UTOPIA COMPUTER

The »New« in Architecture?

Nathalie Bredella, Chris Dähne,
Frederike Lausch (Eds.)

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The critical concern of the book "Utopia Computer" is the euphoria, expectation and hope inspired by the introduction of computers within architecture in the early digital age. With the advent of the personal computer and the launch of the Internet in the 1990s, utopian ideals found in architectural discourse from the 1960s were revisited and adjusted to the specific characteristics of digital media. Taking the 1990s discourse on computation as a starting point, the contributions of this book grapple with the utopian promises associated with topics such as participation, self-organization, and non-standard architecture. By placing these topics in a historical framework, the book offers perspectives for the future role computation might play within architecture and society.

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GREGORY ELIAS CARTELLI

Machines, Fabrics, and Models

ARTORGA and Biology's Cybernetic Utopia

In the mid-1950s, the investment banker Oliver Wells, the operations researcher Stafford Beer, and the cybernetician Gordon Pask collaborated on an experimental publication, ARTORGA*. ARTORGA was a series of experiments that sought to revise cybernetics' disciplinary history, claiming its origins in biology rather than information theory and operations research. The project represented an effort to retain both biological complexity and organic matter in the conception and construction of organizational structures. ARTORGA's proposition of a textile logic of "fabric" can be read as a moment of resistance that prompts a reconsideration of how architecture's attention to the biotic was translated into the computational.*

An invitation

"The first organism will be one which helps to design itself. This and further papers will be the fabric of the organism. It is hoped that you will participate as part of this organism. (you are being invited to act like a cell in the organism)."[1]

Copies of this invitation, part of a three-page document titled "ARTORGA (ARTificial ORGAnism)," were mailed to roughly 4,000 specialists in biology, operations research, and electronics in December, 1958. The mimeographed pages detailed this organism's premise, technique, practice, and mode of development.

1 ARTORGA, no. 1 (December 1958): n. p.

ARTORGA was founded on the belief that a machine, which functioned as an organism, could be created by applying certain parameters onto material, broadly construed. In order to generate its techniques, ARTORGA utilized a non-deterministic approach. The invitation asked recipients what they considered to be the essential principles of life, what could be viable materials for its artificial versioning, and what role design played in evolution and growth: "is it necessary to predict the behaviour of the organism?"[2]

For ARTORGA's founders, the retired investment banker Oliver D. Wells, the operations researcher Stafford Beer, and the polymath cybernetician Gordon Pask, the answer to this question was resoundingly negative. Instead, they proposed that ARTORGA's behaviour be autonomic. ARTORGA's first monthly mailer, referred to as the organism's "communications," noted that it had "no specified aim other than to be"[3]; its sixth declared that its process was "to imitate the living, to develop slowly and with no specified goal."[4] Wells, Beer, and Pask framed the indeterminate teleology of the living as a fundamental technique in order to extrapolate the autonomy of biological life into a larger ideology of self-design, one intended to effect the materiality of the technological, the operation of the artifactual, and, ultimately, to prompt a reconceptualization of knowledge itself. A new form of the present, redefined and reoriented by a biological a-priori, would fulfil their vision of a world in which an inherent, albeit abstracted, humanism would counter the dehumanizing and, more importantly, inorganic processes of mechanization and automation. Operating across scientific, aesthetic, and industrial spheres, Wells, Beer, and Pask understood their biological retrenchment as a progressive position from which to reassert the importance of the organism, if not of a certain organicism.

2 Ibid.

3 Ibid.

4 ARTORGA, no. 6 (May 1959). For clarity, ARTORGA as an object will be referred to in the indefinite singular *it* and *its*. As a subject, with agency ascribed to Pask, Beer, and Wells, its pronouns will be *they* and *their*.

The various projects encapsulated under the title ARTORGA—from the investigation of the utility of organic fabric to the instantiation of the periodical's organismic network and to the production and sale of a device called the "Penrose Machine"—were all premised on the possibility of utilizing biological principles to generate new epistemologies. This was more than simply a restatement of the "elementary order" which characterized the mimetic behaviour of Organicism, a substitute for the unitary rhetoric of holism, or even a reference to the organizational paradigms developed during the 1950s, wherein series of agentive forces and objects were presumed to find coherence within a total form. Further, its brand of vitalism was not one derived from metaphysics or otherwise abstract or dematerialized principles, but, instead, was drawn from biological matter itself. ARTORGA's focus on the utility of the living can thus be linked to the impact of what period rhetoric would refer to as "biological thinking" or, as one of the group's members proclaimed, a "Bio-Logic."[5] However, the difference between life and knowledge was not as clear as it might appear. Ultimately, epistemology was to be seen as a biology unto itself as it was when Pask would mix their meanings by rhetorically posing the possibility of constructing machines that might induce "new kinds of biologies" and "bio-social engines" just before putting that theory into practice.[6]

A body

Premised on the possibility of autonomically generating organic principles for the production of "artificial organisms," ARTORGA's import rests in its recuperation of biology as a viable agent of design writ large. By departing from the mechanical and

5 Heinz von Foerster, "Bio-Logic," in Biological Prototypes and Synthetic Systems, eds. E. E. Bernard and M. A. Kare (New York/NY: Plenum Press, 1962). Von Foerster makes the case here for an understanding of the "fundamental principle of living things their capacity to form coalitions," a conception related to ARTORGA's work with "fabrics."

6 Gordon Pask, untitled notes, 1953; Gordon Pask Archive; The Archive of Complexity at the Institute of Contemporary History; Universität Wien, Austria; 11_32-199-1.

organizational bias of computation and Operation Research's concept of "command and control"—which was reflected in contemporaneous architectural discourse and practice through early parametric designs—ARTORGA represents a materially sensitive conception of computational architecture, one linked to the biological imaginary of the post-war period. For example, while the Italian architect Luigi Moretti was querying the relationship between form and structure, his system of ordered differences creating a proto-semiotics of design and his modified military equations generating curvilinear forms in a transparent mathesis of structure, Wells, Beer, and Pask were content to let the intractability of the organic drive their experimental procedures (fig. 1).[7] Their consideration of biological life as a method, rather than a model, provides a case that allows us to revisit and revise the aspirations of the assembly-driven superstructures of the 1960s.[8] Though during the tenure of ARTORGA's operation, Pask and Beer were not (yet) architects in the disciplinary sense, their work during this period can be used to rethink their later architectural projects, which have often been cast by architects and architectural historians as a valorisation of the technological, and as a dematerialization of the body for the sake of its structure. For instance, Pask's technical programming for Cedric Price and Joan Littlewood's Fun Palace was derived from his earlier work with the organic systems considered in ARTORGA's experiments. Beer's Cybersyn Project for the Allende regime in Chile was similarly premised on models of stability he viewed as fundamentally biological—going so far as to argue, in 1964, that cybernetics had "sprung from biology" instead of developing from information

7 Luigi Moretti, Exhibition of Parametric Architecture and of Mathematical and Operational Research in Town-planning (Milan: Palazzo dell'arte, 1960).

