Tangled Hierarchies:
Gödel, Escher, Bach and Gravity's Rainbow
(An Abstract of Work in Progress)

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Douglas Hofstadter tells us in Gödel, Escher, Bach: An Eternal Golden Braid (1979) that the rapid development of computer technology in the past two decades has brought about a new kind of perspective on just what thought is--its powers and weaknesses, as well as its idiosyncracies. This has been made possible through computer experimentation with what he calls "alien, yet hand-tailored forms of thought--or approximations of thought." The results of this experimentation are reflected in the theory and designs developed in the artificial intelligence (AI) field, and many of these developments are considered at some length in Gödel, Escher, Bach.

The key assumption of artificial intelligence is that symbolic processes of mind are explainable in their own terms, without direct reference to neural events in the brain, though such activity is closely tied to these events. In computer terminology, symbolic processes thus are referred to as "software" and neural events as "hardware." This assumption enables artificial intelligence researchers to proceed on the premise that intelligence, or information processing like human intelligence, can be realized in other types of hardware than brains.

Working from this premise, Hofstadter has extended a process from computer programming to define a kind of thought pattern he believes to exist at the core of human consciousness, called the "strange loop." The general idea of loops in computer programming is the performance of a series of related steps over and over automatically, terminating the process as soon as the specific conditions of the program are met. Recursive looping, a process Hofstadter pays particular attention to, occurs when the looping is happening on several levels at once, but the series of loops are somehow nested within each other. However, since recursion is the notion of something that is defined in simpler versions of itself (such as the frame story in

fiction), the events taking place on each level are not exactly the same in that the levels are not identical.

Hofstadter states that a sufficiently complicated recursive loop in a computer can be a procedure leading to unpredictable results. Subtly complicated recursive systems might be strong enough to break out of predetermined patterns. AI researchers hope to invent programs that not only "call" themselves up, but modify themselves and act upon other programs, extending, improving, and generalizing them. This Hofstadter believes is the kind of tangled recursiveness that lies at the heart of human intelligence. The assumption is, of course, that the human mind is a multilevel system, formalized in the neural behavior of the brain.

Hofstadter writes that the "strange loop," or tangled hierarchy, occurs whenever one moves upwards (or downwards) through the distinct, though related levels of a system, only to find oneself suddenly back at the point of origin. The loop is considered "strange" or "tangled" because it implies a violation of distinctions between levels. Much of Gödel, Escher, Bach is given to tracing such a looping pattern in various areas, from aesthetic patterns to the recombination of genes and the paths of elementary particles.

Hofstadter focuses on J. S. Bach's canons, M. C. Escher's prints, and K. Gödel's Incompleteness Theorem to define and illustrate the essence of this pattern. Bach's canons and fugues feature independent voices playing a central theme against itself, transforming a theme that is fully recoverable in the voices. The "Canon per Tonos," renamed by Hofstadter as the "Endlessly Rising Canon," is a three-voice work that modulates upwards six times until the original key is restored, an octave higher, at the end of the piece. The rising, varied tonalities caused by successive modulations suggest the movement of a spiraling loop that eventually returns to the point of origin. Hofstadter finds the most exemplary visual illustrations of his concept in Escher's prints. Escher's "Waterfall' (1961) lithograph, for instance, renders a multilevel structure in which water is channeled through its

discrete levels in a physically impossible manner. Water splashes down on a water wheel at the point where the water is depicted to begin its zigzagging flow between the two towers of the structure.

Most directly related to Hofstadter's argument as a whole is his analysis of Gödel's Incompleteness Theorem as a strange loop in number theory. Hofstadter gives us a paraphrase of the well-known theorem: "All consistent axiomatic formulations of number theory include undecidable propositions." An undecidable proposition within a formulation is one which that formulation is capable of neither proving nor disproving. What is particularly significant about the theorem, for Hofstadter's purposes, is the proof. Gödel created a code, called Gödel-numbering, which represents numbers by symbols and symbol-sequences, using mathematical reasoning to explore mathematical reasoning. The genius of the proof hinges on the writing of a virtually self-referential mathematical statement, that is, a statement about numbers that in effect talks about itself. As Hofstadter writes, "explanation hinges on understanding not just one level at a time, but the way in which one level mirrors its metalevel, and the consequences of this mirroring."

The idea of a system referring to itself (self-reference) underscores the deepest elements of Hofstadter's metaphor of strange loops. He suggests that language creates strange loops, for instance, when it talks about itself, whether directly or indirectly. Something in the system jumps out and works on the system, as if it were outside the system. Hofstadter ultimately applies his theory to the most complex of symbolic events, the human mind. He believes that what he terms "emergent properties" of our mind/brains--ideas, hopes, images, analogies, consciousness--are based on a kind of strange loop. The functioning of the mind/brain consists of an interaction between levels. The top level reaches down toward the bottom level and influences it, while at the same time being itself determined by the bottom level. The mind has the power to reflect itself; hence, it is a self-referential system. Self-understanding, however, is limited because of the tangledness of the loop. As Hofstadter has written, "We can

come close to seeing and understanding ourselves objectively, but each of us is trapped inside a powerful system with a unique point of view--and that power is also a guarantor of limitedness." This vulnerability, of "self-hook," as Hofstadter terms it, might be the source of the sense of self.

The theoretical framework proposed in Gödel, Escher, Bach clarifies the structure and meaning of Thomas Pynchon's Gravity's Rainbow (1973). Of major importance linking the two works is the fact that Hofstadter experimented with ways in which the very subject of his text could be made to mirror the metaphor which defines his theme, his thesis. He employs devices commonly used in characterizing canons and fugues as musical forms to interweave independent strains of thought that serve to define and extend the notion of strange loops. Inventing fictive conversations between various personae who argue the issues raised elsewhere in the book, Hofstadter alternates these dialogues with the chapters in which the thesis is explicitly developed. Most of the dialogues are in turn patterned after specific works by Bach, and the book's thematic concerns emerge out of the interplay of ideas between the imaginary speakers of these conversations. Contrapuntal movement thus not only characterizes the structure of the dialogues, but also provides the basis for alternating these allegorical conversations with those sections which Hofstadter devotes to exegesis. Moreover, Hofstadter deliberately inserts into the final dialogue a discussion that refers (or loops) the reader back to the beginning of the book. In this fashion, Gödel, Escher, Bach parallels the method and aim of Gravity's Rainbow.

A number of affinities with the rendering of Gravity's Rainbow suggest themselves: experimentation with multiple levels of mind and thought and diverse genres of narrative; coding as a fundamental property of intelligence and belief; and the incompleteness principle as a radical and formal property of knowledge. Of greatest significance, however, is that Pynchon in Gravity's Rainbow can also be shown to employ the strange loop in its various manifestations as a means of demonstrating the characteristics of thought signified by that metaphor.

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