Synopsis of the Principia Cybernetica Project

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1 Principia Cybernetica Ends: Metasystem Transition Theory

As the name Principia Cybernetica implies, it is a project intended to clarify the fundamental principles and produce a unification of the foundations of the domains of cybernetics and systems science.

The philosophical system created by Principia Cybernetica is seen as a clearly thought out and well-formulated, global "world view", integrating the different domains of knowledge and experience. It is based in the perspectives of cybernetics and systems science, which see the world not in terms of space, time, and matter, but of organization, structure, information, and communication. It will provide answers to the basic questions: *"Who am I? Where do I come from? Where should I go? How true is my knowledge? What is the nature of things? What are good and evil?"*

The philosophical system developed by Principia Cybernetica is systemic and evolutionary. **Blind variation and selection retention** [1] is postulated as a fundamental process resulting in the **metasystem transition** (MST) [2] —the primary act of evolution, the free and spontaneous emergence of higher levels of organization and control [3, 4]. Thus we call this philosophical system **Metasystem Transition Theory** (MST Theory).

As the fundamental quanta of evolutionary change, all physical, biological and cultural evolution can be described in terms of successive metasystem transitions. The phenomena explained in terms of metasystem transitions include the origins of life, of sexual reproduction, of multi-cellular organisms, of neural organisms capable of coordinated action and learning, of thought and language, and of human society and industry. In the future we predict the development of global human society and human meta- or super-beings, which preserve the cybernetic organization of human minds through direct human-machine and human-human connections.

Principia Cybernetica will develop MST Theory through a process of **semantic analysis** of the senses of terms in the context of their historical development. This development will be **meta-foundational**, stressing both the need for fundamental principles and the possibility of multiple complementary foundations. Semantic analysis will proceed through a process of **progressive formalization**, where originally vague and intuitive definitions are replaced with increasingly formal usages, while still retaining the previous intuitive senses. Through this process Principia Cybernetica aims to construct **consensus** within the cybernetics and systems science communities about the uses of terms and fundamental theory.

Concepts used directly by MST Theory include: **Action, Distinction, Subject, Variety, Selection, Freedom, Change, Stability, Will, System, Survival,** and **Control**. Related concepts include **Relation, Complexity, Information, Constraint, Order, Organization, Self-organization,** and **Emergence**.

Principles of MST Theory include the **Law of Requisite Variety** [5]; the **Law of Requisite**

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Constraint; the **Law of Requisite Hierarchy** [6]; the **Principle of Uncertainty Minimax** [7]; the **Principle of Blind Variation and Selective Retention** [1]; and the paradigm of **anticipatory control** as used in **Feedback Control Theory** [3].

The body of MST Theory arises from a general philosophy, which includes:

Metaphysics: Based on **actions** as ontological primitives, with an assumption of the **freedom** of systems.

Epistemology: Which understands **knowledge** as the existence in a cybernetic system (or **subject**) of a self-constructed **model** of the **environment** (or **object**), in whose interaction it undergoes **selection**.

Ethics: Based on a distinction between the **will** and **knowledge** of subjects; in which **survival** is the fundamental measure of **value**; the process of **evolution** is the **supreme good**; and it is predicted that **cybernetic immortality** is the ultimate goal of all human activity.

2   Principia Cybernetica **Means: Hypermedia Implemented Conceptual Network**

In the spirit of Whitehead and Russell's *Principia Mathematica* [8], which developed the foundations of mathematics by reflexively applying them to themselves, Principia Cybernetica is **meta-cybernetical**, in that it will reflexively apply cybernetic principles, tools, and methods to their own development. In this way, we hope to demonstrate the conceptual unity of cybernetics and systems science by constructing a philosophical system on that basis.

Because of this self-application, it becomes necessary that the philosophy, concepts, and theory of Principia Cybernetica are developed by methods which are *appropriate* given the particular properties not only of cybernetic theory, but also the **objects** of cybernetic theory, that is **cybernetic systems** themselves. These properties include (at least):

Complexity: The presence of multiple, heterogeneous interacting components.

Mutuality: Their cooperative, parallel, real-time interaction.

Complementarity: Their simultaneous participation in multiple processes and structures, thereby requiring multiple, complementary, irreducible models.

Evolvability: Opportunistic growth and development, as opposed to optimal planning and design.

Constructivity: An increase in size and complexity, resulting in historical linkage to previous forms while simultaneously developing new properties.

Reflexivity: The presence of rich internal and external feedback, resulting ultimately in reflexive self-application.

Therefore, the implementation of Principia Cybernetica will directly utilize the capabilities of **computer technology** to represent systems with the above properties. Principia Cybernetica is to be developed as a **dynamic, multi-dimensional conceptual network**. The basic architecture consists of **nodes**, containing expositions and definitions of concepts, connected by **links**, representing the semantic associations that exist between the concepts. Both nodes and links can belong to various **types**, expressing different semantic and pragmatic categories.

Thus the form of Principia Cybernetica is essentially similar to that of a **semantic network** [9]. By considering projections through the network according to specific sets of node and link types, it is possible to generate a variety of more specialized forms. The selected dimensions could vary with (among others):

Form: To produce articles, books, encyclopedic compendia, histories, textbooks, etc.

"Authorship Granularity": To produce single or multiple authored works.

