The purpose of second-order cybernetics

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Abstract *In this paper, the origins of second-order Cybernetics are sketched, and are particularly identified with circularity: a quality that was at the basis of the studies that lead to the creation of the field of Cybernetics. The implications of the new analysis that second-order Cybernetics (Cybernetics treated cybernetically: that is, Cybernetics when circularity is taken seriously) gives rise to are considered in terms of the two qualities that Wiener gave to Cybernetics in his eponymous book – control and communication. Finally, the analysis is applied to that other proto-cybernetic concept, purpose. It is shown that (and in consequence how) the notion of goal and purpose must be radically reconsidered in second-order Cybernetic systems.*

Apologia

This paper is a summary of a paper that was never given. At the conference of which this issue of *Kybernetes* constitutes proceedings, the original intention was to provide a workshop and forum focusing on second-order Cybernetics and led by Dr Bernard Scott and myself. My intention was, therefore, only to provide a briefing that might open up discussion. However, as things turned out, the conference expanded and the theme and spirit became, I felt, submerged. In the end my presentation was quite different, a response to the changes in circumstance and the fact that, as the last presentation, I had to squeeze it into a short time. The paper presented here is, therefore, essentially the briefing I would have given rather than a written version of the presentation I made at the conference, and does not pretend to be other than that.

Origins

Second-order Cybernetics, the Cybernetics of Cybernetics (or even the New Cybernetics) was given form between approximately 1968 and 1975, at a strange stage in the history of Cybernetics. Mead's (1968) originating paper ("The Cybernetics of Cybernetics") was presented as the inaugural keynote address at the founding meeting of the American Society for Cybernetics (ASC), organised by Heinz von Foerster as a part of the IAAAS meeting in 1968, at a point in the history of Cybernetics that can be seen, in retrospect, to have been a turning point[1], marking both the end of the subject, and its resurrection. The year 1975 marks the publication of the book *Cybernetics of Cybernetics* (edited by von Foerster, 1975), arising out of a course option organised by von Foerster at the University of Illinois (and funded by the Whole Earth Catalogue). This account is simplified and dangerously distorted. For instance, it might appear that Mead provoked the approach, but in actuality von Foerster gave her the title and the briefing for her keynote[2]. While the cybernetics of cybernetics is primarily linked with von Foerster's name, many others played more or less significant parts in its inception and development[3].

Henceforth, in this paper, the assorted names will generally be consolidated into one: the Cybernetics of Cybernetics.

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Characterisation[4]

The Cybernetics of Cybernetics is Cybernetics examined in a cybernetic manner (according to the cybernetic critique). von Foerster's eponymous book and course are exactly this: a number of cybernetic texts analysed using the techniques of Cybernetics. Indeed, Mead's original argument, which characterized cybernetics as a common language shared between disciplines (remember she was a central member of the Macy Conferences that may be said to have been instrumental in the founding of Cybernetics) made the plea that the fledgling ASC should form itself according to cybernetic principles: hence the title. However, in the *Cybernetics of Cybernetics* book, von Foerster also states the following:

> First Order Cybernetics is the Cybernetics of observed systems
> Second Order Cybernetics is the Cybernetics of observing systems.

Given my claim that second-order cybernetics and the cybernetics of cybernetics are synonyms, there should be a link between these two characterisations, and there is. The reason I write with an I, in the first person, exemplifies that relation or link: the presence of the observer: I am in what I write. The essential discovery of the treatment of Cybernetics as revealed through cybernetic analysis and of the duality observed/observing systems is the presence of the observer. It is through the presence of the observer – Maturana's (1970) insistence "everything said is said to an observer" (and the corollary, "everything said is said by an observer") – that the Cybernetics of Cybernetics is seen to be related to constructivism, especially the radical constructivism promulgated by von Glasersfeld (1987), in which the age-old question of what there might be to observe[5] if the observer did not observe it is recognised as both centrally important and completely unanswerable (undecideable).

Thus, the Cybernetics of Cybernetics is Cybernetics when the observer's presence is admitted rather than disguised – or even completely denied.

Circularity

Cybernetics has always been interested in the circularity in which the observer (used as a general term to cover agency) observes what is happening in some system and acts on that system[6]. The Macy conferences were on "Circular Causal, and Feedback Mechanisms in Biological and Social Systems". In the proceedings, the comma was, after a time, removed. The word Cybernetics was inserted at the beginning after Wiener published his formulation that grew, in part, out of these meetings[7].