8 These vertical or horizontal superstructures and megastructures based on the grid as a principle of total design, by architects such as Ionel Schein, Claude Parent, Yona Friedman, et. al. represented the techno-imaginary of the "spatial urbanists" of the 1950s and 1960s as analyzed by the architectural historian Larry Busbea. Busbea remarks how the key programmatic ideals of these architects were "portability, transportability, movement, and adaptation." While similar in kind to the goals of ARTORGA and its biological architects, they differed vasty in method. See Larry Busbea, Topologies: The Urban Utopia in France, 1960–1970 (Cambridge/MA: The MIT Press, 2007).

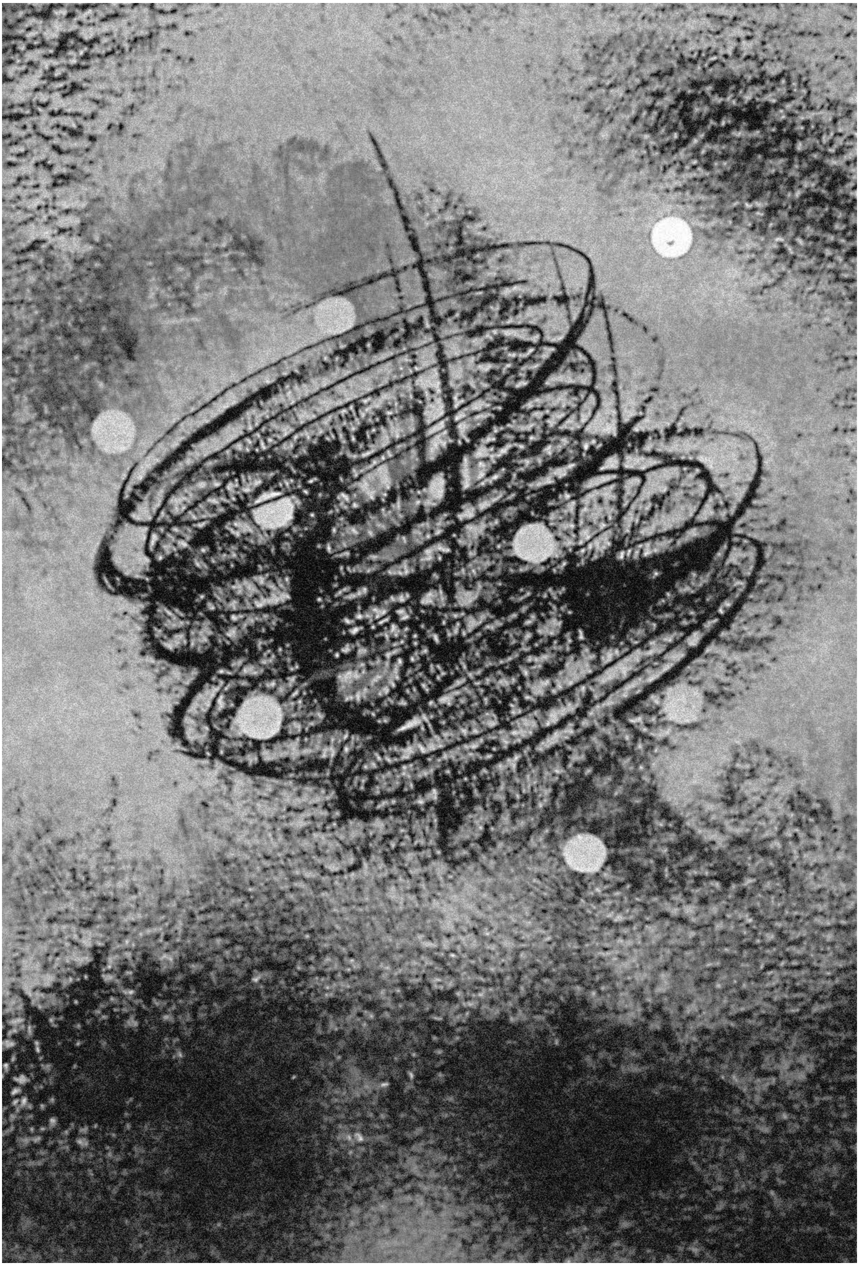


Fig. 1: Cover image of *ARTORGA*, no. 6 (May 1959). Source: *ARTORGA*, no. 6 (May 1959)

theory or operations research.[9] This disciplinary revision was rooted in the period's understanding of biological matter as a reparative media: a conceptualization of the generative potential of life.

These operations contrast conventional narratives concerning the emergence of information theory in the immediate post-war period. These narratives affirm that the repurposing of wartime technologies and disciplines for peacetime purposes led to the proliferation of informational representations of the organic body, which numerically and symbolically rendered its capacities and behaviours.[10] The premise and promise of these operations lay in their relationship to systems of control: the hope that yet another post-war reconstruction could be enacted. However, this time it would not be a reconstruction of the city or the state but a reconstruction of the self. As the historian of science Peter Galison notes, in the earliest strains of the cybernetic interdiscipline, it was not that humanism, physiology, or demography would define this new personhood, but rather that the overriding belief that servomechanical theory, the reduction of human agency to an almost behaviourist formula of mechanical inputs and outputs, "would become the measure of man."[11] Following on from this premise, the architectural historian Reinhold Martin has related

9 Stafford Beer, "The World, The Flesh, and the Metal: The Prerogatives of Systems," Nature 205, no. 2968 (1965): 234. See also Pamela M. Lee, Think Tank Aesthetics: Midcentury Modernism, the Cold War, and the Neoliberal Present (Cambridge/MA: The MIT Press, 2020). Eden Medina, Cybernetic Revolutionaries. Technology and Politics in Allende's Chile (Cambridge/MA: The MIT Press, 2011).

10 See Lily E. Kay, Who Wrote the Book of Life?: A History of the Genetic Code (Stanford/CA: Stanford University Press, 2000). For a more varied selection, see Bernard D. Geoghegan, "From Information Theory to French Theory: Jakobson, Lévi-Strauss, and the Cybernetic Apparatus," Critical Inquiry, no. 38 (Autumn 2011): 96–126. Geoffrey C. Bowker, "How to Be Universal: Some Cybernetic Strategies, 1943–70," Social Studies of Science 23, no. 1 (Feb. 1993): 107–127. Fred Turner, From Counterculture to Cyberculture, Stewart Brand, The Whole Earth Network, and the Rise of Digital Utopianism (Chicago/IL: University of Chicago Press, 2006).

