ONTOLOGY AND ANTIDISCIPLINARITY

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revised: 24 august 2010

to appear in A Barry and G Born (eds), interdisciplinarity: reconfigurations of the natural and social sciences

My aim in this paper is to open up a new front in discussions of interdisciplinarity. The argument hinges on a crude sorting of kinds of science along ontological lines. I distinguish between the 'modern' sciences (more generally: fields of practice and their associated artefacts) and their 'nonmodern' counterparts. Most discussions of interdisciplinarity focus on combinations, juxtapositions and syntheses of modern sciences. But if one focusses instead on the nonmodern sciences, a rather different picture comes into view, not so much of the combination of distinct disciplines, but of the eruption of a relatively unified approach to the world across the disciplinary map (as marked out by the modern sciences themselves). The nonmodern sciences, one might say, offer us an antidisciplinary rather than an interdisciplinary spectacle, and that is what I want to examine from various angles here.[1]

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We can begin with ontology, questions of what the world is like, what its elements are and how they relate to one another. The modern sciences, as defined here, presume a knowable world, of identifiable entities in specifiable interaction with one another, and they take it for granted that their job is to know them. Physics is the obvious example, with its quest to find out about the ultimate constitutents of matter: quarks, strings, or whatever. But since the scientific revolution many other fields have emulated physics: chemistry with its elements, atoms and molecules; biology and DNA; sociology and its social structures, causes and correlations; economics and markets. The departmental structure of the modern western

[1] Barry, Born and Weszkalnys (2008) and Born and Barry (2010) identify three underlying 'logics' that variously run through the interdisciplinary projects they examined. The third and most interesting is a 'logic of ontology.' The present essay can be read as an attempt to clarify this ontological thread and explore it further.

university sociologically enshrines these many quests for positive knowledge, and the dominant forms of interdisciplinarity seek to put these various fields together for various purposes. The difficulty, of course, is one of combining positive descriptions of different aspects of the world (physical, biological, economic, etc).

This much is obvious, so we can turn to the other ontology. The nonmodern sciences, as I conceive them, presume a world that is ultimately not fully knowable—a world of endless unpredictable emergence and becoming. These are the sciences of the unknowable. Though it is not obvious what this phrase even means, my feeling is that in the shadows of the modern one can always find traces of the nonmodern and, to bring the argument down to earth, in what follows I will specialise the discussion to the nonmodern science I know best: cybernetics.[2] Cybernetics is often regarded as a paradigmatically interdisciplinary postwar science, but I want to show that interdisciplinarity here entails something different from its manifestation in the modern sciences and better described as antidisciplinarity.[3]

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[2] As defined here and below, a list of contemporary nonmodern sciences would include many of the fields currently grouped under the heading of 'complexity,' amongst them work on cellular automata, dynamical systems theory, self-organising systems, autopoiesis, situated robotics, artificial life, and enactive and embodied strands of cognitive science and philosophy of mind and the emotions. (The fact that these often connect directly to one another and to cybernetics supports my general point about antidisciplinarity.) Widening the frame, the list extends to include, for example, adaptive architecture and generative music. Some of these fields are discussed briefly below; all of them and more are discussed at length in Pickering (2010a). Though my research is not exhaustive, I believe that all of them display the antidisciplinary characteristics discussed below. See, for example, the variety of fields touched upon in Wolfram's *New Kind of Science* (2002). Aicardi (2010) is an extended account of artificial life research centred on Sussex University and documents in great detail many of the features noted below (and also the fact that the Sussex researchers regard themselves as the current inheritors of the British tradition in cybernetics). As discussed below, cybernetics began as a science of the brain, and can thus be situated within continuing traditions of research in psychiatry and psychology that focus on processes of adaptation. Alchemy, as I understand it, was both a premodern and nonmodern science (Pickering 2001); Hannaway (1975) draws a beautiful and relevant contrast between a nonmodern Paracelsianism and early modern chemistry, the latter arising in a context of institutionalised disciplinary pedagogy. *Naturphilosophie* in the 19th century might also be associated with a nonmodern ontology. Gagnier (2010) discusses Vcitorian 'predisciplinary' and nonmodern forms of knowledge that were eclipsed by the rise of the modern disciplines. My definition of nonmodernity here emphasises time and emergence, but connects with a simpler notion of ontological nonmodernity as a recognition of non-dualist couplings of the human and the nonhuman (Latour 1993). Contemporary sciences that to some extent undercut Cartesian dualism in this sense, but without foregrounding processes of emergence and becoming, would include ergonomics and operations research (Pickering 1995a; for the contrast between operations research and cybernetics, see Beer 1959). I suspect that the latter sciences tend more towards conventional interdisciplinarity (combining, say, modern mathematics, engineering, social science, psychology and physiology) than the antidisciplinarity at issue here. Studies of the foundations of modern physics are interesting to contemplate in the present context. If one takes seriously the Heisenberg uncertainly principle or the measurement problem in quantum mechanics, the Cartesian distinction between observer and observed becomes problematic, and here one indeed finds antidisciplinary and strikingly nonmodern connections made between physics, consciousness and spirituality (eg Capra 1975). See also Fernandez (2010) on connections between David Bohm's quatntum mechanics and esoteric thought.