In classical (first-order) Cybernetics this was presented through a power relationship. The observer was seen as acting on the observed, but the observed was not understood to act on the observer. There was something called feedback by which the results of the observer's actions were relayed back to him. However, bizarrely, the circularity of this got lost behind a perceived need to give precedence to a view dominated by Newtonian thermodynamics, in which the (relatively) tiny amount of energy tapped to be fed back to the observer was taken to be negligible. Thus, the acts of the observed were seen as acted on and amplified by the observer, but not vice versa.

It was not until much later (as the reader will be aware, I have taken 1968 as the token date), when we had realised that a world of information is not one dominated by

energetics, that the essential circularity once again emerged to a prominence unfettered by energetics and the logic of circularity began to be recognised again[8].

Wiener characterized Cybernetics as "control and communication in the animal and the machine." Notice the absence of the word science, and that this is not a definition.

I will now consider how to understand control and communication when circularity is taken seriously: i.e. in the approach of the Cybernetics of Cybernetics.

Control

Let us approach how we might understand control in the terms of the Cybernetics of Cybernetics by using an example beloved of cybernetic text books: the thermostat.

Although the term "thermostat" applies to the whole system, we often take it to refer to a switch on the wall of a room (let us keep it small and simple) which senses the temperature in the room and turns on and off a boiler that creates and distributes heat to that room. In classical (first-order) cybernetic terms, the switch controls the boiler (and hence the room temperature). But is this an adequate account?

What makes the switch turn on and off?

The answer must be the boiler supplying heat to the room.

So the switch controls the boiler (and hence, the heat supplied to the room), turning it on and off, while the boiler supplying the heat to the room in turn turns the switch on and off.

Here we have circularity. We can say that, in cybernetic systems (where there is feedback), control is always essentially circular (portraying it as linear is to simplify).

If control is circular, where is it? And, in the simplest case where there is a control and a controller, which is which? I believe you can see that control can be neither in the controlled nor in the controller, but lies between them: it is shared. Furthermore, there is no control and controller. These are at best just roles. Each is controller to the other's controlled. Neither is controlled, neither is controller: control is in either (or both) but shared between.

This has considerable implications for, for instance, Ashby's "Law of Requisite Variety" (Ashby, 1956), which tells us, in one version, that any effective controlling system must have at least as many states (as much variety) as the system it is to control: with each controlling the other, the variety required can only be the same. In the case of complex (variety rich) systems, the system's variety can rapidly exceed the computable. Such systems are essentially unmanageable (see Glanville, 1997b, arguing the benefits of this).

This view of control, based on a consideration of circularity that takes its form seriously, is radical, of a quite different sort than we have grown up with. It can come about when we understand that we live in a world we can describe through criteria other than energy – for instance, information – and when we take circularity seriously: i.e. as in the Cybernetics of Cybernetics.

Communication

Cybernetic systems need communication for control to be exercised. There is no feedback that is not communicative in intent, and a control intent (to permit the shorthand of first-order Cybernetics) has also to be communicated. Communication is, therefore, necessary to the exercise of control, and therefore to cybernetic systems.

But it is more than that: communication, as we shall see, is a cybernetic system – and a second-order Cybernetic system at that.

The notion of communication that has held sway for some time has been based in such "coding" concepts as etymology, (universal) meaning, and (more recently) the "Information Theory" model proposed by Shannon and Weaver and Chomsky's Transformational Generative Grammar (Chomsky, 1957). But even their models, admitting noise, require feedback to determine communication has taken place.

For many systems observation tells us that there is no effective unambiguous "coded" communication. The difficulties of unambiguous communication are enormous, except where the system is specially set-up to interpret code. If we wish to do this to humans, we must provide a reprogramming course, and even then we only succeed in very limited areas[9].

Furthermore, communication is an openly reflexive process: it is second-order, for it can communicate about communication. In fact, in human intercourse, communication about communication is effectively a sine qua non.

However, there is at least one account of communication that transcends coding. This is the conversational (dialogical) model developed primarily by Gordon Pask. In Pask's version, understandings are not transmitted. Communication takes place between entities that build understandings (meanings) out of their interpretations of what they sense their conversational partner (or partners) offer them. This understanding is fed back to their partner(s) in new offerings that the partner(s) in turn interpret and compare to their original intention. This dual generation of what might have been called messages constitutes feedback and allows errors to be detected and new offerings/messages to be tendered that attempt to correct such errors. This is a complex model that operates both as communication and as communication about communication, simultaneously; where communication takes place between the communication partners so that meaning, insofar as there is any, is uniquely constructed by each partner individually.

