Book Reviews

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How to Grow Science
Universe Books, New York, 1980

In this short and delightfully written popular book, the author expresses his insights and views about science: why and how it is done, measured, investigated, planned, and nurtured. He brings to bear his personal experiences as a physicist and, more recently, as a 'scientometrician' who joined the new or emerging discipline of the 'science of science'. He raises some very important questions about contemporary science: for example, what is an optimal or an adequate fraction of GNP that a country should invest in science. Unfortunately, he offers no answers to such questions.

Several important points of view are forcefully stated. He begins with the premise that science is primarily a human activity rather than an abstract set of laws: its aim is the discovery of natural laws. He states dogmatically that all good basic science eventually turns into important applied science. He attributes four hallmarks to science: objectivity, universality, collectivity, and cumulativeness. Then he asserts that science is the only human activity that is cumulative.

His characterization of *crackpots* in science in terms of five behavior patterns is interesting and useful:

(1) They work on the grandest, most difficult problems.

(2) They are always theorists, offering new ideas rather than experimental results.

(3) They are unable or unwilling to calculate specific quantitative predictions.

(4) They don't take criticism, arguing that genuinely new ideas are not appreciated by the scientific establishment.

(5) They always work alone, never co-author.

With regard to science policy, the author defines a policy as actions designed to accomplish an objective and maintains that such actions require (a) planning *and* (b) decision-making *and* (c) implementation. While agreeing that the discovery of natural laws is unpredictable, he states that planning along broad lines is useful, if only to improve the changes for accidental discoveries. But such planning need not and should not be centralized. He offers stronger arguments for decentralization of decision-making and for even more decentralization in implementation.

The flavor of the book is bitter-sweet. On the one hand, the author states (p. 117) that 'most of us can claim a notable degree of accomplishment and skill in some aspect of life and this gives us some of the self-confidence, pride and satisfaction that are necessary for a contented life." By 'us' the author must mean the 1–2 million community of world scientists; possibly though, he refers only to the 40 000 physicists in the United States, among whom there are only 200 with responsibility for half of the published literature in physics. On the other hand, he states (p. 131), "esthetic enjoyment of non-existent discoveries, curiosity about laws of nature we do not understand, the conversion of talent into accomplishments that do not materialize, competitions that we always lose, priorities that we never attain, peer recognition that we do not receive, service to humanity that we are incapable of – these will hardly bring satisfaction." Very few scientists ever win even one competition, and most never enter any. Does it follow that most scientists are frustrated and unsatisfied most of the time? Or can most of us indeed claim a notable degree of accomplishment in some aspect of life that keeps us contended most of the time?

The author offers no evidence to enlighten his beliefs. Yet the questions he raises are important for human systems management – in both its senses – of not only science but of other human enterprises to which these issues readily transfer. This readable and useful book, while not a work of scholarship or science, is a contribution to the know-how of human systems management, and as such will be of value to many readers of this journal

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Stafford BEER
Heart of Enterprise, The Managerial Cybernetics of Organization
Wiley, New York, 1979, 582 pages

Beer's intent is to apply the principles of cybernetics to the firm, where cybernetics must be understood as the science of control. In his latest volume, Beer extends many views introduced in previous works.

It has become usual when reading Beer, that one is faced with an original and unique presentation. He attempts to explain complex principles of cybernetics in plain English. Whether this effort is a success or failure, will depend on whether the reader feels that a more technical and mathematical treatment of the subject would have been more appropriate.

Beer does it all: writes the text and draws his own figures. To indicate that a greater amount of variety flows between two black boxes, thicker lines are drawn. There are about one hundred drawings in the text. The fact that they appear to be hand drawn by the author, adds life to the subject. As in previous Beer's books, to appreciate it, you have "to get in the spirit of his prose". The job is made all the more difficult when attempts are made to illustrate 'levels of recursion' in three planes. Thus Beer uses a vertical axis, a horizontal axis and a diagonal axis. He elaborates the model started elsewhere (*Brain of the Firm*), where the enterprise is viewed as a viable system operating in three domains: operational, environmental and managerial.