[3] For much fuller documentation and analysis of what follows, see Pickering (2010a). The novelty of the present essay is the focus on inter- and antidisciplinary aspects of cybernetics. My interest in

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What was (or is) cybernetics?[4] In 1959, Stafford Beer (1959, 18) defined it as the science of 'exceedingly complex systems'—meaning entities that are either so complicated we can never hope to understand them, or that evolve unpredictably, so that our knowledge of them is continually going out of date. The latter, especially, is the nonmodern ontology that I will focus on here. But how can one have a science of entities that are always changing? Clearly one can never get to the bottom of them, which is the aspiration of the modern sciences. Instead, cybernetics is best thought of as focussing on processes of adaptation to the unknown, between elements of the nonhuman world, between humans and the nonhuman, or simply between human entities. Cybernetics, one can say, was a science of adaptation. But still, what might that look like in practice? The trick here is to start with the distinctive machines that were at the heart of early cybernetics, and one example is enough to get the discussion going.

In 1948, Ross Ashby built a machine that echoed through the subsequent history of cybernetics, especially in Britain. The homeostat as he called it was an electromechanical device that converted input currents into output ones through some complicated circuitry comprising an electronic valve, a bipolar relay, a stepping switch, and some wires, capacitors and resistors. The details are irrelevant here, but the important point is that when two or more homeostats were connected together they would find themselves in one of two conditions. They might be in a stable form of dynamic equilibrium, meaning that the input and output currents of each tended to zero in the face of small disturbances. Or they might be in an unstable condition, meaning that the currents would tend to increase. In that case, once the current within a homeostat exceeded some preset limit, the relay would trip, moving the

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cybernetics grew out of my studies of practice in the modern sciences, where I had been led to an antidisciplinary argument from an epistemological angle (Pickering 1993, 1995b). The argument was that mainstream modernist approaches to the history, philosophy and sociology of science systematically obscure the performative and emergent aspects of scientific practice that I refer to as dances of agency, and that what I called 'eclectic interdisciplinarity' can do nothing to remedy this situation. We therefore need what I called an antidisciplinary approach centred on the non-dualist and emergent—nonmodern—phenomena that characterise practice. (For simpler versions of this argument focussing on everyday rather than scientific examples, see Pickering 2005a. 2008a). The whole 'posthumanist' wing of science and technology studies (Pickering 2008b) can, in this sense, be understood as itself a nonmodern science, and Latour's attempts to forge links between posthumanist STS, politics and the arts dramatise its antidisciplinary aspects: see Latour and Weibel (2002, 2005). For a different political vector of extension of posthumanist theory, see Pickering (2009a). See also Biagioli (2009) on 'postdiscplinary liaisons' between science studies and the humanities.

[4] I use the past tense here since the focus is on the history of cybernetics, but the field continues to exist today, less prominently than in the past.

stepping switch to its next position, which in turn changed the resistance or polarity of its circuits at random. The upshot of this might be that the multi-homeostat set-up achieved a state of equilibrium, in which case nothing more would happen. Or it might be that this set-up remained in an unstable state, in which case the relay would trip repeatedly until in a state of equilibrium was found. The homeostat was thus an example of an ultrastable machine, as Ashby called it—a machine which could adapt to its environment (other homeostats) by finding its way into stable equilibrium with it.

HOMEOSTAT SET-UP AND WIRING DIAGRAM

Norbert Wiener, the man who gave cybernetics its name, called the homeostat 'one of the great philosophical contributions of the present day' (1967, 54) and we should pause to wonder why. Above all, we should think of a multi-homeostat set-up as 'ontological theatre,' as staging for us a vision of the nonmodern ontology more generally. None of the homeostats in such a set-up knew anything in a representational sense about the others; each reacted and transformed itself in a performative interaction—a dance of agency, as I call it (Pickering 1995b)—with the unpredictable becomings of the others. This, I take it, is the basic ontology of nonmodern sciences like cybernetics; a multi-homeostat set-up was a simple model of the general picture. Think of the world as built from entities somehow akin to homeostats and you begin to get the hang of the nonmodern ontology.[5]

