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Reflections on Cybernetics

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At the same time as I received the request to contribute some reflections to this column, I received an email asking for the whereabouts of a paper Margaret Mead had read at the first Annual Symposium of the American Society for Cybernetics. I remembered that this paper was in a book I had on my shelves and, given that I wanted to write something about how my view of cybernetics has changed through the years, it struck me that in Mead's paper, written more than thirty years ago, I might quickly find a starting point.

It turned out to be a happy accident. At the top of the second page I read:

> I specifically want to reconsider the significance of the set of cross-disciplinary ideas which we first called 'feedback' and then called 'teleological mechanisms' and then called 'cybernetics'... (Mead, 1968; p.2).

In the rest of her talk, Mead did not have to explain exactly what was intended by 'feedback' and 'teleology', because she could be reasonably sure that her listeners were familiar with the cornerstones of the literature that these terms had ignited some twenty years earlier. I do not know to what extent this would still be the case among the members of the ASC today. Most other people have by now become accustomed to the word 'feedback', although the meaning and implications that Margaret Mead and her colleagues in cybernetics attached to it will at best be rather hazy. And with regard to the term 'teleological mechanisms', I have the impression that few have emancipated themselves from the pre-cybernetic view that teleology is something that only old fogies like Aristotle believed in and that proper *science* should have nothing to do with it. Hence I thought that it may not be a waste of time if I briefly lay out some of the things I have learned about the two ideas in these thirty years.

Positive feedback of the kind manifested in electronic amplifiers, or in the sense of a teacher telling the student that he or she is on the right track, is only

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loosely connected with teleology; negative feedback, however, is inseparable from it, and therefore it is what I want to discuss here. Norbert Wiener demonstrated it with the example of a smoker picking up his cigarette, an activity that was not only socially accepted but considered quite normal in the 1940s:

> Our motion is regulated by some measure of the amount by which it has not yet been accomplished. (Wiener, 1961, p. 97)

Several things are tacitly implied in this description. To speak of an action as 'not yet accomplished' one must have an idea of what it means to have accomplished it; that is, one must have a goal. It does not mean that one believes the goal which is not yet achieved is pulling the action towards itself. This would be 'teleology' in the historical sense. Aristotle saw an ideal world at the end of time and wanted to believe that it had the power to draw all development ultimately to its perfection. But he was not so foolish as to disregard behavior that was goal-directed in a much more prosaic way. He saw in it the fourth of his explanatory principles, called it the 'final causes', and explained it as:

> …that for the sake of which a thing is done, e.g. health is the cause of walking about. ('Why is he walking about?' we say, 'To be healthy', and, having said that, we think we have assigned the cause.) (Aristotle, Physics, Book II, ch.3, 194b)

Aristotle gives several other examples. But he does not explain one necessary connection as clearly as he might have, had he had the benefit of reading David Hume's analysis of the concept of causality. What he had in mind was obviously this: Experience has shown that walking takes the stiffness out of our joints, reduces fat, accelerates the circulation, stimulates the heart, etc. Thus it has generally shown itself to be beneficial. In other words, walking - today we might say jogging - has proved an 'efficient' cause of health. Consequently we go for a walk, or jog, to improve our physical state; just as we drink water when we are thirsty, or take off a sweater when we feel too hot. There is nothing mysterious about it, no supposed 'action of the future upon the present'. It is simply a matter of applying a rule which we have inductively gathered from experience and of which we expect that it will work once more the way it worked in the past (cf. Glasersfeld, 1990, 1998).

This principle is, indeed, universal. If there is something we would like to create or have, we look for some specific event or action to which experience has tied the desired item as 'effect'. If we find it, we try to implement its causal function, hoping that it will produce what we wanted. Scientists, although this is not always explicitly stated, spend most of their time to establish reliable cause-effect associations.

Returning to Wiener's example of negative feedback, there are two other points that may need clarification. How can one measure or establish the amount by which an undertaken action 'has not yet been accomplished'? This would seem to require the impossible access to something that has not yet happened. But this

apparent paradox springs from the somewhat misleading formulation of the principle. The discrepancy is not assessed or measured from the desired future end-state of the present action, but from the representation of a state such actions have reliably produced in the past.

The good old thermostat, the favorite example in the early literature of cybernetics, is still a useful explanatory tool. In it a temperature is set as the goal-state the user desires for the room. The thermostat knows nothing of the room or of desirable temperatures. It is designed to eliminate any discrepancy between a set reference value and the *feedback* it receives from its sensory organ, namely the value indicated by its thermometer. If the sensed value is too low, it switches on the heater, if it is too high, it switches on the cooling system. Employing Gordon Pask's clever distinction (Pask, 1969, p.23-24): from the user's point of view, the thermostat has a *purpose for*, i.e. to maintain a desired temperature, whereas the *purpose in* the device is to eliminate a difference.

This example may also help to clarify a second cybernetic feature that is rarely stressed. Imagine a thermostat that has an extremely sensitive thermometer. If it senses a temperature that is a fraction below the reference value, it switches on the heater. The moment the temperature begins to rise above the reference, it switches on the cooling system - and thus it enters into an interminable oscillation. This would hardly be desirable. Therefore it is important to design the device so that it has an area of inaction around the reference value where neither the one nor the other response is triggered. In other words, rather than a single switching point, there have to be two, with some space for equilibrium in between.

To my mind, this illustrates what is perhaps the most valuable feature of the cybernetical analysis of phenomena in general, and of 2nd-order Cybernetics in particular. It leads us to think in terms, not of single causes and effects, but rather of equilibria between constraints. This helps to avoid the widespread illusion that we could gather "information" concerning a reality supposed to be causing our experience; and it therefore focuses attention on managing in the experiential world we do get to know.

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