A COMPILATION OF SYSTEM DEFINITIONS AND CONCEPTS

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von Bertalanffy, General Systems Theory

Systems: science, technology, philosophy, ontology, epistemology.

p27: structure (order of parts) = function (order of processes)

Concepts:

p40 equifinality: final state in an open system reached from different initial conditions in different ways. Contrast determinism of closed systems. Via dynamic interaction

p46 feedback: homeostatic maintenance of a state or a goal-seeking based on circular causal chains and monitoring back information on deviations. Open re information; closed re energy and matter.

p49 perspectivism: contrast to reductionism. Find constructs and laws within individual non-reducible levels.

p54 ff:

distinctions between elements: number, species, relations

number and species are summative, temporal concepts;
relation is emergent, instant.

system: set of elements with interrelations.

R defines different behavior of E than R'.

analysis re differential equations:

eigenvalues stable, unstable, or fluctuate.
differential matrix:
if i =/= j is 0 then independent and additive
otherwise whole.

organization

wholeness

growth: or progress: moving from undifferentiated wholeness (fully interactive) to differentiation by parts. Progressive segregation, progressive mechanization.

dominance: one component or element dominates the system. System is centered around D. D is a trigger. Progressive centralization is progressive individualization.'

finality: dependence upon the final state (in the future). The reverse of causality. Types:

static teleology or fitness: arrangement useful for a specific purpose.

dynamic:
1. direction toward a final state
2. direction of structure, homeostasis and feedback
3. equifinality
4. purposiveness: behavior determined by foresight of goal.

dynamic equilibrium or steady state:

Theorem: Initial conditions do not enter into the solution for the steady state for an open system. A closed system cannot be equifinal for all parameters.

metabolism: exchange of components across system boundaries (to maintain steady state.

Prigogine's expanded entropy function

change in entropy dS =
production of S in system + S transport by metabolism

p72 individual: indivisible

directiveness

teleology

differentiation

hierarchical order

dominance

control

competition

Boulding

law of optimum size: communication channels limit performance size.

law of instability: cyclic fluctuation result from interaction of subsystems, rather than stable equilibrium

Blauberg et al in Unity through Diversity p254

Problems:

1. derivation of characteristics of the whole from those of the parts, and vice versa.

2. hierarchy of the structure and the specific characteristics of the interrelations between levels.

3. individualization of system objects and dfs of objects.

4. control esp. between levels.

5. expansion of the idea of causality.

6. integrity of description of a system and conditions for existence.

7. differentiation between common "material" of the system.

Principles:

1. contrast to medium or environment.
   element =/= atom. Define element re system.

2. connection that defines system.

3. system structure as set of interconnections, and their stability.

4. system level hierarchy, vertical connections and structure.

5. control and regulation of levels, rigidity.

6. internal control, self-organization

System:

1. complete set of elements and interconnections

2. a specific unity within an environment

3. an element of a higher-order system

4. elements are lower order systems.

Koestler in Unity through Diversity p305:

Some General Properties of Open Hierarchical Systems OHS:

1. Holon

1.1 structurally not an aggregation of elementary parts;
functionally not a chain of elementary behaviors.

1.2 multi-leveled hierarchy of semi-autonomous sub-wholes = holons.

1.3 holons are self-regulating, both autonomous wholes and dependent parts.

2. Dissectability

2.1 holons as nodes; control/communication channels as links.

2.2 depth = levels; span = number

3. Rules and strategies

3.1 functional holons governed by fixed rules and flexible strategies.

3.2 rules = canon; determines invariances and structural pattern.

3.3 steps in strategy guided by contingencies of E.

3.4 evolution = strategic variations on canonical themes.

3.5 skills are functional hierarchies.

4. Integration and self-assertion

4.1 holons preserve and assert individuality as well as integrate into whole.

4.2 polarity: assert = wholeness, integrate = partness.

4.3 Integrate-ness shown by steady-state, symbiosis, cohesion, bonding; flexible integration, improvisation, creation.

4.4 Assert-ness by competition, individualism, separation; stubbornness, habit, ritual, stereotype.

5. Triggers and scanners

5.1 output hierarchies use trigger-release; simple signal releases complex pre-set behavior. Eg learned skills

5.2 input hierarchies use filters (reverse of trigger); strip, abstract and digest by holon relevance.

