efforts in preserving and bringing to light important cybernetic concepts for a contemporary audience are valuable and commendable.

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