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As ontological theatre, the homeostat can be read as a contribution to philosophy, albeit an odd one, a machine rather than a verbal argument (and we can come back to the theme of oddity below). But its significance was by no means solely philosophical. The homeostat figured as the centrepiece of Ashby's 1952 book, *Design for a Brain*, and Ashby designed it as a first step towards building a synthetic brain. This is a point that may require some elaboration. If it is not immediately clear how the homeostat might be a model of the brain, that is a reflection of our dominant conception of the brain as a representational organ—an organ that somehow stands apart from the world and contains and manipulates representations thereof. This is the brain as modelled in symbolic AI, where the aim is to reproduce the programs that the brain runs—a distinctively modern version of brain science. The cybernetic

[5] The general image should be of indefinite open-ended becomings, and the homeostat only offered a limited model of this. In fact, each homeostat could exist in just 25 different states (corresponding to the 25 settings of its stepping-switch), so that a four-homeostat set-up could take on 25^4 = 390,625 different states—certainly not infinite, but enough to convey the general idea.

understanding, instead, was of the brain as performative and adaptive—as the organ that helps us get along in situations we have never encountered before, in a world that is ultimately unknowable—and this is the sense in which the homeostat could be seen as a model brain.

Now we can see the homeostat as immediately a contribution to two fields: philosophy (as ontology) and brain science, and we can continue in this direction. Ashby's professional life (until 1960) lay in the psychiatric milieu of the mental hospital, and he typically framed his discussions of the homeostat as contributions to psychiatry. Here he aligned himself with a long-standing tradition that saw mental abnormality as evidence of a lack of adaptability, a feature that he could also model and analyse in terms of his homeostats. So the homeostat was, at once, a contribution to philosophy, brain science and psychiatry.

And going further, cybernetics quickly overflowed the brain, in Ashby's work and more generally. In *Design for a Brain*, for example, Ashby outlined the design of a cybernetic autopilot. If one wires up a conventional autopilot backwards, it tends to destabilise flight, the opposite of its intended function. Ashby pointed out that a cybernetic version would not be subject to this pathology: whatever the initial wiring, it would eventually achieve a state of dynamic equilibrium with the aeroplane. Again, in a 1945 note published in *Nature*, he drew on his existing research on stability and instability in multi-element systems to open an argument in economics—that price controls on the British economy might induce economic instabilities, rather than the stability they were intended to encourage. In subsequent work leading up to his second book, *An Introduction to Cybernetics* (1956), he argued that the mathematical analysis in which the homeostat was embedded applied to all 'state-determined systems'—which, in fact, as a class encompassed all physical phenomena. His cybernetics was, then, a theory of everything—or such was the claim.

Philosophy, brain science, psychiatry, engineering, robotics, economics, a theory of everything—the multiplicity of fields crossed by Ashby's cybernetics is one key aspect of what one might be tempted to call the interdisciplinarity of the field. But I can emphasise now how this multiplicity differs from conventional images of interdisciplinary endeavour. Ashby's achievement was not to add up and integrate existing positive knowledge from disciplines like mathematics, psychiatry and economics. It was rather to show how the model offered by his multi-homeostat set-ups could be further specified and made concrete in those fields and others. This is what I meant earlier by saying that cybernetics erupted across the disciplinary map: at one and the same time, cybernetics could be instantiated, so to speak, in all sorts of fields. And this gets us back to my notion of antidisciplinarity: conventional

disciplinary boundaries hardly mattered from a cybernetic perspective; cybernetic approaches crossed them relatively easily—though such crossings always entailed creative work—and tended to efface them.[6]

Perhaps one more observation would be useful before moving on. In getting to grips with the antidisciplinarity of cybernetics it helps to reflect that cybernetic projects differed from conventional ones in a specific way. The modern sciences aim to burrow more and more deeply into specific objects, and they do this by operating specific machineries of instruments, methods and concepts. These machineries, and the objects that they elicit and analyse, are what give the disciplines their distinctive identities and keep them apart, and thus define the boundaries and lacunae that interdisciplinarity struggles with. Cybernetics was not like that. If its defining feature was its nonmodern ontology of exceedingly complex systems engaged in processes of coupled becomings, it did not aim to burrow more deeply into that. There was nowhere to go in that direction. Instead, the research project of cybernetics was precisely to grasp more and more aspects of the world in terms of that ontology, on the model of a multi-homeostat assemblage (or some other cybernetic model). That is why cybernetics was an intrinsically antidisciplinary science.