5.3 triggers: signal to pattern. spell, concretize, particularize.

scanners: pattern to signal. habituation, constancy, pattern-recognition, decoding of meaning.

6. Arborization and reticulation; principles of architecture

6.1 Hierarchies as vertically arborizing structures, branches interlock with other hierarchies at multiple levels to form horizontal networks.

6.2 environmental contingencies guide, correct and stabilize, not determine. environments are hierarchical.

7. Regulation channels

7.1 communication does not skip levels.

8. Mechanization and Freedom

8.1 Higher level holons are more complex, flexible, less predictable.

8.2 Progressive mechanization is automation of skill.

8.3 Monotony in the E facilitates mechanization.

8.4 Surprise shifts control to higher levels.

8.5 Upward shift defines freedom.

8.6 Mental and mechanical are relative to level of control.

8.7 Consciousness emerges from top level control and maximum Integrate-ness.

9. Equilibrium and Disorder

9.1 dynamic equilibrium = assert and integrate in balance.

9.2 equilibrium is not part to part but part to whole.

9.3 transactions with E involves stress that is transitory.

9.4 if critical level exceeded, holon may over assert and monopolize functions. opposite is erosion of individuality, regressed integration, primitive identification.

10. Regeneration

10.1 is fluctuation from higher to lower, then up again with new higher pattern.

Klir in Trends in GST p14:

system: collection of variables with a space-time resolution level.

Rapoport p46:

mathematical system:
set of elements and relations. Elements are defined exclusively in terms of relations between them. "Operation" is redundant. Contentless.

Richard Mattessich, Axiomatic Representation, in Cybernetics and Systems:

distinguish: conceptual systems from concrete systems. Reflective information processing systems are both.

axiomatics:

concrete system: two different connected things.

atomic-composition at time t: x is-a-part-of S

atomic-environment: x not-in S & y in S & x acts-on y or y acts-on x

atomic-organization: B is-set-of Bonding relations, B-bar is non-bonding Rs, R-in-B union B-bar & B not-empty

closed system: empty atomic-environment, otherwise open.

open with respect to property P: P related to some property of atomic-E and P is-of S

internal atomic-structure: relations among atomic-parts

subsystem of S: atomic-composition of x contained-in atomic-comp of S & E of x contained-by E of S & atomic-structure of x contained-in Ss

nested systems: partial ordering with core S
named level n-ary structure

containment of levels, belongs to a level, level structure...

property system of S: properties lawfully related

functional system: processes lawfully related

system: if property system or functional system

inputs and outputs: actions of E, actions on E, activity of E is union

transfer function: composes with out to yield in

x assembles into y: B changes from empty to non-empty
self-assembly and self-organization

total qualitative novelty, emergent properties...

selective action of E, selection pressure...

ancestry, progeny, lineage...

stable, unstable...

Tart, States of Consciousness:

p5 Stabilization by:

1. loading: large input from E
2. negative feedback: correct deviations from normal
3. positive feedback: strengthen when within desired limits
4. limiting: restrict destabilizing functions

Weinberg, Introduction to General Systems Thinking:

Boulding's Main Article of Faith:

Any set of order relations is itself ordered. Laws about laws...

Law of Conservation of Laws:

When the facts contradict the law, reject the facts or change the definitions, but never throw away the law.

Happy Particularities:

Any general law must have at least two specific applications.

Unhappy Peculiarities:

Any general law is bound to have at least two exceptions. Laws that are never wrong are never useful.

Composition:

The whole is more than the sum of its parts.

Decomposition:

The part is more than a fraction of the whole.

Ashby:

Facts are relations between the E and the Observer. The product space represents uncertainty of O, and changes with changing O.

System: a point of view

Banana:

Heuristics don't tell you when to stop.

Purpose is a relation. So are emergent properties.

Arbitrary systems cannot be described.

Sets: Define them by enumeration, typical member, or a rule. Mathematical systems are an undefined primitive and are sterile.