This circular process is a conversation (Pask, 1975), and will be understood immediately by the reader when thinking of how conversations occur in everyday life. It is a second-order cybernetic process and, as such, is one of the essential devices of the Cybernetics of Cybernetics. As an understanding it arises the moment the circularity of communication is taken seriously. As a model, it offers many understandings we are only just beginning to explore[10].

Just as linear control is a specially limited version of circular control, linear communication (coding) is also a specially limited version of circular communication, i.e. conversation.

Purpose

The origins of what we call Cybernetics can be traced back in time to the ancient Greeks. One of the key proto-statements of modern times was the paper "Behaviour, Purpose and Teleology" by Rosenblueth *et al.* (1943), as discussed in Stewart (1959/2000). This paper arose out of discussions that took place during the Second World War and which can be seen as precursors (although unconnected) to the Macy Conference Meetings and was particularly concerned to (re-)consider the concept of goal.

As Stewart (1959/2000) points out[11], this paper brings to the forefront that other concept used to characterise cybernetic systems: purpose (i.e. teleology), or goal/goal-orientation. In traditional cybernetic terms, systems that exhibit control are thought of as goal orientated, teleological or purposive. They have a desired state, and the act of control brings them towards that state.

So from the earliest days, cybernetic systems have been discussed in terms of purpose. Having a purpose requires that there is this said goal towards which a system can be seen to aim, the attainment of which achieves the system's purpose. Being in some state and wishing to remain in that state may also involve a goal, and the purpose of such a system is to remain as it is – that is, the state it is in is the goal state. In this case, whenever there is a perturbation, the system works to return to its goal state, thus acting with purpose and reaffirming the difference between the system and the goal. If there were no possibility of a perturbation, it is (in my opinion) doubtful that a system would need a goal or demonstrate purpose.

As has already been stated, in first-order Cybernetics, the observer is outside the system being observed: he treats it as an artifact "under his cold gaze," where neither artifact nor observer is changed by the act of observation: all that happens is that a record of the behaviours (states) observed is recorded, supposedly "as is". Here, I am using the language of first-order Cybernetics and of our great scientific tradition. Note that, in this description I am separating the goal from the system under consideration. It is also possible to talk of the "whole system," which would include the goal. But then the goal is inside the system and no longer visible to the external gaze.

Under these circumstances, the system being observed can be observed to have a goal. In some sense, this goal is always external to the system under consideration. It is, of course, a state that may be seen as desirable and, which the system can achieve. This implies that there is a separation between the system and goal. Unless the system is ended (terminated) by the attainment of the goal) this separation exists even when the goal is attained and the purpose fulfilled, for cybernetic systems accept that the world in which they are found is full of perturbations and that, therefore, attaining the goal is always a tentative achievement since any perturbation may shift the system from its goal state. Thus, we can talk of the system as being stable in chasing the goal state and as being stable in maintaining it.

An example of a system that is terminated by the attainment of a goal is the system involving a gun firing a shell at a target (i.e. goal). When the shell hits this target, the target (in the simple case) ceases to exist and the system comes to an end. Of course, a system can be restarted with another target (and another shell), when it becomes possible to think of the collection of these systems as a grander and far more general system. In that case there is a continuing problem of attaining the goal that persists outside the achievement of the individual goals of hitting this or that particular target.

What is critical here is the separation (in the observations made) of the goal from the system so that it remains desirable, that is, the system is seen by the observer to have a purpose. Using a spatial metaphor, the goal is observed to be outside the system, and even though the two may come together, they retain this separation. The connection between the two elements, system and goal, is provided (observed) by the observer who thus generates from the behaviour of the one towards the other a sense of purpose[12]. Thus, the observer is also separate from the system and the goal. The observed arrangement is transparent to the observer because both these elements are

separate and both are observable to and separate from him. There is separation and transparency, and there is no effect although there is interpretation.

Typical examples include the steering of a ship at sea towards some port or other land- or seamark, and the thermostat, battling to maintain a constant temperature against the vagaries of an irregular nature (providing the perturbations).