11 Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," Critical Inquiry 21, no. 1 (1994): 233. Bowker, op. cit. proposes the term "interdiscipline" to characterize the variety of professions, fields, and practices, that together composed "cybernetics." In adopting this term, I look to highlight the particular European formation of cybernetics which consisted of greater disciplinary variety than did the American branch which, as Galison notes, was primarily defined by servo-mechanical theory first developed within the American war-machine.

these base practices of cybernetic control to the development of "efficient mechanisms of self-organization... [which] helped invent new kinds of cities, new kinds of architectures, and with them a new 'self.'"[12]

But such a narrative relies on the fact that cybernetics not only predicated a collapse between the physical and the psychic, the interior and the exterior of the body, but a complete ontological revision of what a body was. This was a transformation that combined the dematerialization of the corporeal—its abstraction into numbers, diagrams, and algorithms—with a rematerialization of its operations as the mechanical realizations of "information" represented by those numbers, diagrams, and algorithms. Yet the dream of cybernetic interaction as a new politic often resulted in more dismal realities. The relegation of personhood to tabulated variables as a means of accessing a natural, thermodynamic conception of the operation and regulation of systems resulted in dehumanizing processes of corporate management and predefined methods of stimulus and response. Either way—materially or spiritually—the utopia of the computer obviated the body. As the literary scholar N. Katherine Hayles' investigation of how "information lost its body" to the advances of the post-war technosciences reminds us: "for information to exist, it must always be instantiated in a medium."[13] Yet this narrative proceeds along the lines of the progressive de-corporealization of information. As organic processes become mirrored by computational logics, the translation of life into operations loosens its relationship to matter, eliding the necessity of considering the materiality of living things. The homologies between the animal and the machine that had rooted the cybernetic interdiscipline's earliest text were soon replaced by computational logics.[14]

12 Reinhold Martin, The Organizational Complex: Architecture, Media, and Corporate Space (Cambridge/MA: The MIT Press, 2003), 7.

13 N. Katherine Hayles, How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics (Chicago/IL: University of Chicago Press, 1999).

14 Evelyn Fox Keller has traced the fluctuations of the ontological categories delimited by the cybernetics, from Kant to Maturana and Varela's Second Order Cybernetics in Evelyn Fox Keller, "Organisms, Machines, and Thunderstorms: A History of Self-Organization, Part One," Historical Studies in the Natural Sciences 38, no. 1 (Winter 2008): 45–75.

The realization of ARTORGA's organic ideology assists in the restoration of corporeality to Beer and Pask's computational "architectures," and to architecture itself, whose corporeal metaphors obviate material distinctions in the same way as cybernetics. Writing on the body in post-rationalist architecture, the architectural historian Anthony Vidler finds it "lost," an aporia he implies results from the atomizing ideology of deconstructionism.[15] While this departure from anthropometric rationalism can be understood as the emergence of the "body-as-organism," as the architectural historian Emmanuel Petit has described it, only a slightly more biologically affirmative interpretation of the networked "body without organs" is achieved.[16] Whether in Martin's portrayal of the subjecthood of the indistinguishable "self" or in Vidler's portrayal of architectonic and psycho-aesthetic dismemberment, architecture never loses bodily analogies, but it does indeed lose the body.

Accordingly, functioning as a pre-history to these events, which is also pre-architectural (though no less tectonic), ARTORGA departed from the consistent immateriality and absence of architecture's bodies by attending to the changing materiality of the informational body. Instead of rendering the biological in the terms of the mechanical, Wells, Pask, and Beer performed cybernetics' disciplinary exchange in reverse: attempting to model mechanical information systems in non-symbolic terms through the recruitment of biological models, and, more explicitly, organic matter. Exceeding metaphoric transposition, this inversion involved the recomposition of the material basis of the machine itself through the use of extant life-forms as constructional components. What this amounted to was an attempt to restore a body to cybernetics' informational schema. However, this body was not considered human (or intellectual), nor machinic (or computational), but simply biological.

15 Anthony Vidler, The Architectural Uncanny: Essays in the Modern Unhomely (Cambridge/MA: The MIT Press, 1992), 70.

16 Emmanuel Petit, "On the Entrails of Architecture's Organism," Perspecta, no. 42 (2010): 168–175.

An interview and an exhibition

In August, 1961, an image of two men standing on a hill in Hampshire, England accompanied the article "ARTORGA: une extraordinaire société scientifique" in the French popular-science journal *Science et Vie* (fig. 2). The interviewer, Gérald Messadié, was pictured looking down at a long horizontal object held by ARTORGA's financial manager, Oliver D. Wells. The object, named the Penrose Machine, consisted of a three-foot long L-shaped wooden bracket holding a series of identical wooden forms. The caption described how the device was used "to make the members of ARTORGA understand the simultaneously extremely simple and extremely complex principle of protein formation."[17] Wells used the magazine feature as a soapbox to proclaim ARTORGA's radical goals and deliver a condemnation of contemporary science. Targeting what he viewed as obsolete concepts: those which reinforced the "elemental splits" of mind and body, structure and function, animate and inanimate, and body and environment, Wells declared "We must reconsider everything."[18] Throughout the interview, he pushed against conventional cybernetic relationships between humans and machines, deriding the habit of fashioning thinking machines from the structure of the brain. He argued that to design a brain was to inherently constrain its operation. Picking a flower from the hillside and continuing his demotion of the status of machines based on humans, Wells ruminated: "this plant is not just an electronic wonder; by its agreement with its environment it is an admirable example of self-organization. It is from it that cyberneticians must be inspired."[19] For ARTORGA, the promise of cybernetics lay in understanding how organic fabric, rendered on a level that included the individual, societal, and environmental interactions of organisms, could be coupled to the artificial

17 Gérald Messadié, "ARTORGA: Une Extraordinaire Société Scientifique," Science et Vie (August 1961), 114. Translation author's own.

18 Ibid., 115.

19 Ibid.

ARTORGA

M. Wells (à droite) qui dirige Artorga et notre reporter G. Messadié

Pour bien faire comprendre aux membres d'Artorga un principe à la fois très simple et très complexe de la formation des protéines, Oliver D. Wells a fait fabriquer un modèle en bois, appelé « machine de Penrose » qui fascine les savants internationaux. Secoués d'une certaine façon, les éléments de la « machine » se combinent pour former des paires dans un certain ordre, tout comme, apparemment, les protéines.

Fig. 2: Cover image depicting Gérald Messadié, Oliver Dimock Wells, and the Penrose Machine. Source: "ARTORGA: Une Extraordinaire Société Scientifique," *Science et Vie* (August 1961)

systems and constructs of society in order to improve, or indeed replace, them.