Observation is the act of choosing an element from a set of all possible observations.

Aspects: kinds of observations, range of choices.

Cartesian product prevents undergeneralization. Introduces a super-observer who dominates, and unifies, all points of view.

Indifference:

Laws should not depend on a particular choice of notation or perspective.

Eye-Brain:

Computational power can compensate for lack of input. Fails when input is not constrained.

Brain-Eye:

Input can compensate for lack of computational power.

Learning requires recognition of the same state twice. Discriminating too many state is undergeneralization.

Generalized Thermodynamic:

More probable states are more likely to be observed than are less probable states, unless specific constraints exist to keep them from occurring.

Frequent things are frequent because:

1. there is a physical reason for favoritism, or
2. there is a mental reason (observational bias).

Lump:

To learn something, we can't try to learn everything.

Choice of scope and grain defines belief, relevance, importance.

Functional notation:

Defines scope and grain via arguments. Can express partial knowledge, eg: $F = f(a, b, c)$, f not specific. Can express intermediate states of knowledge, eg: $F = h(a, b) + k$.

Dominance of observers: $A = f(B)$

Reduction fails when incompleteness. Completeness means further decomposition introduces nothing new.

If grain size of observation is fundamentally limited, then complementary views must result. Complementarity is a special case of incompleteness.

Complementarity:

two mutually irreducible points of view that are not entirely independent.

Generalized Complementarity:

Unless infinite observation, any two points of view are complementary.

Difference:

Laws should not depend on a particular choice of symbols, but they usually do. EG: different ways to decompose.

Methods:

Complete view, avoids surprise.
Minimal view, no unnecessary observations.
Independent view, no interaction.

Axiom of Experience:

The future will be like the past, because, in the past, the future was like the past.

Two things are alike if one in the present can be substituted for one in the past.

Rather than separating, boundaries connect.

A quality is a way of grouping system states. Extensive and intensive qualities are relative to the transformation in question. If intensive qualities do not change, then the transformation is proper.

Invariance:

With respect to any given property (transformation), there are those transformations (properties) that are preserved and those that are not.

Change is defined by what remains invariant; permanence is defined by what is transformed.

Varying single factors requires a previous partition. This process is empirical.

Perfect Systems:

True systems properties cannot be investigated.

Strong Connection:

Systems, on the average, are more tightly connected than the average.

A system is a collection of parts, no one of which can be changed.

In systems, all other things are rarely equal (strong interdependence).

Diachronic view: one system at different times.

Synchronistic view: different systems at one time.

Holes in state space indicate:

1. incomplete observations, or
2. categorization into properties too broad.

Picture:

When speaking about a dimensional reduction, insert the words "a picture of".

Diachronic:

If a line of behavior crosses itself, either:

1. the system is not state determined, or
2. the view is a projection, and is incomplete.

Synchronistic:

If two systems occupy the same position in the same space at the same time, then the space is underdimensioned, the view is incomplete.

Time removes cycles.

Count To Three:

If you cannot think of three ways of abusing a tool, you don't understand how to use it.

Cycles indicate a state-determined behavior. If a state-determined system is divided into S and E, the S will generally not be state-determined.

Abstraction is used to transfigure open system behavior to determinate behavior.

The observer can be either O or E, therefore can either predict or influence.

Indeterminability:

We cannot attribute with certainty observed constraint either to S or E.

Significant units in a mature system have invariance over time.

Stability:

1. acceptable behaviors of the system and
2. expected behaviors of the environment.
3. critical limits

Change implies change in transformations.

Effect:

Small changes in structure usually lead to small changes in behavior.
white box black box

Small changes in behaviors will usually be found to result from small changes in structure.

There is no absolute way to distinguish regulation from adaptation.

Used Car:

1. A system that is doing a good job of regulation need not adapt.
2. A system may adapt in order to simplify its job of regulating.

Therefore, change indicates an increase in the cost of regulation.

1. A way of looking at the world that is not putting excessive stress on the observer need not be changed.

2. A way of looking at the world may be changed to reduce the stress on an observer.