

Holons and Holarchy of Arthur Koestler

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Some general properties of
self-regulating open hierarchic order (SOHO)
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Note

The idea of the "holon" was introduced by Arthur Koestler in *The Ghost in the Machine* (1967) and was presented again at the Alpbach Symposium (1968) in a paper titled: *Beyond Atomism and Holism - the concept of the holon*.

The "holon" represents a very interesting way to overcome the dichotomy between parts and wholes and to account for both the self-assertive and the integrative tendencies of an organism.

The following text is the Appendix to the intervention at the Alpbach Symposium, whose acts were published in 1969 as a book edited by Arthur Koestler and J. R. Smythies with the title *Beyond Reductionism*.

1. The holon

1.1 The organism in its structural aspect is not an aggregation of elementary parts, and in its functional aspects not a chain of elementary units of behaviour.

1.2 The organism is to be regarded as a multi-levelled hierarchy of semi-autonomous sub-wholes, branching into sub-wholes of a lower order, and so on. Sub-wholes on any level of the hierarchy are referred to as holons.

1.3 Parts and wholes in an absolute sense do not exist in the domains of life. The concept of the holon is intended to reconcile the atomistic and holistic approaches.

1.4 Biological holons are self-regulating open systems which display both the autonomous properties of wholes and the dependent properties of parts. This dichotomy is present on every level of every type of hierarchic organization, and is referred to as the "Janus phenomenon".

1.5 More generally, the term "holon" may be applied to any stable biological or social sub-whole which displays rule-governed behaviour and/or structural Gestalt-constancy. Thus organelles and homologous organs are evolutionary holons; morphogenetic fields are ontogenetic holons; the ethologist's "fixed action-patterns" and the sub-routines of acquired skills are behavioural holons; phonemes, morphemes, words, phrases are linguistic holons; individuals, families, tribes, nations are social holons.

2. Dissectibility

2.1 Hierarchies are "dissectible" into their constituent branches, on which the holons form the nodes; the branching lines represent the channels of communication and control.

2.2 The number of levels which a hierarchy comprises is a measure of its "depth", and the number of holons on any given level is called its "span" (Herbert Simon).

3. Rules and strategies

3.1 Functional holons are governed by fixed sets of rules and display more or less flexible strategies.

3.2 The rules - referred to as the system's *canon* - determine its invariant properties, its structural configuration and/or functional pattern.

3.3 While the canon defines the permissible steps in the holon's activity, the strategic selection of the actual step among permissible choices is guided by the contingencies of the environment.

3.4 The canon determines the rules of the game, strategy decides the course of the game.

3.5 The evolutionary process plays variations on a limited number of canonical themes. The constraints imposed by the evolutionary canon are illustrated by the phenomena of homology, homeoplasia, parallelism, convergence and the *loi du balancement* (Geoffroy de St. Hilaire).

3.6 In ontogeny, the holons at successive levels represent successive stages in the development of tissues. At each step in the process of differentiation, the genetic canon imposes further constraints on the holon's developmental potentials, but it retains sufficient flexibility to follow one or another alternative developmental pathway, within the range of its competence, guided by the contingencies of the environment.

3.7 Structurally, the mature organism is a hierarchy of parts within parts. Its "dissectibility" and the relative autonomy of its constituent holons are demonstrated by transplant surgery.

3.8 Functionally, the behaviour of organisms is governed by "rules of the game" which account for its coherence, stability and specific pattern.

3.9 Skills, whether inborn or acquired, are functional hierarchies, with sub-skills as holons, governed by sub-rules.

4. Integration and self-assertion

4.1 Every holon has the dual tendency to preserve and assert its individuality as a quasi-autonomous whole; and to function as an integrated part of an (existing or evolving) larger whole. This polarity between the Self-Assertive (S-A) and Integrative (INT) tendencies is inherent in the concept of hierarchic order; and a universal characteristic of life.

The S-A tendencies are the dynamic expression of the holon's wholeness, the INT tendencies of its partness.

4.2 An analogous polarity is found in the interplay of cohesive and separative forces in stable inorganic systems, from atoms to galaxies.

4.3 The most general manifestation of the INT tendencies is the reversal of the Second Law of Thermodynamics in open systems feeding on negative entropy (Erwin Schrödinger), and the evolutionary trend towards "spontaneously developing states of greater heterogeneity and complexity" (C. J. Herrick).

4.4 Its specific manifestations on different levels range from the symbiosis of organelles and colonial animals, through the cohesive forces in herds and flocks, to the integrative bonds in insect states and Primate societies. The complementary manifestations of the S-A tendencies are competition, individualism, and the separative forces of tribalism, nationalism, etc.