The object in Wells' hands in Hampshire had first debuted at the London Institute of Biology's annual "Conversazione" in 1957, under the title "A Self-Reproducing Analogue" (fig. 3). Created

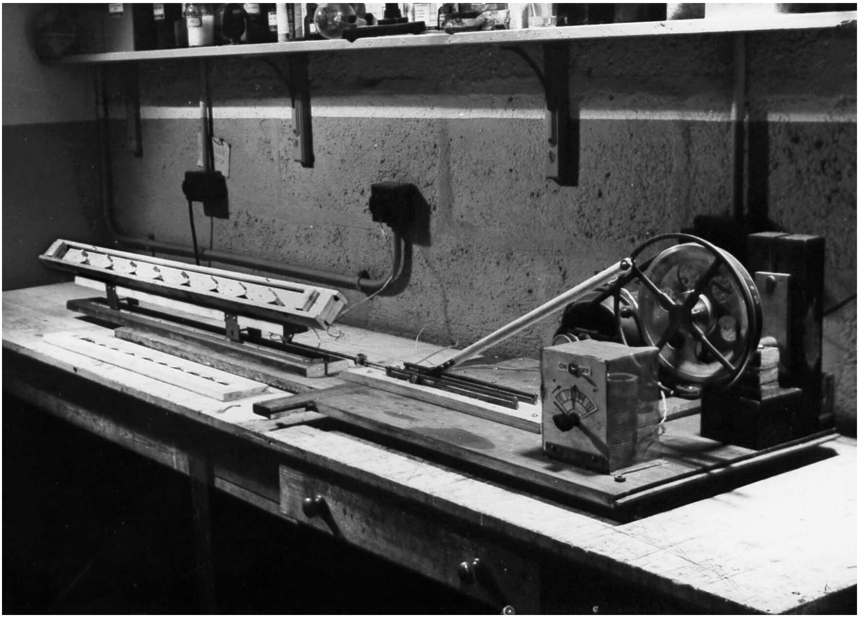


Fig. 3: Penrose's simple elements were arranged in their track and hooked up to a linear force applicator at his workshop in the Galton Laboratories. Source: Penrose Papers, UCL Special Collections; 2/12/16/4, 63r

by the geneticist Lionel Sharpless Penrose, the Penrose Machine was an object lesson which synthesized ARTORGA's project. It represented the process of pseudobiosynthesis, demonstrating "how objects with specified properties can be assembled so that they generate precise copies of themselves."[20] When arranged end to end and subject to lateral kinetic force, the blocks remained inert. However, when two blocks were manually joined before the application of force, the other blocks would respond to the composite by replicating its structure. The device thus represented both self-reproduction and self-organization. It combined in an

20 Institute of Biology, London Branch, "Details of Exhibits at the Conversazione," June 25, 1957; Penrose Papers, University College London; London, United Kingdom; 2/12/2/3, 39. See also, J.L. Cloudsley-Thompson, "Institute ofBiology Conversazione," Nature 180, no. 4581 (August 1957): 319.

inanimate object what for Wells, Beer, and Pask were the defining characteristics of organisms: the stability and viability provided by homeostasis and its transitive property of self-organization.

The conditions of the Machine's development reflected its ontological uncertainty. Rather than based on mathematical theorems, Penrose utilized John von Neumann's logical description of self-reproduction, the automata theory first articulated in 1948. The logical description of self-reproduction that von Neumann composed embodied a radically different conception of organic operations than information theory would have supplied. Though the Penrose Machine might have appeared to be nothing more than a demonstrative device, it reflected how complexity might be developed rather than structurally detailed. Instead of a series of equations representing a process, von Neumann's theory operated as a series of logical axioms that described an organism: a teleological system that was fundamentally related to the biological process that it was modelled from.[21] With von Neumann's theory as a foundation, Penrose's Machine allowed for the intractable nature of organic operations to become tacitly accessible, without recourse to mathematic or logical abstraction. Moreover, in its active wooden form, it represented a process as well as an object or an "artifact."

Accordingly, compared to the naturalistic representations of life that populated the exhibition hall, these wooden shapes must have seemed strikingly out of place. Yet, considering the Perspex economy of scientific models in post-war Britain, it would not have been so surprising to encounter inanimate objects that represented the critical components of biological life.[22] However, the Penrose Machine differed from the physical structures that proliferated in laboratories, journals, and television broadcasts in the 1950s. As a kinetic representation of a process, it possessed

21 See John von Neumann, Theory of Self-Reproducing Automata, ed. Arthur W. Burkes (Urbana/IL: University of Illinois Press, 1966).

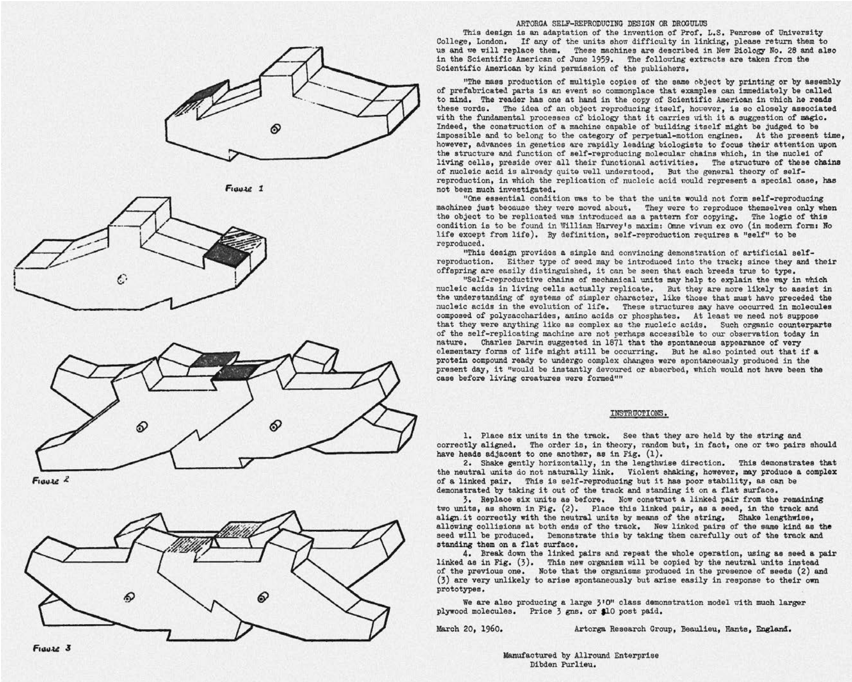
22 The term Perspex economy comes from Soraya de Chaderavian. See "Introduction" and "Models and the Making of Molecular Biology" in Models: The Third Dimension of Science, eds. Soraya de Chaderavian and Nicholas Hopwood (Stanford/CA: Stanford University Press, 2004), 1–19 and 339–369.

an animate nature of its own. Its appearance signalled how the abstraction of life into a formal operative theory could lead to its physical materialization in a mechanized form. What was most striking about the wooden blocks was how the agency of their procedural abstraction allowed the machine to be understood as neither artificial nor natural. It was instead widely considered as simply representative of a biological process.

Accordingly, the machine's form and operation align with how Judith Roof has depicted the popularization of biological disclosures as representing a merging of "element and principle": the convergence of a structure and its explanatory process that she first locates in the cultural effect surrounding the at once materialist, mechanical, and vital discovery of DNA's structure.[23] Roof extends this argument to the simultaneous development of structuralist paradigms in psychoanalysis and anthropology, illustrating the construction of a biologically-rooted genetic imaginary wherein nucleic acid is a "signifier par excellence," the centre of a seemingly endless series of binaries that it both justifies and generates. The subsequent proliferation of the Penrose Machine—sold via ARTORGA's network and popularized through numerous television programs—reflected the animate nature of its operation and affirmed the generative concept of life that emerged in this period, which the biologist François Jacob would also comment on (fig. 4). In 1970, tracing a history of biological disclosures, Jacob named the discovery of DNA in 1953 as the moment where reproduction supplanted generation as the defining capacity of organism, remarking on the discipline's newfound ability to "build its own truth" and create an "architecture of the living." Jacob further related this point to an epistemic shift: "a new way of considering objects, a transformation of the very nature of knowledge."[24]

23 Similar to the latitude of cybernetic concepts, Roof finds in DNA both the "self-identical functional structure" reflected in European structuralism as well as "the impress of emerging nonlinear modes of analysis" that marked the emergence of less dialectical modes of knowledge. Judith Roof, The Poetics of DNA (Minneapolis/MN: University of Minnesota Press, 2007), 32–35.