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The theme of antidisciplinary eruption is worth developing further as a way of emphasising its scope, and we can do this by moving beyond Ashby himself and noting some instances in which others developed distinctive approaches growing out of his work. Beyond the phenomenon of adaptation to the unknown, Ashby was interested in the speed of adaptation. The brain would be of no use if it took longer to adapt to its surroundings than, say, the age of the universe, a possibility that readily arose in multi-homeostat set-ups, and Ashby devoted considerable energy to estimating probabilities of stability of differently configured assemblages. This work was taken over directly by Christopher Alexander (1964, 1977) in elaborating his distinctive work in architecture (concerning the fit between elements of buildings and each other and the environment), which fed in turn into his well known work on ‘pattern languages’ (of considerable importance in architecture and also computer software design). A stripped down version of the same problematic appears at the origins of Stewart Kauffman’s (1969a, b) theoretical biology, where the elements finding equilibrium (or not) are idealised genes. And, though there is no direct historical connection, it appears again in

[6] To be clear, then: The antidisciplinarity at issue was not necessarily driven by any prior antipathy towards specific disciplines or disciplinarity in general. It was, instead, almost a side-effect of the working out of a nonmodern ontological stance.

Stephen Wolfram's mathematical work on cellular automata, which fed into the development of what he calls a 'new kind of science'—another theory of everything, a nonmodern one, different in kind from that of the particle physicists (Wolfram 2002).

In the late 1950s, Ashby's friend, Stafford Beer, founded the field of management cybernetics by considering the relations between elements of organisational structures and between organisations and their environments on the model of multiple homeostats. This led first to some extremely imaginative work in the early 1960s on 'biological computing' (Pickering 2009b). Rather than building adaptive machines like the homeostat, the idea was that nature is already full of adaptive systems which one could seek to entrain in human projects. A pond ecosystem, to give a relevant example, adapts to unpredictable changes in its environment by reconfiguring itself—much like a homeostat, though at a much higher level of complexity. Beer understood the function of management as precisely one of adaptation to an always changing environment, and he therefore explored all sorts of possibilities for substituting naturally occurring adaptive systems for human managers. This project failed, not on any point of principal, but on the practical difficulty of coupling nonhuman systems into the world of human affairs—of getting ponds to care about us. Beer later developed what he called the Viable System Model in which information flows and transformations were designed to turn organisations themselves into performative and adaptive 'brains,' again capable of reconfiguring themselves in response to transformations in their business environment. The most spectacular implementation of the VSM was to the reorganisation of the entire Chilean economy under the socialist regime of Salvador Allende in the early 1970s, though the approach continues to thrive up to the present—as does an approach to collective decision-making, again modelled on the homeostat, that Beer called Syntegration (Beer 1959, 1981, 1994; Pickering 2004).

In the work on biological computing, Beer collaborated with Gordon Pask, now remembered principally for his cybernetic approach to the arts. As an undergraduate, Pask built his famous Musicolour machine which turned a musical performance into a light show. Musicolour adapted to the human performer by becoming 'bored' and ceasing to respond to repeated musical tropes, thus obliging the performer to adapt to the machine—again on the lines of a multi-homeostat set-up. A Musicolour performance was thus once more a symmetric dance of agency, now between human and machine, another striking and also literal example of nonmodern ontological theatre (Pask 1971). Pask later pursued this line of development into interactive robot artworks, interactive theatre and adaptive architecture (Pickering 2007).

This brief run-through of some further cybernetic projects is enough to establish that cybernetic antidisciplinarity was of much wider scope than conventional visions of interdisciplinarity. I began by calling cybernetics a 'science,' but this was simply a way of getting the discussion going. Certainly it included threads that one can easily count as 'science'—brain science, theoretical biology, cellular automata—but others not. Along similar lines, we tend to think of interdisciplinarity as a matter of intersections between different university departments, while cybernetics erupted beyond the university into all sorts of institutions and across social life: management, architecture firms, consultancies, the arts wherever they are to be found, and so on. In fact, the centre of gravity of cybernetics was never to be found in the academy, but rather in real-world projects—it was a sort of 'science in the wild.'[7] And, of course, one can see why that might be. The nonmodern ontology is about performance, not representation, while the modern university deals, precisely, in words.[8]

One last remark in this connection. The cybernetic dust cloud extended even further than so far indicated, into realms of the self and spirituality. In fact various forms of mystical and often, though not always, eastern spirituality continually surface thoughout the history of cybernetics. In the late 1920s, Ashby stated that intellectual integrity required him to admit (in the privacy of his notebooks at least) the claims of British spiritualism; in the 1940s, he declared himself a 'time worshipper' (also in his notebooks). Pask wrote a series of unpublished adventure stories about a Victorian psychic detective. Besides his management consultancy, Beer taught tantric yoga and wrote poems expressing, for example, his awe at the computing power of the Irish Sea (see Blohm, Beer and Suzuki 1986).[9]

