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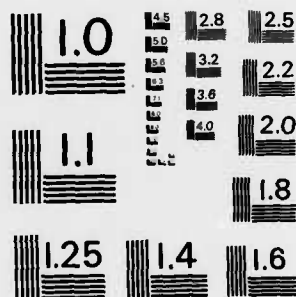
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SYSTEM SCIENCE TERMS: A SYSTEMATIC VOCABULARY

R. L. Goodbody

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Language used in system science is itself a system and can be the subject of system analysis. Each definition is a component of the system which is related in an orderly way to other definitions. These relationships are defined and are illustrated by a "wiring" diagram.

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INTRODUCTION

The purpose of this document is to contribute to a dialogue to develop and refine standard system science terminology. To the extent that English language descriptions of any system are ambiguous, then translations of such descriptions into system designs and protocols by different designers will result in incompatible designs. In the particular case of decision support systems (DSS), some agreement on terminology is a necessary condition for (a) agreements on standards and specifications for production of "open systems" — systems which are interoperables, as defined by the International Standards Organization (ISO),[1] and (b) application of system science to practical DSS designs. Further, Beishon[2] discussed the difficulty of teaching system science because of the lack of agreed-on terminology.

We present a system of definitions used in system science; it is not just a set of definitions (see the definition of system below). It is of course a limited system, not adequate for all cases, intended as an example which can be extended. Only forty words, and only one definition of each word, are selected out of the English language to construct an internally consistent system.

The concept is that the language used in system science is itself a system and can therefore be the subject of system analysis. Each definition is a component of the system which is related in an orderly way to other definitions. To show such relationships, any word used in a definition in the section SOME DEFINITIONS OF SYSTEM SCIENCE TERMS is underlined if it is itself defined therein.* Those relationships are further illustrated by the "wiring"

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*Except that "space-time," the concept of which is the genesis for all other terms, is not defined. An attempt to define space-time would cause the system to loop back on itself and become self-referent. See Hofstadter[3] on problems of self-referent systems and "funny loops."

1. des Jardins, Richard, "Overview and Status of the ISO Reference Model of Open Systems Interconnection," Computer Networks – The International Journal of Distributed Informatique, V 5, No 2, Apr 1981, p 77.
2. Beishon, John, "Learning About Systems," Cybernetics and Systems: An International Journal, V 11, No 4, Dec 1980, pp 298 through 303.
3. Hofstadter, D. R., "Gödel, Escher, Bach," Vintage Books division of Random House. New York, N.Y., Sept 1980.

diagram, figure 1; an arrow points from one word to another to show that the word being pointed to depends for its definition on the word(s) being pointed from.

An interesting aspect shown in this document is that language, like all naturally evolving systems, tends toward parsimony in the use of key resources.* That is, words evolve in language to express increasingly varied and complex concepts of nested space-time relationships. Here, parsimony refers to the power of a single word to express a concept. An example of parsimony in this document is the definition of "norm," which is: "The expected state or behavior." Some persons might be tempted to change this definition to: "The expected state or behavior of a system." The word system is redundant, however, because the concept "system" is already incorporated in both "state" and "behavior." ("System" is incorporated in "state" via "process," and in "behavior" via "input, output.")

This system of definitions is intended to:

- help discussions of system concepts to be more precise, parsimonious, and intelligent

- illustrate a systematic approach to terminology

- illustrate an approach to the taxonomy of terminology

- contribute to the etymology of terminology

- illustrate a heuristic principle for evolving terminology

- illustrate a tool for life-cycle management of system-science terminology

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*In this case, words. Thus, a rich variety of words will evolve to express a rich variety of concepts, e.g., in the Eskimo language, a large number of words have evolved to express their many concepts of snow.