24 François Jacob, The Logic of Life: A History of Heredity, trans. Betty E. Spillman (New York/NY: Pantheon Books, 1973), 16.



ARTORGA SELF-REPRODUCING DESIGN OR DROGULUS

This design is an adaptation of the invention of Prof. L.S. Penrose of University College, London. If any of the units show difficulty in linking, please return them to us and we will replace them. These machines are described in New Biology No. 28 and also in the Scientific American of June 1959. The following extracts are taken from the Scientific American by kind permission of the publishers.

"The mass production of multiple copies of the same object by printing or by assembly of prefabricated parts is an event so commonplace that examples can immediately be called to mind. The reader has one at hand in the copy of Scientific American in which he reads these words. The idea of an object reproducing itself, however, is so closely associated with the fundamental processes of biology that it carries with it a suggestion of magic. Indeed, the construction of a machine capable of building itself might be judged to be impossible and to belong to the category of perpetual-motion engines. At the present time, however, advances in genetics are rapidly leading biologists to focus their attention upon the structure and function of self-reproducing molecular chains which, in the nuclei of living cells, preside over all their functional activities. The structure of these chains of nucleic acid is already quite well understood. But the general theory of self-reproduction, in which the replication of nucleic acid would represent a special case, has not been much investigated.

"One essential condition was to be that the units would not form self-reproducing machines just because they were moved about. They were to reproduce themselves only when the object to be replicated was introduced as a pattern for copying. The logic of this condition is to be found in William Harvey's maxim: Omne vivum ex ovo (in modern form: No life except from life). By definition, self-reproduction requires a "self" to be reproduced.

"This design provides a simple and convincing demonstration of artificial self-reproduction. Either type of seed may be introduced into the track; since they and their offspring are easily distinguished, it can be seen that each breeds true to type.

"Self-reproductive chains of mechanical units may help to explain the way in which nucleic acids in living cells actually replicate. But they are more likely to assist in the understanding of systems of simpler character, like those that must have preceded the nucleic acids in the evolution of life. These structures may have occurred in molecules composed of polysaccharides, amino acids or phosphates. At least we need not suppose that they were anything like as complex as the nucleic acids. Such organic counterparts of the self-replicating machine are not perhaps accessible to our observation today in nature. Charles Darwin suggested in 1871 that the spontaneous appearance of very elementary forms of life might still be occurring. But he also pointed out that if a protein compound ready to undergo complex changes were spontaneously produced in the present day, it "would be instantly devoured or absorbed, which would not have been the case before living creatures were formed""

INSTRUCTIONS.

1. Place six units in the track. See that they are held by the string and correctly aligned. The order is, in theory, random but, in fact, one or two pairs should have heads adjacent to one another, as in Fig. (1).

2. Shake gently horizontally, in the lengthwise direction. This demonstrates that the neutral units do not naturally link. Violent shaking, however, may produce a complex of a linked pair. This is self-reproducing but it has poor stability, as can be demonstrated by taking it out of the track and standing it on a flat surface.

3. Replace six units as before. Now construct a linked pair from the remaining two units, as shown in Fig. (2). Place this linked pair, as a seed, in the track and align it correctly with the neutral units by means of the string. Shake lengthwise, allowing collisions at both ends of the track. New linked pairs of the same kind as the seed will be produced. Demonstrate this by taking them carefully out of the track and standing them on a flat surface.

4. Break down the linked pairs and repeat the whole operation, using as seed a pair linked as in Fig. (3). This new organism will be copied by the neutral units instead of the previous one. Note that the organisms produced in the presence of seeds (2) and (3) are very unlikely to arise spontaneously but arise easily in response to their own prototypes.

We are also producing a large 3'0" class demonstration model with much larger plywood molecules. Price 3 gns. or $10 post paid.

March 20, 1960. Artorga Research Group, Beaulieu, Hants, England.

Manufactured by Allround Enterprise
Dibden Purlieu.

Fig. 4: Description and instruction sheet for the Penrose Machine written by Lionel S. Penrose for *ARTORGA*'s reproductions of Penrose's model, March 20, 1960. Source: *ARTORGA*, no. 16 (March 1960): n. p.

If von Neumann's automata theory gave the Penrose Machine a biological foundation, then, following Roof, Penrose's association of its operations to DNA's recombinant processes linked the biological to the epistemological.[25] In the model, systems of life were no longer simply rendered in the obscured interior of the cell, the diffracted crystallographic images of its molecules, or in the static ball and rod atomic models. Instead, the Penrose Machine enabled the critical processes of living things to be acted out and performed, facilitating an active engagement with representations of life's processes rather than simple

25 While at first Penrose refrained from specifying which biological procedure his machine represented, preferring the subjectless of analog relations, he would ultimately relate it to DNA in an unpublished paper. See Penrose Papers; UCL Special Collections; 2/12/18/13.

observation. This recuperation of cybernetic artifacts as containing an organic potential that complements the human, rather than a mechanical nihilism that subjugates it, supports a consideration of ARTORGA's methodology as fundamentally interactional: concerned with trans-material and trans-ontological collaboration, and not with flattening the biological into a machine. As Penrose was exhibiting his machines at the "Conversazione," Beer and Pask were in the midst of experimenting with organic analogues of mechanical systems through their work on "organizational fabrics" and "organic computers," a practice that they termed "applied cybernetics."[26] Despite their methodological and material differences, both would come to inform ARTORGA's initial performative and participatory structure, and in doing so, establish the foundation for its revisionist impulses.

A fabric

Reflecting the fragmentation of biology in the post-war period, what the historian of science Steve Heims has called the "invasion" of the discipline, ARTORGA's relationship to life was particularly marked by the development of cybernetics in Europe, which in contrast to its American contingent included more biologists than engineers. Wells, Beer, and Pask had met in 1956 at the inaugural "Congrès international de cybernétique" in Namur, Belgium, where they discussed the "terrific precision of genetic substances as machine tools."[27] It is in light of this prioritization of practical applications over conceptual development that ARTORGA's use of the term "fabric" in their initial invitation relates to the bio-cybernetic architectonics developed prior to the publication's existence. For, rather than an exploration of synthetic materials, or any static consolidation of warp and weft, the term "fabric" denoted the dynamic interlacing of life: the complex and collective cooperation of an aggregation of biological elements.

26 See Stafford Beer, Cybernetics and Management (London: The English Universities Press, 1959), 158.

27 ARTORGA, no. 2 (January 1959).

As originally formulated in the interwar period by the developmental biologist Paul Weiss, the metaphor of “fabric” countered the metaphoric mechanization of biologic processes—the translation of “facts into inorganic terminology.”[28] Unlike the period’s dominant metaphor of the crystal, the utility of the concept of fabric was in how it recognised structural rigidities within organisms as merely part of a larger plastic system, rather than as a totalizing organizational paradigm.