4.5 In ontogeny, the polarity is reflected in the docility and

determination of growing tissues.

4.6 In adult behaviour, the self-assertive tendency of functional holons is reflected in the stubbornness of instinct rituals (fixed action-patterns), of acquired habits (handwriting, spoken accent), and in the stereotyped routines of thought; the integrative tendency is reflected in flexible adaptations, improvisations, and creative acts which initiate new forms of behaviour.

4.7 Under conditions of stress, the S-A tendency is manifested in the aggressive-defensive, adrenergic type of emotions, the INT tendency in the self-transcending (participatory, identificatory) type of emotions.

4.8 In social behaviour, the canon of a social holon represents not only constraints imposed on its actions, but also embodies maxims of conduct, moral imperatives and systems of value.

5. Triggers and scanners

5.1 Output hierarchies generally operate on the trigger-release principle, where a relatively simple, implicit or coded signal releases complex, preset mechanisms.

5.2 In phylogeny, a favourable gene-mutation may, through homeorhesis (Conrad Waddington) affect the development of a whole organ in a harmonious way.

5.3 In ontogeny, chemical triggers (enzymes, inducers, hormones) release the genetic potentials of differentiating tissues.

5.4 In instinctive behaviour, sign-releasers of a simple kind trigger off Innate Releasive Mechanisms (Lorenz).

5.5 In the performance of learnt skills, including verbal skills, a generalized implicit command is spelled out in explicit terms on successive lower echelons which, once triggered into action, activate their sub-units in the appropriate strategic order, guided by feedbacks.

5.6 A holon on the n level of an output-hierarchy is represented on the $(n + 1)$ level as a unit, and triggered into action as a unit. A holon, in other words, is a system of relata which is represented on the next higher level as a relatum.

5.7 In social hierarchies (military, administrative), the same principles apply.

5.8 Input hierarchies operate on the reverse principle; instead of triggers, they are equipped with "filter"-type devices (scanners, "resonators", classifiers) which strip the input of noise, abstract and digest its relevant contents, according to that particular hierarchy's criteria of relevance. "Filters" operate on every echelon through which the flow of information must pass on its ascent from periphery to centre, in social hierarchies and in the nervous system.

5.9 Triggers convert coded signals into complex output patterns. Filters convert complex input patterns into coded signals. The former may be compared to digital-to-analogue converters, the latter to analogue-to-digital converters (Miller, G. A., Galanter, E. and Pribram, K. H., *Plans and the Structure of Behaviour*, 1960).

5.10 In perceptual hierarchies, filtering devices range from habituation and the efferent control of receptors, through the constancy phenomena, to pattern-recognition in space or time, and to the decoding of linguistic and other forms of meaning.

5.11 Output hierarchies spell, concretize, particularize. Input hierarchies digest, abstract, generalize.

6. Arborization and reticulation

6.1 Hierarchies can be regarded as "vertically" arborizing structures whose branches interlock with those of other hierarchies at a multiplicity of levels and form "horizontal" networks: arborization and reticulation are complementary principles in the architecture of organisms and societies.

6.2 Conscious experience is enriched by the cooperation of several perceptual hierarchies in different sense-modalities, and within the same sense-modality.

6.3 Abstractive memories are stored in skeletonized form, stripped of irrelevant detail, according to the criteria of relevance of each perceptual hierarchy.

6.4 Vivid details of quasi-eidetic clarity are stored owing to their emotive relevance.

6. S The impoverishment of experience in memory is counteracted to some extent by the cooperation in recall of different perceptual hierarchies with different criteria of relevance.

6.6 In sensory-motor coordination, local reflexes are short-cuts on the lowest level, like loops connecting traffic streams moving in opposite directions on a highway.

6,7 Skilled sensory-motor routines operate on higher levels through networks of proprioceptive and exteroceptive feedback loops within

loops, which function as servo-mechanisms and keep the rider on his bicycle in a state of self-regulating, kinetic homeostasis.

6.8 While in S-R theory the contingencies of environment determine behaviour, in O.H.S. theory they merely guide, correct and stabilize pre-existing patterns of behaviour (P. Weiss).

6.9 While sensory feedbacks guide motor activities, perception in its turn is dependent on these activities, such as the various scanning motions of the eye, or the humming of a tune in aid of its auditory recall. The perceptual and motor hierarchies are so intimately cooperating on every level that to draw a categorical distinction between "stimuli" and "responses" becomes meaningless; they have become "aspects of feed-back loops" (Miller et al.).

6.10 Organisms and societies operate in a hierarchy of environments, from the local environment of each holon to the "total field", which may include imaginary environments derived from extrapolation in space and time.