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- illustrate how a natural language such as English can be used as a tool (in a way similar to mathematics) to generate system-scientific concepts — not just express them.
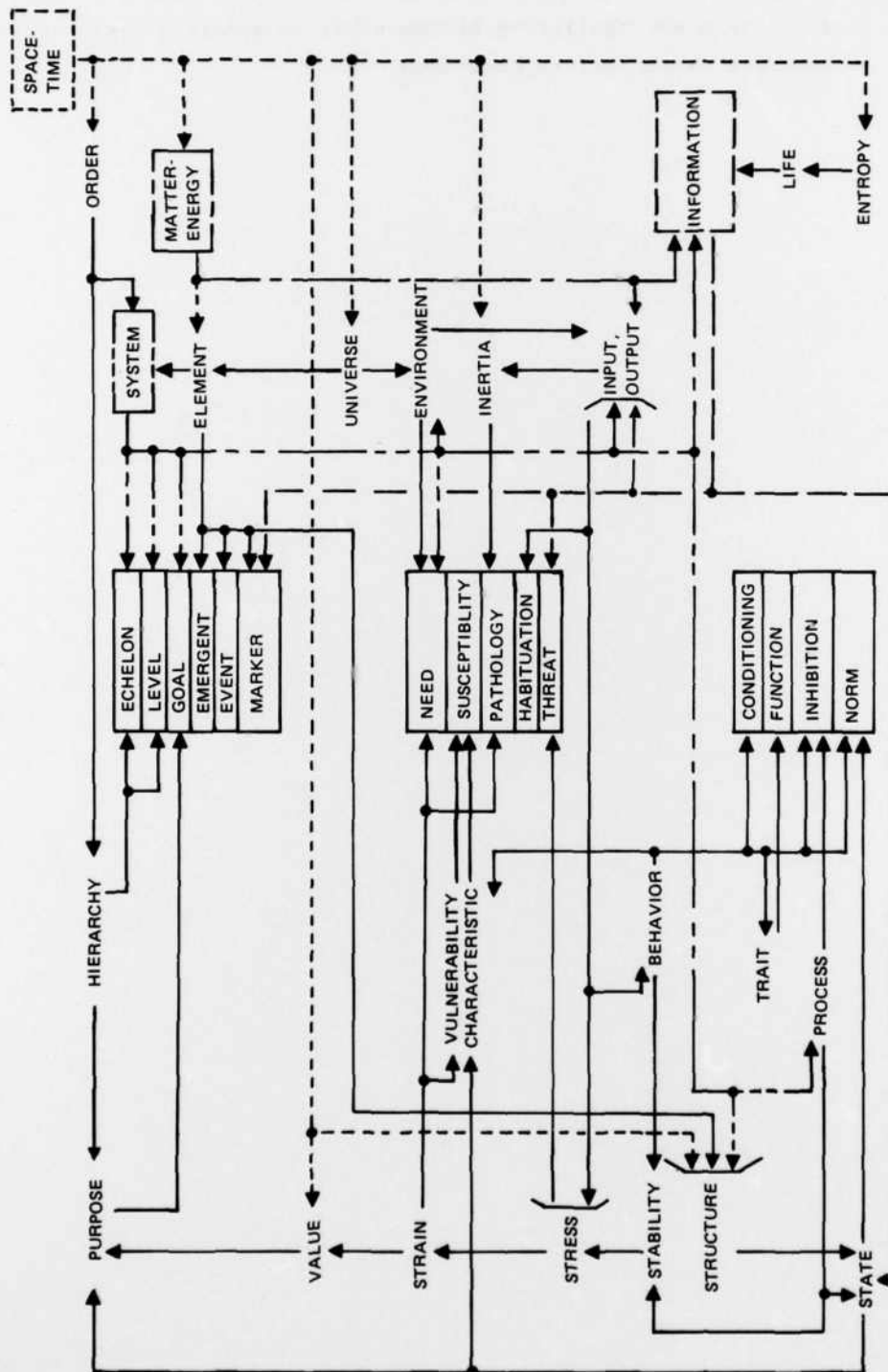
Figure 1. 'Wiring' diagram of System Science terminology.