A question posed by Beer in 1954—“What kind of viable fabrics are glass and wire?”—matched his sentiments a decade later when he borrowed the title of J. D. Bernal’s catechistic work of prospection, *The World, The Flesh, and The Devil* (1929), for a talk entitled “The World, The Flesh, and The Metal.”[29] For Beer, metal—and, by association, machine materials—generated a psychological rigidity: an intellectual stasis engendered by disciplinary specialization and the corresponding loss of a “capacity for creative thinking”[30] that was not only due to the material’s composition, but a result of what it composed. Organizational paradigms departing from machinic logic had led to a world of compressed structures: the regimentation and stratification immanent to industries and corporations. Accordingly, Beer’s “World” was composed of geopolitical boundaries; his “Flesh” consisted of the pseudo-animate corporeality of firms and economics; and “Metal” itself denoted the manmade “machinery, artifacts, and devices” that populated the two.[31] To Beer, the present represented boundaries that were “too rigid,” the ineffective

28 Paul Weiss, “Tierisches Verhalten als ‘Systemreaktion.’ Die Orientierung der Ruhestellungen von Schmetterlingen (Vanessa) gegen Licht und Schwerkraft,” Biologia Gen. 1 (1925), 168–248. Cited in Donna J. Haraway, Crystals, Fabrics, and Fields: Metaphors that Shape Embryos (Berkeley/CA: North Atlantic Books, 2004), 147. As Haraway also argues, a focus on form in biological practice implicates an organicist perspective at work. See ibid., 58.

29 Beer recounts this query in Stafford Beer, “A Progress Note on Research into a Cybernetic Analogue of Fabric,” ARTORGA, no. 40 (April 1962). See also Beer, “The World,” and John Desmond Bernal [1929], The World, The Flesh and The Devil: an Enquiry into the Future of the Three Enemies of the Rational Soul (London: Verso, 2017).

30 Beer carried through this criticism from Bernal who, abdicating cognitive autonomy to physical and physiological factors, left the description of a psychological future to be generated by changes in the body and the world. See Bernal, The World, The Flesh and The Devil, 43.

31 Beer, “The World,” 229.

compartmentalization of function, and a lack of organic behaviour within systems.[32] While this technological nihilism had been echoed by others, Beer proposed a practical solution that substituted the plasticity of the biological for the dogmatism of metal.[33] Though Penrose's intention was to mitigate the biological complexity of self-reproduction and self-organization by requiring only simple mechanisms, Beer and Pask did not want to reduce the complexity of living organisms, but to study and eventually create them. Their inquiries were impelled by a dissatisfaction with the limitations of conventional machine materials. From their perspective, the analogic replication of organic processes in synthetic materials might well serve to reproduce the isolated functions of organisms, but in no way could they reproduce the malleable behaviouristic and cognitive capabilities of their models: their ability to grow, adapt, and learn. Considering that automatic systems of production and prediction (from assembly lines to guided missiles) represented an unrelenting linearity, Beer and Pask viewed cybernetics as reliant upon only automatic functions that lacked the capacity to adapt or evolve in response to new or irregular stimuli.

In the attempt to overcome these limitations, they looked past machinery toward biological precedents. However, their recourse to organic life as a corrective to machinic procedures was not simply rooted in behaviouristic paradigms but was based on the material affordances and informational capacity of biological life. Considering these capabilities inherent to organic matter, Beer and Pask saw unlimited potential in the recruitment of a complexity that could not be engineered, a utilization of the world's pre-existing self-organizing systems. They hoped that their search, which looked for new fabrics, "the stuff of construction," and often living material, would uncover a viable organic machine.[34] Accordingly, commenting that "fixed circuitry is a

32 Ibid., 227.

33 This had been most clearly expressed in Jacques Ellul's 1954 description of the categorial imperative of mechanical techniques. Jacques Ellul, The Technological Society, trans. John Wilkinson (New York/NY: Vintage Books, 1964).

34 Ibid., 159.

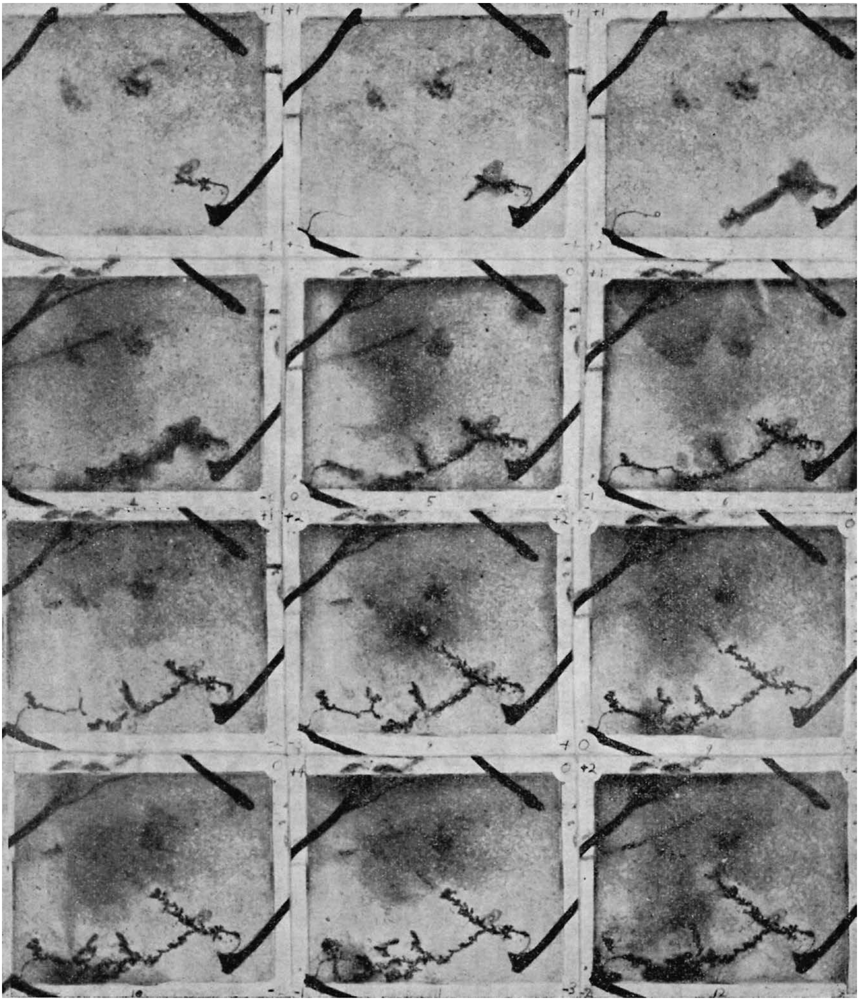


Fig. 5: Stages of growth in one of Pask's fungoid fabrics, "The idea of making such devices is entirely practical and the photographs shown indicate the physical character of a decision making system, several of which exist." Source: Fig. 6 in Gordon Pask, "The Growth Process in a Cybernetic Machine," in *Proceedings of the Second Conference of the International Association of Cybernetics, Namur* (Paris: Gauthier-Villars, 1960), 790–791

liability," and relating that fixedness to acts of conscious design, Beer summarized their project as an attempt to "constrain a high variety fabric rather than fabricate one by blueprint."[35]