It would take us too far afield to follow this thread at any length, but I want to note that one can begin to understand what is going on here by returning to the basic nonmodern ontology (Pickering 2008c, 2010b). The idea that the world is ultimately unknowable tends directly towards the sort of hylozoist awe at the performativity of matter expressed in Beer's poetry and Ashby's time worship. The idea that we are ourselves exceedingly complex systems points to an endlessly open horizon of possibilities, in which the spirits of the dead (and ESP, nirvana and yogic feats) might find a place. And the idea that we are adaptive systems, always

[7] Discussions of conventional interdisciplinarity often focus on problems of connecting the modern disciplines with 'users' outside the academy. In contrast, cybernetic projects were often real-world enterprises, immediately engaged with their users; no such gap existed to be crossed.

[8] For short but trenchant critique of the representationalist university, see Huxley (1963). For an extended and elaborated version, see Shusterman (2008).

[9] One of the best popular introductions to cybernetics, complexity and self-organisation is Capra (1996), which immediately assimilates these worldly sciences to a Buddhist world-view.

mangled in a world of becoming, points to sort of decentring of the self that resonates strongly with eastern philosophy and spirituality. Again, the point to grasp here is that cybernetics did not so much combine elements of different fields as cash out the same nonmodern ontology in science, the arts, politics and, now, spirituality. For Beer, the basic diagram of the VSM was at once a map of both the adaptive worldly organisation and a great chain of being leading upwards fom individual biological cells to the cosmos itself, all elements of which could be grasped in meditative practice. Cybernetics was (or could be) simultaneously a form of science, art and spirit—all of these apparently heterogeneous aspects flowed continuously into one another in an antidisciplinary fashion.[10]

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I now want to make explicit another feature of cybernetics that has been close to the surface throughout. Conventional interdisciplinarity is about synthesising objects, concepts and methods from different disciplines, but the eruption of cybernetics across the disciplines did not take that form. As it crossed the terrain of diferent fields, cybernetics did not typically fit in as an extension of existing projects. It did not solve any already recognised technical or conceptual problems. Against the frame of the conventional disciplines, cybernetics projects and artefacts looked odd. Adaptive machines look odd in comparison with AI computer programs, and building them was also an odd way of doing psychiatry. Cellular automata are an odd form of mathematics (similarly, Benoit Mandelbrot spoke of fractals as 'monsters,' Pickering 2005b). Even Gordon Pask had no clear idea of what his Musicolour machine was. He spoke of trying to 'sell it in any possible way: at one extreme as a pure art form, at the other as an attachment for juke-boxes' (Pask 1971, 85). Mainstream architects referred to his style of adaptive architecture as 'anti-architecture'—not really architecture at all (Landau 1968). Hymns of praise to the computing power of water are an unusual form of worship.

The point I want to emphasise, then, is that while it makes some sense to describe cybernetics as interdisciplinary, it is misleading inasmuch as cybernetics almost inevitably implied a transformative displacement of the disciplines as it crossed their paths. Cybernetics unified

[10] There remains the question of whether antidisciplinary eruption should be thought of as a *necessary* concomitant of a nonmodern ontology. The answer is probably not. Rodney Brooks' situated robotics. for example, is in a direct line of inheritance from Grey Walter's prototypically cybernetic robot tortoises of the late 1940s, but Brooks (1999) has explicitly declined to explore antidisciplinary readings of his work. More broadly, many contemporary cyberneticians regret the associations of cybernetics with spirituality. What is at issue here, then, is the demonstrable *possibility* of ontologically mediated antidisciplinary extensions, whether taken up in the work of specific individuals or not.

the disciplines, it is true, but only at the expense of remaking them in its own nonmodern ontological image.

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It is perhaps useful to rephrase this point from a more sociological angle. I have been trying to get at the antidisciplinarity of cybernetics by looking at the work of individuals and seeing how it span off in many directions. The more usual sense of cybernetics as interdisciplinary derives from looking at the variety of fields represented in the field as a whole. The Macy conferences in which cybernetics as a field was born and named are the usual example (Heims 1991). Held in the USA between 1946 and 1953, regular attendees came from all sorts of fields: mathematics, physics, engineering, psychology, anthropology, psychiatry. Membership in the formative Ratio Club in Britain and attendances at the European Namur cybernetics conferences in Europe were even more diverse, in terms of kinds of institutions as well as fields of study, including hospitals, research institutes and government laboratories besides all sorts of university departments. But we should not think of this heterogeneity as sweeping up disciplines en masse. We should think rather of an accumulation of oddities. Just as cybernetic objects and projects looked odd against the backdrop of the modern disciplines, so the cyberneticians looked odd, too, within their fields and departments. One should probably think in terms of metaphors of attraction and repulsion. The people who came to the Macy and Namur meetings were outsiders in their own fields (if they had one) by virtue of proto-nonmodern interests, and were likewise drawn to one another on a shared ontological basis. Though often coming from fields with familiar names, these cybernetic groupings existed almost orthogonally to their modern counterparts.