7. Regulation channels

7.1 The higher echelons in a hierarchy are not normally in direct communication with lowly ones, and vice versa; signals are transmitted through "regulation channels", one step at a time.

7.2 The pseudo-explanations of verbal behaviour and other human skills as the manipulation of words, or the chaining of operants, leaves a void between the apex of the hierarchy and its terminal branches, between thinking and spelling.

7.3 The short-circuiting of intermediary levels by directing conscious attention at processes which otherwise function

automatically, tends to cause disturbances ranging from awkwardness to psychosomatic disorders.

8. Mechanization and freedom

8.1 Holons on successively higher levels of the hierarchy show increasingly complex, more flexible and less predictable patterns of activity, while on successive lower levels we find increasingly mechanized, stereotyped and predictable patterns.

8.2 All skills, whether innate or acquired, tend with increasing practice to become automatized routines. This process can be described as the continual transformation of "mental" into "mechanical" activities.

8.3 Other things being equal, a monotonous environment facilitates mechanization.

8.4 Conversely, new or unexpected contingencies require decisions to be referred to higher levels of the hierarchy, an upward shift of controls from "mechanical" to "mindful" activities.

8.5 Each upward shift is reflected by a more vivid and precise consciousness of the ongoing activity; and, since the variety of alternative choices increases with the increasing complexity on higher levels, each upward shift is accompanied by the subjective experience of freedom of decision.

8.6 The hierarchic approach replaces dualistic theories by a serialistic hypothesis in which "mental" and "mechanical" appear as relative attributes of a unitary process, the dominance of one or the other depending on changes in the level of control of ongoing operations.

8.7 Consciousness appears as an emergent quality in phylogeny and ontogeny, which, from primitive beginnings, evolves towards more complex and precise states. It is the highest manifestation of the Integrative Tendency (4.3) to extract order out of disorder, and information out of noise.

8.8 The self can never be completely represented in its own awareness, nor can its actions be completely predicted by any conceivable information-processing device. Both attempts lead to infinite regress.

9. Equilibrium and disorder

9.1 An organism or society is said to be in dynamic equilibrium if the S.A. and INT tendencies of its holons counter-balance each other.

9.2 The term "equilibrium" in a hierarchic system does not refer to relations between parts on the same level, but to the relation between part and whole (the whole being represented by the agency which controls the part from the next higher level).

9.3 Organisms live by transactions with their environment. Under normal conditions, the stresses set up in the holons involved in the transaction are of a transitory nature, and equilibrium will be restored on its completion.

9.4 If the challenge to the organism exceeds a critical limit, the balance may be upset, the over-excited holon may tend to get out of control, and to assert itself to the detriment of the whole, or monopolize its functions - whether the holon be an organ, a cognitive structure (*idée fixe*), an individual, or a social group. The

same may happen if the coordinate powers of the whole are so weakened that it is no longer able to control its parts (C. M. Child).

9.5 The opposite type of disorder occurs when the power of the whole over its parts erodes their autonomy and individuality. This may lead to a regression of the INT tendencies from mature forms of social integration to primitive forms of identification and to the quasi-hypnotic phenomena of group psychology.

9.6 The process of identification may arouse vicarious emotions of the aggressive type.

9.7 The rules of conduct of a social holon are not reducible to the rules of conduct of its members.

9.8 The egotism of the social holon feeds on the altruism of its members.

10. Regeneration

10.1 Critical challenges to an organism or society can produce degenerative or regenerative effects.

10.2 The regenerative potential of organisms and societies manifests itself in fluctuations from the highest level of integration down to earlier, more primitive levels, and up again to a new, modified pattern. Processes of this type seem to play a major part in biological and mental evolution, and are symbolized in the universal death-and-rebirth motive in mythology.

For more on these and related topics see also:

The holon, a new way to look at hierarchies

<http://www.holon.se/folke/kurs/Distans/Ekofys/Recirk/Eng/holarchy>

[en.shtml](#)

Holarchies: <http://www.worldtrans.org/essay/holarchies.html>

Arthur Koestler: http://orwell.ru/people/koestler/ak_en

From: <http://www.panarchy.org/koestler/holon.1969.html>

The holons which constitute a living organism or a social body are, as we have seen, Janus-like entities: the face turned towards the higher levels in the *holarchy* is that of a subordinate part in a larger system; the face turned towards the lower levels shows a quasi-autonomous whole in its own right

– Arthur Koestler, *Bricks to Babel: Selected Writings with Comments by the Author*

They [holons] are Janus-faced. *The face turned upward*, toward the higher levels, is that of a dependent part; *the face turned downward*, towards its own constituents, is that of a whole of remarkable self-sufficiency.

– Arthur Koestler, *Janus: A Summing Up*