35 Beer, "Progress Note," n. p.

Beginning in 1954, Beer and Pask recruited a series of life forms across taxa and superimposed the functions they wanted to model onto the active systems of the living. Preferring the "inherently organizing" and thus non-designed systems of organic life, they proceeded from "fungoids" (colloidal cell cultures), "animalcules" (the aquatic daphnia crustaceans), and "biological gas" (the eukaryote eugenia), to "social insects" (bees, ants, and termites), "vertebrates," and "human beings"[36] (fig. 5). Along the way, they catalogued the tendencies of each "fabric" in accordance with cybernetic rhetoric. Since each form of organic life possessed the basic criteria of living things: "variability," "self-replication," "self-organization" and "homeostasis," each could be viewed as a viable component of an organic machine. As the experiments progressed, Beer and Pask attempted to produce interfaces between the organic fabrics (as they termed the biological communities they created) and the mechanical systems that they envisioned as their enclosures.[37] Though the fabric formed by each experimental subject varied in terms of its overall organization and operation, each was intended to act as an organic modulator: a processing system able to cope with external complexity. They were to perform as animate regulating bodies coupled to a device that would render the variables of inorganic systems into organic stimuli. Transposing the natural stability of the organic to the artificial, the device would respond in kind to the fabric's behavioural response, bypassing the need for symbolic or linguistic translations.[38]

These manipulations of fabric reflect an ecological understanding of world systems, the entangled and irreducible economies of

36 Ibid.

37 Ibid. Through material and environmental interference, from the deposition of metallic filings or the institution of environmental systems—from mazes to stimulus-response tests—Beer and Pask attempted to ascertain how inherent behavioral responses could unknowingly, and without quantification, process received stimuli.

38 Beer, "Progress Note." The afterlives of these experiments in Beer's industrial practice was explored by Andrew Pickering in "The Science of the Unknowable: Stafford Beer's Cybernetic Informatics," Kybernetes 33, no. 3/4 (2004): 499–521. Pickering has also advanced a performative-ontological theory of material agency within scientific practice, using applied cybernetics as an example of what he refers to as the "mangle." See Andrew Pickering, The Mangle of Practice: Time, Agency, and Science (Chicago/IL: The University of Chicago Press, 1995).

nature and society whose 19th century roots lie in what the historian of science Lynn Nyhart has termed a “practical naturalism.”[39] Yet ARTORGA’s revision of their discipline’s material basis called into question what the cultural anthropologist Stefan Helmreich has recently problematized as the relationship between life forms and forms of life: the naturalization of a biopolitical continuity that presumes a causal and structural relationship between “embodied bits of vitality” to the “social, symbolic, and pragmatic ways of thinking and acting that organize human communities.”[40] In Pask’s formulation, the idea that a new biology could emerge from the structural-material employment of the biological life in artificial systems represents the naive fallacy that characterized the vulgar materialism of organicism’s holism. However, as Beer and Pask combined the engineering and construction of life forms with observational practices, which for them entailed not only the classificatory urge of the naturalist but the interactionism of a field biologist, they began to shift how the processes and organizations of life forms were understood. Explicating this methodological hinge, Penrose himself noted: “we construct objects with properties like living things… examine them carefully, observing their abilities and limitations, and study their natural history.”[41]

A language

As Pask argued in 1960, in order to study the self-organization of fabrics one must inherit the “interactive aspects of natural history,” what he described as the “art of knowing an animal, almost

39 Nyhart introduces this term while tracing the emergence of an ecological understanding that characterizes the “biological perspective” of the discipline’s origin. Lynn K. Nyhart, Modern Nature: The Rise of the Biological Perspective in Germany (Chicago/IL: University of Chicago Press, 2009).

40 Stefan Helmreich, Sophia Roosth and Michele Friedner, “What Was Life? Answers from Three Limit Biologies,” in Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond (Princeton/NJ: Princeton University Press, 2016), 1–16.

41 Lionel S. Penrose, “Automatic Mechanical Self-Reproduction,” Lecture, University College London, January 14, 1958; Penrose Papers, UCL Special Collections; 2/12/7/4, 26. The lecture notes would be turned into the article “Automatic Mechanical Self-Reproduction” New Biology 28, no. 92 (1959), the publication of which was delayed because of a strike.

by living the part of the animal."[42] This self-reflexivity formed the operative basis of ARTORGA's publication, with each recipient of the mailer "like a cell in the organism," recalling its initial invitation. Within its first year, however, ARTORGA had to face the problems involved in "growing the principles of design." Each of the monthly iterations of its first twelve "communications" varied in content, structure, layout, and even binding and paper stock. Consisting of often purposefully inchoate discourse, the opacity of the statements, suggestions, and axioms that populated its pages over the first year reflected the publication's concern with how the parameters of its materiality would be discursively framed. The initial invitation had elaborated that the "words and written materials"—described as "relatively unformed fabric"—should serve the same function as "valves, circuit diagrams, cell boundaries, or enzyme systems."[43]

ARTORGA's method therefore reflected the material specificity of fabric (centred on the capabilities of organic matter) and its critical operative difference from biology's dissections and cybernetics' constructions. Departing from the reduced and enclosed bodies of fungoid networks and aquarium tanks, ARTORGA began to utilize the substrate of the world itself. This enlargement required a reconsideration of how the immanent principles of the organic could operate within a body that lacked any localized biological model. While ARTORGA still imposed its method on existing systems, these were now the geopolitical networks of modernity rather than delimited and controlled environments. More simply put, its paper moved through the post. Ostensibly two discrete "fabrics" emerged here. One, language, acted as the semantic fulfilment of the relationship between the form-giving function of "genetic substance and machine tools" that Beer, Pask, and Wells had discussed; the other, the postal service, indicated the spatial extent of its body. Accordingly, rather than the utility of the organic, here issues of language and information

42 Gordon Pask, "The Natural History of Networks," in Self Organising Systems, eds. M. C. Yovits and S. Cameron (London: Pergamon Press, 1960), 235.

43 ARTORGA, no. 1 (December 1958).

were prioritized in terms of correspondence and self-description. Indeed, by proposing the term "fabric," Weiss had also been concerned with obtaining a true description, a parallelism between language and reality.[44] Reflecting ARTORGA's continuous attention to the biological, language was primarily considered in terms of inter- and intra-organismal communication, rather than being subsumed into incorporeal concepts of code.

