

Outline by John Protevi
Department of French Studies
Louisiana State University
www.protevi.com/john
protevi@lsu.edu

Autopoiesis and Cognition: The Organization of the Living (1973)
Humberto Maturana and Francisco Varela. Boston: Reidel.

Introduction (73-76)

Biological appearance = “autonomous entities of bewildering diversity”

Autonomy = “self-asserting capacity of living systems to maintain their identity through the active compensation of deformations”

Contemporary biology is synthesis of molecular and evolutionary

“Cybernetic principles ... require from the biologist the very understanding that they want to provide” – attempt to hide from organization question by encompassing biology under “comprehensive theories governed by organizing notions.”

Evolutionary thought obscures search for key to autonomy

Concern with observers and “descriptive domain”

Organization is explained in terms of relations, not component properties

Pointing out the “dynamism apparent in living systems and which the word ‘machine’ connotes”

1) On Machines, Living and Otherwise (77-84)

a) Machines:

i) Both organization and structure are sets of relations: “network of interactions and transformations into which they enter in the working of the machine which they integrate and constitute as an entity.”

ii) Organization = “relations that define a machine as a unity, and determine the dynamics of interactions and transformations which it may undergo as such a unity.”

iii) Structure = “actual relations which hold among the components which integrate a concrete machine in a given space.”

iv) Organization is “independent of the properties of its components ... a given machine can be realized in many different manners by many different kinds of components” (77)

b) Living Machines

i) Autopoietic machines: “It follows that an autopoietic machine continuously generates and specifies its own organization through its operation as a system of production of its own components, and does this in an endless turnover of components under conditions of continuous perturbations and compensation of perturbations. Therefore, an autopoietic machine is a homeostatic (or rather a relation-static) system which has its own organization (defining network of relations) as the fundamental variable which it maintains constant” (79).

(1) Autonomous

- (2) Individual
- (3) Unified
- (4) Immanent (no input / output)
- ii) Living Systems: “autopoiesis is necessary and sufficient to characterize the organization of living systems”
- 2) Dispensability of Teleonomy (85-87) (purpose and ontogeny are observer-dependent)
 - a) Purposelessness
 - b) Individuality: “any change in it should take place subordinated to its mechanism”; “Ontogeny ... is the expression of the becoming of a system that at each moment is the unity in its fullness, and does not constitute a transit from an incomplete (embryonic) state to a more complete or final one (adult)” (87).
- 3) Embodiments of Autopoiesis (88-95)
 - a) Descriptive and Causal Notions: Autopoietic organization defines a ‘space’ [scare quotes in original] w/in which it can be realized as a concrete system; “a space whose dimensions are the relations of production of the components that realize it” (88). That is, relations of constitution, specificity, order
 - i) “energetic and thermodynamic considerations ... do not enter into the characterization of the autopoietic organization” (89)
 - ii) specification / order are referential notions, limited to context of autopoiesis
 - iii) Autopoietic organization “acquires topological unity by its embodiment in a concrete autopoietic system”; space defined by autopoietic systems is “self-contained and cannot be described by using dimensions that define another space” (89)
 - iv) “Notions such as coding and transmission of information do not enter into the realization of a concrete autopoietic system”
 - b) Molecular Embodiments (90-93)
 - i) Production of Constitutive Elements: “determine the topology of the autopoietic organization, and hence its physical boundaries” (90-91)
 - ii) Production of Relations of Specifications: “determine the identity (properties) of the components of the autopoietic organization, and hence, in the case of the cells, its physical factibility” (91)
 - iii) Production of Relations of Order: “determine the dynamics of the autopoietic organization by determining the concatenation of the production of relations of constitution, specification, and order, and hence its actual realization” (91). “In the cell, relations order are established mainly by the production of components (metabolites, nucleic acids and proteins) that control the speed of production of relations of constitution, specification and order” (91). “A network of parallel and sequential relations ... constitute the cell as a system in which the relations of production ... are maintained constant”(92).
 - c) Origin: “question about the conditions that must be satisfied for the establishment of an autopoietic space” (93)
 - i) “topological unity in the space in which the components have existence as entities that may interact and have relations. For living systems such a space is the physical space” (93-94)
 - ii) “establishment of an autopoietic system cannot be a gradual process” (94)