At each level of recursion, five different systems can be identified. System One, which accomplishes the main function for which the organization exists, (i.e., the manufacturing plant in a manufacturing company) is the only operational unit which has the independent life of a viable system. The other four systems 'serve' the operational unit and provide the metasystemic support functions which are fundamental to its viability.

System Two is anti-oscillatory, i.e. it intervenes to dampen possible oscillations which can arise when each of the operational units operate on their own, without possessing the requisite variety needed to know the states of parallel units. According to Beer, System Two does not have an identifiable managerial analog in the traditional organization chart. It must be designed.

System Three is the system which provides cohesiveness to the organization. It provides a synoptic view of all operational functions to integrate them. System Three is conceived as 'fundamentally synergistic' and provides 'variety-interconnections' to absorb the interaction of elemental units. As in all of Beer's work, control is interpreted through Ashby's law of Requisite Variety according to which only 'variety absorbs variety'. He recalls that "the regulator has to be capable of generating a variety, equivalent to the variety that has to be regulated". Accordingly, Beer conceives organizational circuits with variety amplifiers and variety attenuators to provide closure to the system's variety. The internal and continuous stability of the enterprise is assured when the sum of the 'horizontal variety' disposed by the operational elements is equal to the sum of the 'vertical variety' disposed by the components of corporate cohesion made up of System Two and Three. Whereas Systems Two and Three regulate the internal environment of the enterprise (the Inside and Now), System Three and Four are designed to manage the metasystemic administration of Ashby's Law in the relationships of the firm to the outside environment (The Outside and Then). System Three is a common element of both, and acts as a 'fulcrum'.

System Four provides viability by embodying Conant and Ashby's principle whereby "every regulator must contain a model of that which is regulated". Indeed, it is in System Four where the operational and managerial models of the enterprise converge. Movement of what the firm 'is', toward what the firm 'ought to be' originate from divergences between their respective views of what *is* with what *ought to be.*

Finally, System Five can be seen as the management centre which relates and provides closure between the variety of Systems Three and Four. As Beer noted in *Brain of the Firm* (which precedes *The Heart of Enterprise*) like the human brain cortex, System Five is not open to the outside environment.

The rules for a viable system are presented in the form of *maxims*, *principles, theorems, axioms,* and *laws* which lack mathematical proofs or derivations Most of these inferences are based on experience. Therefore, it would be difficult for an uninitiated cybernetician to implement Beer's model to an organization. In spite of this shortcoming, there are sufficiently illuminating thoughts in the book to make the reading, arduous as it is, worthwhile. Beer's prose is serious and academic and, at the same time, jocular and anecdotal. Each chapter is followed by a dialogue entitled "Later in the Bar..." which he uses as a peda-

gogical tool to drive his ideas home.

I conceive Ashby's Law of Requisite Variety, whereby one matches the variety of the system to that of the regulator, as a conceptual tool. In my limited experience, the measurement of the entropy displayed by the system is a very difficult task. It has been tried for instance, to determine the mental effort required of operatives and to compare this contribution, at several levels of mechanization and automation. In the real world of complex systems, the calculation of entropic equations, whereby the entropy 'disposed' by one system can be compared to the entropy 'absorbed' by another, is well nigh impossible.

As we read Beer, we arrive at the conclusion that his intent is not to arrive at mathematical rigor whereby so many units of entropy go in and so many go out, but to establish whether the necessary and sufficient conditions of viability are met and whether obvious mismatches in the exchanges of variety between systems can be identified.

In the first four hundred pages, Beer endeavors to describe his theory. If the reader has the fortitude to get this far, then he can attempt to 'walk the last mile' and read another 150 pages where Beer illustrates the theory's implementation. Obviously, this last part can be the most useful because it describes how Beer applied his scheme to several examples. I believe one needs a close exposure to cybernetic principles and to Sir Stafford himself, before possessing the knowledge required to understand how to apply the variety operations to a real-world example. The average reader may not be able to do it on his/her own. The theory is there, but it is hard to master. To be in a position to implement Beer's theory and principles, requires more knowledge and practice than can be acquired by merely reading the book.