Subject: To produce a variety of specialized or general works on single or multiple subjects.

Such tools will allow the construction and publication of structured, nonlinear documents by a collaborative group of spatially separated contributors in a hybrid natural and formal language environment. On a Whorfian view, in which the form of expression affects the content, this new tool may allow the development of previously inexpressible thoughts and ideas.

The computer-based tools to be used to implement the PRINCIPIA CYBERNETICA conceptual network may include **hypermedia, textual markup, electronic publishing, electronic mail, knowledge structures**, and **computer-supported collaborative environments**. More specifically, PRINCIPIA CYBERNETICA may use the ISO HYTIME standard [10, 11] of SGML [12] to represent nodes and links and prepare text for publication; and is now using `PRNCYB-L`, a `LISTSERV` electronic mailing list and file server to coordinate project participants. These computer based tools are intended to support the process of collaborative theory building by a variety of contributors, with different backgrounds and living in different parts of the world.

3   Specific Goals for PRINCIPIA CYBERNETICA

PRINCIPIA CYBERNETICA has the following specific goals:

Collaboration: For a group of researchers, perhaps not all geographically close, to collaboratively develop a system of philosophy. The task of growing such a system should be beyond the grasp of any one individual. In order to achieve progress, openness, and the participation of the scholarly community, balance in the content of the system must be reflected by a balance of opinions of its authors and between editorial control and public participation.

Constructivity: To produce a system of philosophy that can develop dynamically over time, with continuing refinement and expansion, while retaining a record of its history. Such a system must be "grown"—it will begin small, and become larger. But change in the philosophy must not only be in its growth, but also in revision, the correction of error, and incorporation of new opinions and participants. Thus it must be possible for parts of the system to be changed and deleted on an ongoing basis.

Active: The content of the project should not just be a passive reflection of what the authors construct, but be a *model* able to generate its own activity, and to act on itself and its organization. The structure of the system should not just *represent* the principles being developed, but also *manifest* them in its actions.

Semantic Representations and Analysis: For the system of philosophy to fully reflect and incorporate the multiple semantic relations inherent among the terms being explicated, and to unify and synthesize notations and the senses of terms as used in different disciplines. The semantic relations among the terms and concepts are complex and intricate. In this way, knowledge can be represented in its breadth, depth, and other orderings as conceived by the readers and authors. The coherence of a system of thought is aided by the unification and synthesis of terminology. Much of the development of the system will be done through the explication of concepts and the multiple senses of terms in the context of their history in the literature.

Consensus: To support the process of argument and dialogue among experts toward the development of consensually held views among a number of researchers, while preserving their individual views.

Multiple Representational Forms: To support mathematical notation and the easy movement among natural language, formal language, and mathematics, and to support bibliographical and historical reference. There are many different forms of linguistic expression aside from natural language which are very useful for philosophical work. These include graph notation (nodes and arcs), set notation, predicate logic, mathematical notation, and other forms of lists, tables, and diagrams.

Flexibility: To allow researchers to develop or read the philosophical system in various orders and in various degrees of depth or specificity. It must be possible for readers to have access to all of the orderings and dimensions of this large multi-dimensional semantic system, and to travel freely along and among them.

Publication: To support the traditional publication of different stages of parts or the whole of the philosophical system and of various special purpose documents, including journal articles, books, dictionaries, encyclopedias, texts on a subject, reference pages, essays, dialogues on a subject, or "streams of consciousness".

Multi-Dimensionality: To allow the representation and utilization of knowledge in its breadth, depth, and any other arbitrary orderings.

4 Participation

Development of PRINCIPIA CYBERNETICA is seen as a long term project involving many participants. It is managed by a **Board of Editors**, currently the authors of this article, who are responsible for implementation of the system and the collection and development of the material. Similar to a journal, it may rely on an Editorial Advisory Board, and other associated editors, referees, and contributors. The editors are actively looking for like-minded researchers to participate in the Project.

Thus PRINCIPIA CYBERNETICA is seen as necessarily open ended and developing, essentially a process of discourse among a community of researchers. A variety of **collaboratory granularities** are possible, ranging from contributions by individual authors, through groups of authors, to consensual statements of all project participants.

Participants are free to develop their material within PRINCIPIA CYBERNETICA while having it simultaneously available for traditional publications. Copyright is initially held by PRINCIPIA CYBERNETICA, which then liberally grants permission for external publication. Thus traditional publication of parts or the whole of the network by individual authors or groups of authors will be made periodically.

PRINCIPIA CYBERNETICA regularly organizes conferences and meetings, allowing participants to get personally acquainted. Their atmosphere is informal, with an emphasis on discussion.

PRINCIPIA CYBERNETICA publishes a Newsletter, which is freely distributed by electronic mail (or by post to those without access to electronic mail) to all people requesting to be on our mailing list (currently some 200 addresses worldwide). There have been two issues to date (numbers 0 and 1). The Newsletter appears irregularly, and summarizes the main developments (meetings, publications, theory, practical issues), and the discussions from `PRNCYB-L`. It is edited by F. Heylighen.

Several publications on PRINCIPIA CYBERNETICA are available, and more are being prepared, including a special issue of *World Futures: the journal of general evolution* on MST Theory. The most important appear in the references.

Those interested in working with PRINCIPIA CYBERNETICA, or wanting more information, may contact the authors.

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