- iii) “Autocatalytic processes do not constitute autopoietic systems because ... they do not determine their topology” (94)
 - iv) two problems: “factibility” and “possibility of spontaneous occurrence” (94)
- 4) Diversity of Autopoiesis (96-111) “reproduction requires ... a unity to be reproduced”; “evolution requires reproduction and the possibility of change”
 - a) Subordination to the Condition of Unity: [epistemological focus] “Unity (distinguishability from a background, and, hence, from other unities), is the sole necessary condition for existence in any given domain.” “Unity distinction ... is an operative notion referring to the process through which a unity becomes asserted or defined.” (96). “Autopoiesis implies the subordination of all change in the autopoietic system to the maintenance of its autopoietic organization” (97).
 - i) “domain of ontogenic transformations (including conduct) of each individual is the domain of the homeostatic trajectories through which it can maintain its autopoiesis” (97)
 - ii) All biological phenomena are “determined and realized in individual autopoietic unities in the physical space, and consists of the paths of transformation that they undergo as homeostatic systems” [conserving network of relations constituting their autopoietic organization] (97).
 - iii) Maintaining identity = a unity in physical space remaining a unity in autopoietic space (97).
 - iv) Reproduction dependent upon autopoietic unity
 - b) Plasticity of Ontogeny: “ontogeny is history of structural transformations” (98)
 - i) “different classes of autopoietic systems have different classes of ontogenies”
 - ii) biological appearance bound w/in range of compensatable permutations
 - iii) mode of realization of autopoiesis of a unity may change during its ontogeny
 - iv) difference btw internal and external perturbations is observer dependent; but for each system “they braid together to form a single ontogeny”
 - v) ontogenic change does not come from a representation of environment on part of the system
 - vi) compensation can be conservative or innovative
 - (1) conservative: only the relations btw components change
 - (2) innovative: the components themselves change, leading to a “change in the way autopoiesis is realized ... a displacement ... in the autopoietic space”
 - c) Reproduction, a Complication of the Unity
 - i) Replication
 - ii) Copy
 - iii) Self-reproduction
 - (1) Must take place during autopoiesis
 - (2) Is a form of autopoiesis
 - (3) Variation “can only arise as a modification during autopoiesis of a pre-existing functioning autopoietic system ... continuous complication of autopoiesis” (102-103)
 - (4) “notions such as coding, message, or information are not applicable to ... self-reproduction ... an attempt to represent it in the language of heteropoietic design” (102)

- d) Evolution, a Historical Network
- i) “evolution is the history of change in the realization of an invariant organization embodied in independent unities sequentially generated through reproductive steps, in which the particular structural realization of each unity arises as a modification of the preceding one (or ones)” (104)
 - ii) “production of an historical network in which the unities successively produced embody an invariant organization in a changing structure as each unity arises as a modification of the previous one” (105)
 - iii) difference btw ontogeny and evolution
 - (1) In ontogeny, the identity of the unity is never interrupted. “unities only have ontogenies” (104)
 - (2) In evolution, “succession of identities ... that which changes (evolves), the pattern of realization of the successively generated unities [,] exists in a different domain than the unities that embody it” (104)
 - (3) Selection “is a process of differential realization in a context that specifies the unitary structures that can be realized ... evolution takes place only is adaptation is conserved by the unities that embody the invariant organization of the evolving lineage” (105)
 - (4) “reproduction must allow for structural change” (105). DNA (role of nucleic acid in protein specification) is essential now as mechanism of variation, but that’s only because it was “a condition virtually constitutive of the original autopoietic process which was secondarily associated to reproduction and variation” (106).
 - (5) “Cultural evolution takes place through sequential copy of a changing model in a process of social indoctrination” (106).
 - (6) “A species ... nodes in a historical network ... share a genetic pool ... equivalent pattern of autopoietic realization under historical transformations” (106-7). “Yet the species exists as a unity only in the historical domain, while the individuals ... exist in the physical space” (107). “a historical network ... is at any moment represented historically by the species ... what evolves is a pattern of autopoietic realization embodied in many particular variation in a collection of transitory individuals ... The species is only an abstract unity in the present” (107).
- e) Second and Third Order Autopoietic Systems
- i) Coupling: linked conduct of independent systems leading to an emergent unity: “In general ... coupling leads also to the generation of a new unity that may exist in a different domain from the domain in which the component-coupled unities retain their identity” (107)
 - ii) “as long as their respective paths of autopoiesis constitute reciprocal sources of compensable disturbances” (108)
 - (1) [A naïve objection, but not too bad at all, is that autopoiesis represents all activity as a perturbation or disturbance, i.e., a threat to identity that needs compensation, rather than as an opportunity for forming new alliances. My challenge is to see if I can find this shift in perspective in the later Varela, rather than importing it from an external Deleuzean perspective.]