This observation might lead us to think further about the social basis of cybernetics. As noted earlier, when we think of interdisciplinarity we usually think of collaborations across departments in the university. But as also noted, the centre of gravity of cybernetics was not in the university at all. Where was it then? The simplest answer is: nowhere. Exaggerating only slightly, one can say that cybernetics has never found a stable home. Ross Ashby was a research psychiatrist by profession, but he referred to his early work on the homeostat as his ‘hobby.’ The other great first-generation British cybernetician, Grey Walter, built his famous robot tortoises at home using spare parts from clocks and wartime surplus shops. Stafford Beer was the leader of the Operations Research and Cybernetics Department of a major steel company in the early 60s, but he did his research on biological computing in his spare time, experimenting on his own children and taking them for walks to collect pond water. After a

spectacular career in academic physics, Stephen Wolfram founded his own company, Wolfram Research, which is now the institutional foundation of his new kind of science. Collectively, conference series and dining clubs (and now internet chatgroups and websites) have provided an always improvised basis for the field to come together.

Two remarks follow. The first returns us to my opening remarks on marginality. Cybernetics flourished in the interstices of a hegemonic modernity, largely lacking access to the means of reproduction, the educational system. If power resides in institutions rather than individuals, the cyberneticians had very little of it. As an antidisciplinary formation, cybernetics grew in the shadows—achieving wider visibility only in the 1960s, no doubt by virtue of ontological intersections with the counterculture, itself quickly forgotten.

Second, at the level of content, the improvised social basis of cybernetics helps to account for another sense in which it has been antidisciplinary—namely, in lacking the disciplinary apparatus that university PhD programmes wield. I talked earlier about 'science in the wild,' and cybernetics itself has always been wild and undisciplined in its open-ended capacity for surprising mutation—from brain science to theoretical biology, management, the arts and eastern spirituality, even finding its way into William Burroughs' *Naked Lunch* (1959) and Brian Eno's music (Eno 2003). Lacking an effective police force, individuals have been free to adapt and transplant cybernetic exemplars as they will.[11]

[11] Aicardi's (2010) study of artificial life research at Sussex documents in detail many of the above observations, running from a sort of inner antidisciplinarity in the work of specific individuals, to crossovers amongst disparate fields of science, philosophy and art, and the lack of a stable institutional base. A question that arises here is whether institutional instability is inevitably a feature of nonmodern antidisciplinarity. Many of the researchers Aicardi studied were actively opposed to attempts to achieve regular departmental status, precisely on the grounds that it would stifle creativity and openness. On the other hand, there are examples of the achievement of a quasi-stable social basis in the history of cybernetics, most notable Heinz von Foerster's Biological Computing Laboratory at the University of Illinois, where Ashby worked in the 1960s (Müller and Müller, 2007), and the Cybernetics Department at Brunel University, where Gordon Pask held a part-time appointment. Both of these institutions proved ephemeral, pointing not to the impossibility but to the sheer difficulty of maintaining nonmodern antidisciplinarity within the modern disciplinary frame of academia. Outside the world of the university one thinks of the Santa Fe Institute as a relatively stable institutional base for work on complexity but, significantly, Aicardi notes that artificial life research has been dropped from its agenda as insufficiently scientific and too closely associated with the arts and continental philosophy. Historically, Black Mountain College, North Carolina (1933-1957) appears to have been a fascinating, but in the end also ephemeral, attempt to establish an institutional base for forms of nonmodern antidisciplinarity (www.bmcproject.org). Likewise, the short-lived 'anti-universities' of the countercultural 1960s. (For some information on the Anti-University of London, see Green 1988; for a fictional evocation of the anti-university, see Byatt 2002.) Also in the 1960s, Alexander Trocchi's sigma project imagined the construction of a countercultural institutional base that could grow in parallel with, and eventually displace, the institutions of modernity. A concrete inspiration for Trocchi (1991a, b) was Kingsley Hall, discussed below.