All in all, a provocative book from a stimulating author. After reading it, one can only wish that more cyberneticians like Beer would explain how they conceive that the control of the ever-increasing complexity of the world which surrounds can be accomplished.

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Stafford BEER
Platform for Change
Wiley, New York, 1975, 457 pages

In spite of being more than five years old, *Platform for Change* is "a new sort of book for a new sort of world." And indeed it is a 'new sort of book', not only for its content but also for its format and presentation. The author has chosen to implement his ideas in the form of "a cybernetic system' "operating at four autonomous levels of recursion with 'algedonic' feedback." (The word 'algedonic' means 'pain and pleasure'.)

Each of four different forms of discourse are printed in different color paper. The overall thesis of the book is built like a total system with eight subsystems. Each subsystem consists of a narrative, an argument for change, a thesis, and, where deemed warranted, a metalanguage. The latter is required because "there are always propositions *about* the language itself that cannot be expressed *in* the language." Similarly, to discuss what has gone wrong at the level of a system, it has to be observed and discussed at the metasystem level.

Beer's entire thesis is a blueprint on how we should proceed to manage the total system of today's world, not a society of '*things* – stone, wood, iron' but a world of 'complexity'. To do so, Beer involves Science:

(1) "to measure and manipulate complexity through mathematics,

(2) to design complex systems through general systems theory,

(3) to devise viable organizations through cybernatics,

(4) to work effectively with people through behavioral science,

(5) to apply all this to practical affairs through operational research."

Beer's book is a call to arms, a revolution by which the stereotype solutions of what will work to solve the problems of the world are 'overthrown'. We must replace *Homo Faber,* 'man the maker' by *Homo Gubernator,* 'man the steersman of large, complex, interactive systems'. Advocating the *evolutionary* change of social systems "will not work any more". What is needed is *structural* change which "by its nature is revolutionary".

This encyclopedic 'treatise' deals, in part, with Beer's encounter with Presidente Salvador Allende who invited him to design the Cyberstride to con-

trol and monitor the Chilean economy. It is addressed to the Operations Researchers as well to the group of 'influentials' in the health service. It considers the metric of money and of utility and proposes a new hypothetical metric called 'eudemony' which depends on the measurement of *information flow* "which will prove critical in the good management of affairs and even to the preservation of human freedom."

On the subject of planning and freedom, Beer argues that the amounts of planning and of freedom which are designed into the system evolve directly from his cybernetic concept of the total system. Designing for freedom is not so much an ethical problem as a 'viability' question. Thus, if there is too much freedom, the system will lapse in chaos through lack of guidance. It will trend toward collapse and death, to a point where entropy is maximized and equal to unity. If there is too much control, the system will be too rigid to remain flexible and adaptable. Thus, the designer cybernetician is concerned with calculating (i.e. planning) the amount of freedom which is compatible with keeping the system within viable bounds and with meeting the objectives which the society set for it. As Beer vividly describes, even in the case of Chile during the fateful days of President Allende, to think of planning and freedom as opposite poles is an 'absurdity'. In Beer's terms: "The degree of autonomy, and its complement, the degree of centralization (i.e. control) are computable functions of viability." "By separating the levels of recursion (i.e. feedback), and within those levels, by preserving freedom for each separately designed interlocking homeostat, (i.e. level of control) the maximum autonomy, consistent with effective organization, is assured." Planning in this context consists of investigating the predictable effects of our present action on the system. Freedom consists of making choices among alternative futures and changing the future. "The science of effective organization . . . (called) cybernetics, joins hands with the pursuit of effective freedom (called) politics."

Stafford Beer's book is to be treated with reverence. It is a poem complete with verses and rhymes. To be sure, irregular verses, as all modern poetry should be, but truly musical to the ear. *Platform for Change* is an achievement of a true human being who, all in one, happens to be a scholar, a visionary, a benevolent revolutionary, and last but not least, a poet.

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