From ARTORGA's first communication, its pages contained suggestions about the effect of specialized scientific terminology on the description and performance of artificial functions. Ultimately, ARTORGA rejected the adoption or adaptation of existing languages for the same reason its founders had avoided pre-determined designs and functions. If metal, glass, and wire were programmatically overdetermined materials, then extant languages similarly contained built-in predispositions of value and order. Instead, ARTORGA underscored the need to develop a new language. Only one generated autonomically, and so without design, could oppose existing semantics and semiotic structures, and begin to accomplish the epistemological revision Wells had argued for. Accordingly, ARTORGA's founders viewed its indeterminate program as a proven biological technique—as they noted: "most organisms start each generation with a minimum of assumptions."[45]

Yet the linguistic experimentation evidenced in each issue—the mixtures and misuses of syntax, semantics, and semiotics—would never cohere. ARTORGA instead decided to recruit an existing model of biological processes to further materialize their language. They selected the Penrose Machine. This choice was in fact a commodification. Announced in its pages in January 1960, the machine's form was utilized not only as a communicative medium, but also as a representation of ARTORGA's process

44 See the continuation of this argument in Paul Weiss, "Perspectives in the Field of Morphogenesis," The Quarterly Review of Biology 25, no. 2 (June 1950): 177–198. See also Weiss, "Organic Form: Scientific and Aesthetic Aspects," Daedalus 89, no. 1 (Winter, 1960): 177–190.

45 ARTORGA, no. 8 (July 1959).

and a reflection of its structure. However, it was the model's materialization of the descriptive function of language that ultimately impacted ARTORGA's epistemological goals.

Penrose's models had been popularly extolled for their relevance for chemical, biological, logical, and mechanical processes. Wells, Beer, and Pask applied this lability of meaning to ARTORGA's models, which were anti-categorical, neither machine nor organism, and reflected processes of self-reproduction and self-organization. Regardless of whether such a positioning was understood as reductionist, or, more positively, rudimentary, it was particularly valuable for ARTORGA, which had recently published such sentiments as "perhaps the single cell is already too far advanced!" and "certainly one would want to go back way down the evolutionary scale, back to a non-verbal world of pictures."[46]

This is not to say that concepts of self-reproduction and self-organization were absent from ARTORGA's linguistic goals. By opposing the material logics of metal, and by reverting the concept of the organization to the organism and the corporation to the corporeal, they sought to generate objective biological truths from a collation of human and organic subjectivities, rather than accepting analogical principles gained from computational similarities. Viewing biological processes as universalized procedures allowed Beer, Pask, and Wells to attempt to redefine the binaries inherited from dualistic conceptions of the world that sought to create discontinuities in an autonomous and autonomic natural order.

An unfinished process

That a paper publication, with dreams of an organic existence (corporealized through mimeographed pages) would become a platform from which to argue for a new standard of scientific practice founded on systemic thought—free from the strictures of convention or any pre-set design processes—seems like an

46 ARTORGA, no. 6 (May 1959); and ARTORGA, no. 9 (August 1959).

unlikely transformation, and one very far from ARTORGA's initial intention of solving the "practical problems" of organization and strategy. However, in Wells' hands the Penrose Machine was not simply a model of protein formation, but ultimately something both simpler and more complex; ARTORGA was decidedly not non-deterministic but relied on the appearance of flexibility; and Wells was not a scientist, or a businessman, but a mixture of both. The appearance of all three in Hampshire in 1961, despite their different goals, would seem to implicate the presence of a template or structure, or at the very least a shared ideology. Though this ideology was fundamentally a materialist one, its reactionary aspects were necessary in order to maintain a connection to the organic body across cybernetics' metaphoric, morphic, and analogic transformations, and its own machines, fabrics, and models.

At the end of the 1961 interview in *Science et Vie*, ARTORGA's project was summarized as "the will to triumph over mathematical and systemic thought, and the desire to understand nature as it is, and not as it is conceived of." The non-cognitive approach implicit in these closing lines dovetails with the "concrete" epistemology later put forth by Francesco Varela, himself a member of ARTORGA's "organism." Varela's framework consisted of "knowledge built from small domains," from an organism's "readiness for action," which constituted an "unruly conversation" from which a "cognitive moment can come into being."[47] In ARTORGA we witness the proposal of a relationship to the living that departs from a post-Cartesian perspective, one which understood the world not as pre-given, but as continuously enacted and performed by material assemblages of organic and inorganic life: a non-decomposable creative act, and an utopia without controls.

However, ARTORGA never reached a conclusion. In 1972 it ceased publication, having only repeatedly redefined the terms of its own operation. Yet to think of its fundamentally biotic method

47 For the embodied theory of cognition that supports this claim, see Francisco Varela, "The Re-Enchantment of the Concrete," in Zone 6: Incorporations, eds. Sanford Kwinter and Jonathan Crary (New York/NY: Zone Books, 1992), 320–340.

of epistemological generation is to recognize the emergence of a bio-technical form of knowledge that embraced the variability of life on its own. The less didactic variant of self-organization, is, of course, autopoiesis, a term which references not only autonomic action, but the relationship between poetics and structure, the result of its play on binaries. Beer, Pask, and Wells' consideration of replicative and organizational processes of biological life as universalized procedures—derived from the conception of intractable organic rather than machinic logics—was foundational to ARTORGA's attempt to redefine the binaries inherited from dualistic conceptions of the world. Employing what we might now call a biopoetics as the rudiment of the operation of world-systems, ARTORGA's experiments in the late 1950s highlight the still seemingly intractable issue of discriminating between the fundamental binaries of our world, while signalling the potential of fabrics to provide alternative visions of life based in the labile operations of the autonomous techniques of biological life.

In introducing ARTORGA's method as a biological technique, I have attempted to track their departure from conventional cybernetic practice through their projects and constructions and highlight how the procedures they initiated within fabrics, machines, and models retained the corporeality of the organic body, even as the body as a cybernetic model itself became impinged upon by informational representations. While ARTORGA was never meant to construct a building *per se*, its attempts to construct an organization, to grow principles, and constrain fabrics are part of the same ideology that informs architecture's continuing fascination with biology as a cure-all for design. While the etymological connection between fabric and fabrication indicates their basic compositional similarities, the active agency of fabrication implies the need to create de novo, while fabric itself signals the underlying structural framework of nature, which exists and persists without any intentional intervention. Although terms like art and artifice become muddy when practically applied—for fabric is always fabricated in some fashion—they are distinguished by their agency. This is the difference between how a structure develops and how it is constructed. Accordingly, the fabrics, machines, and models of ARTORGA depict the generative architectonics of life—the principles, programs, and procedures of living structures—as the basis of a universal epistemology, a way of knowing connected to the very mode by which we as humans are able to process knowledge, one defined by the interaction between parts: structure working itself out, rather than being worked out.

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The critical concern of the book “Utopia Computer” is the euphoria, expectation and hope inspired by the introduction of computers within architecture in the early digital age. With the advent of the personal computer and the launch of the Internet in the 1990s, utopian ideals found in architectural discourse from the 1960s were revisited and adjusted to the specific characteristics of digital media. Taking the 1990s discourse on computation as a starting point, the contributions of this book grapple with the utopian promises associated with topics such as participation, self-organization, and non-standard architecture. By placing these topics in a historical framework, the book offers perspectives for the future role computation might play within architecture and society.

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