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One final distinctive oddity of cybernetics is worth mentioning. As Heidegger (1977) noted, the modern sciences lend themselves readily to projects of domination and the 'enframing' of people and things. The positive knowledge they generate invites a planned re-engineering of the world. Cybernetics, in contrast, problematised this stance. In a world built from exceedingly complex systems one should expect such plans to go awry; exceedingly complex systems, by definition, are refractory to 'command and control.' The cybernetic ontology instead invites respect for an uncontrollable other, and translates into a stance, not of domination through knowledge, but of open-ended and performative engagement with an ultimately unknowable other—an openness to what the world has to offer us, for better or worse, that we could refer to in Heideggerian terms as a stance of 'revealing' or '*poiesis*' (Pickering 2008a).

This stance of revealing is an enduring thread running through all of the antidisciplinary manifestations of cybernetics, from Ashby's homeostats that explored the behaviour of their environments by reconfiguring themselves, up to Pask's Musicolour machine that searched through coupled spaces of human and nonhuman performativity. What surfaces here, then, is, in a very general but important sense, a political divergence between cybernetics and modern science and engineering, one pointing towards processes of experimental adaptation to the other; the other to asymmetric relations of domination. The latter is, of course, hegemonic today, though the very existence of nonmodern fields like cybernetics might serve to denaturalise that hegemony. Conversely, one might think that this odd stance of revealing accounts, at least in part, for the marginality of cybernetics—it did not fit in with our usual ways of world-making.

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This completes a first pass through cybernetics as an antidisciplinary formation. Despite its reputation as an interdisciplinary science, I have tried to show that cybernetics entailed something other than the combination of existing disciplines. I have argued, instead, that cybernetics amounted to the explosion of a nonmodern ontological stance across, and beyond, the disciplinary map. This is what served to undermine disciplinary boundaries and to bring together practitioners of all sorts of fields and disciplines, but these practitioners and their projects themselves looked odd from the perspective of the modern disciplines, substantively and politically. Alongside this, I have also noted how poorly cybernetics fitted into existing

institutional structures, finding its social basis in the cracks and interstices of the modern world.

To conclude, it seems proper to complicate the picture a little. I have so far described cybernetics and the modern sciences as two incommensurable socio-ontological formations, ships that pass in the night. As a first approximation, and as a way of getting the present notion of antidisciplinarity into focus, I think this is right. But, as a matter of fact, the two paradigms could be brought into a variety of relations with one another, and I want to explore some of these intersections briefly at the levels of ontology and politics, as an opening into thinking about another form of interdisciplinarity, now of the modern and the nonmodern.[12]

We can start once more with the homeostat. I described a multi-homeostat set-up as ontological theatre inasmuch as it conjures up and instantiates the nonmodern ontology that defines cybernetics. But seen from another angle, the homeostat was itself an evidently modern device: its electrical and mechanical components were undoubtedly the products of modern engineering. Somehow, then, the homeostat brought together the modern and the nonmodern, in a way that is worth exploring. My suggestion is that we should see the homeostat as staging a hybrid or mixed ontology in which the two paradigms were fused: an ontological vision of the world as containing both fixed, knowable elements (modelled by the homeostat's valves and capacitors, etc) and exceedingly complex systems (the homeostat's environment) constitutively coupled to one another. We could think of this fusion as entailing, in effect, a pinning down of some but not all of the elements of the basic cybernetic ontology.

The point then to note is that under this description the homeostat takes on the character of a bivalued gestalt figure. Grasped one way, the engineering components recede into the background, foregrounding processes of performative adaptation to the unknown. This was the gestalt that characterised the antidisciplinary eruption of cybernetics that I have sketched out thus far. Grasped differently, however, the homeostat's modern elements come into sharp relief, and this was the gestalt in which Ashby could count his cybernetics as a contribution to a modern science of the brain: he was finding out about the sorts of structures an adaptive brain might contain.

This hybrid ontology and the non/modern gestalt switches that go with it deserve more thought than I can give them here, but we can remark that it was the availability of the

[12] Barry, Born and Weszkalnys' discussions of a 'logic of ontology' (note 1 above) focus upon interdisciplinary projects in 'art-science' where ontological clashes much like those at issue here surface.

modern gestalt that put Ashby in a position to align his cybernetics with more conventional approaches to the brain. As just stated, this gestalt allowed Ashby to situate his cybernetics in the same space as neurophysiology, say—both were concerned with understanding the go of the material brain.[13] It also allowed him to offer a cybernetic underpinning for the psychiatric world in which he worked. He used his homeostats, for example, to model the 'great and desperate cures' (Valenstein 1986)— chemical and electrical shock therapy and lobotomy—that dominated psychiatry from the 1930s to the 1960s, and thus offered them an added degree of legitimacy.