SOME DEFINITIONS OF SYSTEM SCIENCE TERMS

Behavior = Relationships between <u>inputs</u> and <u>outputs</u>.

Characteristic = A typical (possibly distinguishing) <u>state</u> or <u>behavior</u>.

Conditioning = The acquisition of new <u>behavior</u> as a result of experience.

Echelon = A place or rank in a <u>hierarchy</u> of equivalent <u>systems</u> distinguished
by importance, rank, or ability.

Element = An undivided <u>matter-energy</u> relationship in a chosen partitioning of
the <u>universe</u>.

Emergent = An unpredicted result of a combination of <u>elements</u>.

Entropy = A tendency of <u>space-time</u> relationships toward randomness and
ultimately toward undifferentiated <u>space-time</u> progression
(nothingness).

Environment = The portion of the <u>universe</u>, external to a <u>system</u>, which is
considered to have measurable effects on the <u>system</u> or vice
versa.

Event = An <u>elemental</u> change.

Function = A desired <u>trait</u>.

Goal = Something to achieve external to a <u>system</u> to satisfy that <u>system's</u>
<u>purposes</u>.

Habituation = The gradual decrease of <u>outputs</u> resulting from continued similar
<u>inputs</u>.

Hierarchy = An ascending <u>order</u> of complexity, importance, rank ability, time
(urgency), etc.

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Inertia = Space-Time lag between inputs and associated outputs.

Information = Interpretation of matter-energy relationships by a living*
            system.

Inhibition = A restraining of a process or behavior.

Input = Matter-energy or information received into a system from its supra
      system or its environment.

Life = A condition promoting (at least locally) negative entropy (creation).

Level = A place in a hierarchy of increasing system size and complexity. (A
      subsystem of one level is constructed of a combination of subsystems
      at lower levels).

Marker = An element used for carrying information.

Matter-energy = Space-time relationships (eg, photon, electron, molecule)
              that result in departures from the nothingness of
              undifferentiated progressions of space-time.

Need, Drive = A reaction to strain impelling change to reduce the strain.

            Psychogenic Need = A reaction to strain due to information
                             stress.

            Viscerogenic Need = A reaction to strain due to matter-energy
                              stress.

Norm = The expected state or behavior.

Order = Predictability and repeatability of space-time relationships.

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* See life.

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Output = <u>Matter-energy</u> or <u>information</u> transferred from a <u>system</u> to its <u>supra-system</u> or its <u>environment</u>.

Pathology = A condition of <u>strain</u> where the cost or <u>inertia</u> of adjustment is significant.

Process = Change in a <u>system</u>.

Purpose = Preferential <u>hierarchy</u> of <u>values</u> that gives rise to decision rules which determine preference for one internal steady-<u>state</u> <u>value</u> rather than another.

Stability, range of = The range within which the rate of correction of deviations in a <u>process</u> or <u>behavior</u> is minimal or zero.

State = <u>Structure</u>, and related <u>information</u> during a <u>process</u>.

Strain = Effect produced by <u>stress</u>.

Stress = An <u>input</u> or <u>output</u> lack or excess which forces one or more variables beyond the <u>range of stability</u>.

Structure = <u>Spatial</u> relationships of the <u>elements</u> of a <u>system</u> at a given <u>time</u>.

Susceptibility = A <u>characteristic</u> which could result in a <u>vulnerability</u>.

System = A complex unity formed of many often diverse <u>elements</u> subject to some <u>order</u>.

Threat = <u>Information</u> about expected <u>stress</u>.

Trait = A <u>behavior</u> which is typical.

Universe = The totality of <u>space-time</u>, relationships.

Values = Benefits and costs in relation to <u>space</u> and <u>time</u> for reducing each of specific <u>strains</u>.

Vulnerability = A predicted conditional <u>strain</u>.

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