- (2) “the coupling remains invariant while the coupled systems undergo structural changes” (108)
 - (3) composite autopoietic systems “in which the individual autopoiesis of every one of its autopoietic components is subordinated to an ambience defined through the autopoiesis of all the other autopoietic components of the composite unity” (108). Of course, this higher level autopoietic system must be able to be defined by “relations of production of components” etc.: [Here is where FV will eventually part company with HM; FV will distinguish cellular autopoiesis from organizational closure of higher level systems, which requires in addition to organizational description, the complement of symbolic description.]
 - (4) recognition of autopoietic systems as “cognitive problem” for an observer who must perform “an operation of distinction that defines the limits of the system in the same domain in which it specifies them through its autopoiesis”; this is usually no problem in the case of the cell (109)
 - (5) In some cases, an observer will describe “an autopoietic component of a composite system as playing an allopoietic role ... the allopoietic function is exclusively a feature of the description and pertains to a frame of reference defined by the observer” (110)
 - (6) When such autopoietic unities are put to allopoietic functions, then we see “an autopoietic unity of second order ... actually happened on earth with the evolution of the multicellular pattern of organization ... the component (living) autopoietic systems become necessarily subordinated, in the way they realize their autopoiesis, to the maintenance of the autopoiesis of the higher order autopoietic unity” (110)
 - (7) “there is ... an ever present selective pressure for the constitution of higher order autopoietic systems” (111)
- 5) Presence of Autopoiesis (112-123)
- a) Biological Implications
 - i) Distinguish “statical phenomena ... relations btw properties of components ... while biological phenomena are ... relations btw processes” (113)
 - ii) Always possible to reduce to non-autopoietic mechanical descriptions, which are relations btw properties of components (113)
 - b) Epistemological Implications
 - i) Critique of social implications of Darwinism as subordination of individual to species: individual become subordinated to “transcendental values supposedly embodied in notions such as mankind, the state, or society” (117).
 - ii) M and V “do not fully agree on ... the biological [i.e., autopoietic] character of human societies” (118)
 - c) Cognitive Implications
 - i) “the domain of all the interactions in which an autopoietic system can enter w/o loss of identity is its cognitive domain ... the domain of all the descriptions is can make ... its behavioral diversity ... the cognitive domain of an autopoietic system changes along its ontology only to the extent that its mode of autopoiesis changes” (119). [HERE is a key: MV will allow for a change of “mode” of autopoiesis or for a change in the “particular way” in

which autopoiesis is realized (to allow for diversity in evolution) while claiming that autopoiesis “itself” cannot change.]

- ii) cognitive domain and hence knowledge (“descriptive conduct”) is relative to “particular way in which ... autopoiesis is realized ... no absolute knowledge is possible” (119)
 - iii) “communicative interactions” = “mutually triggering consensual conducts ... a linguistic domain ... intrinsically non-informative” (120)
 - iv) linguistic recursion is possible:
 - (1) treat its own linguistically generated states as “objects of further interactions, giving rise to a metadomain of consensual distinctions ... the domain of such recursive interactions is in principle, infinite” (121)
 - (2) “domain of self-observation”
- 6) Appendix: The Nervous System (124-134)
- 7) Glossary (135-138)