What happens in second-order cybernetics? The distinction between the first- and second-order cybernetics depends, as has already been developed, on a change in attitude to the observer who, in second-order cybernetics, is understood to be both within the system being described and affected by it. That is to say, the boundary of what is being observed is no longer the same. Where there was, in the case of first order cybernetics, a crucial boundary between the observer and the system-and-goal (in the terminology used here), in the case of second-order cybernetics there is no such boundary. This means that there is no longer the separation of the goal and system from the observer that there had previously been, and which was deemed essential to the determination by the observer that there is a goal. When the observer is within the boundary (as opposed to outside it), while he may or may not discern a goal, we cannot know which quality of the observation that allowed the giving of the roles, system and goal, has been changed, for the internal observer is maintained within the boundary, and so the relationship that existed between the different constituents no longer pertains. The observer is no longer observing the same distinction, and the consequences of his observing are different for his observing is no longer "under his cold gaze".

Thus, the determination that there is a goal (and hence purpose), which was determined to be constructed through the separation of the observer from the system and goal, may be attributed to the (first-order) view of the observer as external, detached and untouched: whereas in the second-order cybernetic view the observer is not external, and so the necessary criteria for the determination of the goal do not exist[13]. If there is a goal, if the system has purpose, it is not visible to us as such in a second-order cybernetic system, though it may be observed to have both when observed as a first order system.

Goal and purpose are, then, characteristics of first-order rather than second-order cybernetic systems. This discovery is surprising and unnerving, for cybernetics has often been regarded as the study of purposive, goal-directed systems, which cannot be assumed in the case of second-order cybernetics[14].

Notice that, in this way of talking, there is a system and there is a goal.

It may turn out that the Cybernetics of Cybernetics requires us to radically rethink the meaning of goal and purpose so that systems become ineffable. But then, it has already required us to reconsider control and even the value of unmanageability[15].

We live in interesting times.

Notes

1. This is not the place to discuss this point in depth. Suffice it to say that Cybernetics, in the science utopian attitudes of the 1950s (remember free energy for all!), was seen (and sold) as a sort of new answer to everything. When it turned out not to be so, it fell from grace. Some of the fall was due to other new sciences offering equally ultimate solutions, such as Bionics and Artificial Intelligence, diverting what suited their purposes from Cyberentics. By 1968, conventional Cybernetics was beginning to run out of steam (and credibility). The Cybernetics of Cybernetics could be seen as a rescue operation. Nevertheless, in a more

technical form, the original Cybernetics, by now almost indistinguishable from control engineering, survives in some areas.

2. See the account of the development of second-order Cybernetics in Glanville (2002).
3. The names of those who were involved in this 7 year period would include Mead, Bateson, Pask, Maturana, Varela, Glanville, Leofgren, Guenther, although not all would eventually sign on. Beer and Ashby also have important places.
4. A reviewer has pointed out to me that this account is painted in broad brushstrokes. At the risk of sounding over-defensive, let me remind the reader of the scale and ambition of this paper. A more detailed description may be found in Glanville (2002), and the references it contains.
5. Often traditionally thought of as a Mind Independent Reality.
6. It is important to explore and discuss the relationship between observing and acting. But not here.
7. There were no transactions before the sixth meeting (24-25 May 1949), when von Foerster was adopted into the group and the job of secretary and editor was created to assist him in learning English. See Heims (1991) for a pretty accurate account. It is interesting to speculate how the history of the subject and its current general appreciation would have changed had Gregory Bateson written the first book, pursuing a less technical approach, rather than Norbert Wiener.
8. Shannon and Weaver's (1949) formulation of "A Mathematical Theory of Information" (commonly, Information Theory) was more or less simultaneous with Wiener's *Cybernetics*. My insistence on the date 1968 as the starting point for the Cybernetics of Cybernetics is, of course, another tremendous oversimplification.
9. Military (and para-military) forces are reprogrammed by training so that individual differences are removed. They are also drilled to respond to limited command codes without interpretation, i.e. unambiguously. The result is warriors who have numbers and no individual differences.
10. There are many advantages to this model. The removal of interpretation from the world of the objective is one. But advantages include such extra benefits as the ability to explain how novelty can be generated, through the use of conversational processes.
11. Stewart, (1959/2000) gives a very good account of the early days of Cybernetics which can be found on the Web site of the Cybernetics Society (www.cybsoc.org/hfrorg/Cybernetics-pages/origins.htm)
12. Thus, it is not a question whether or not there is such a sense of purpose: this is generated by the observer and is not part of the system but is a relationship the observer makes and then describes.
13. This assertion does not deny that there may be a goal, nor does it confirm it. It merely argues that we can never know.
14. A different argument making a similar point may also be of interest (Glanville, 1997a).
15. See Glanville (1997b) for arguments concerning the advantages of being unmanageable.

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