Another of Ashby's elaborations of the hybrid ontology is also worth considering in this connection. I described the homeostat as being free to reconfigure itself in response to interactions with its environment. But the machine included a switch which disconnected the relay and stepping switch, so that its circuitry was fixed and non-adaptive. The homeostat itself, as well as its electrical components, could thus be pinned down as a classically modern entity. And Ashby understood psychiatric practice (and warfare) on the asymmetrical model of a homeostat whose parameters were free to vary seeking to come into equilibrium with another whose parameters were fixed. The latter here stood for the psychiatrist, understood as an exemplar of unvarying mental normality, who forces the patient through a series of homeostat-like reconfigurations (via electroshock or whatever) in the hope that one of them will be a return to normality thus defined. This further ontological specification thus located the psychiatrist and the sufferer on opposite sides of the non/modern divide and, in doing so, legitimated the conventional hierarchic power relations of the mental hospital. This ratification of the social status quo is what one can think of as the political aspect of the hybridity of Ashby's ontology.

Far from being ships that pass in the night, then, Ashby found ways to insert his cybernetics into modern brain science and to use it to underpin psychiatric practice. The relay here was the adoption of a modern gestalt on a hybrid ontology. The price of this, of course, was to isolate these aspects of his cybernetics from the overall antidisciplinary explosion that has concerned us here. If the homeostat indeed ran through the wider history of cybernetics, it was not as a scientific model of the efficacy of electroconvulsive therapy; it was as nonmodern ontological theatre.

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[13] Despite this accommodation to modernity, Ashby's cybernetics remained a strange science precisely in its hybridity. Since the scientific revolution the modern sciences have each presumed its own closed and homogeneous realm of objects. Newtonian mechanics is a science of point masses and nothing else. Modern interdisciplinarity aims to somehow plug these closed worlds into one another. The nonmodern sciences, in contrast, retain their reference to the constitutive otherness of exceedingly complex systems.

Having said all that, we can return to the antidisciplinary thrust of cybernetics by noting that in many cybernetic projects the option of adopting the modern gestalt was either not taken or simply unavailable. Pask's Musicolour machine was built from much the same electrical components as the homeostat, but he did not try to read its circuits as contributions to the science of anything: Musicolour was securely within the nonmodern gestalt as a contribution to a strange adaptive artform. Beer and Pask's biological computing project did not pass through modern engineering at all. It staged a purely nonmodern ontology, attempting to insert one exceedingly complex system (a pond ecosystem, say) into others (the firm and its economic environment). In this respect, then, many cybernetic projects indeed sailed straight past their modern cognates. Or, at the other end of the spectrum from Ashby's accommodation to modernity, they collided with their modern counterparts as critique. These collisions were especially acute in contests over common ground, which is where the prefix 'anti-' was often applied to cybernetics, as in the description above of adaptive architecture as 'anti-architecture.' To explore such collisions a little further, we can close with another 'anti'—'anti-psychiatry' as it grew from the work of Gregory Bateson.

Bateson was another of the founders of cybernetics, one of the original participants in the US Macy conferences. He was especially interested in processes of communication, which he understood on the symmetric model of multiple homeostats reciprocally adapting to one another. In 1956 he introduced his famous notion of the 'double-bind'—his name for a situation in which such reciprocal adaptation arrives at an unfortunate form of equilibrium, in which one or more of the partners is left with no good way to go on. Bateson argued that repeated double-binds are what precipitate schizophrenia, and that psychosis is itself a manifestation of some drastic adaptation process which, left to itself, can lead to the undoing of double-binds and spontaneous remission (Bateson et al, 1956).

Various points about Bateson's theory of schizophrenia are worth noting. First, in drawing on the model of the homeostat it remained close to Ashby's cybernetic psychiatry, but with the modern scientific impulse now stripped away. Bateson had no interest in tracing out the electrical (or biochemical) substrates of madness; he was interested in coupled becomings of exceedingly complex systems and their possible pathologies. In this sense, Bateson's approach to psychiatry staged a purely nonmodern ontology from which the hybrid quality of Ashby's, and the possibility of adopting a modern gestalt, was absent. Second, unlike Ashby's, Bateson's symmetric cybernetics functioned as a critique of mainstream psychiatry. On Bateson's account, the great and desperate cures functioned only to stop naturally

occurring adaptive processes in their tracks and to leave patients stuck in their double binds. And Bateson's analysis functioned as a critique of the social relations of psychiatry, too. The symmetric model of reciprocal adaptation discouraged the idea of the doctor as a fixed paragon of sanity, and instead pointed to an experimental approach to therapy, in which the therapist had to adapt in trying to latch onto the patient, and, indeed, to be open to the possibility of learning in the encounter.

Bateson's work was largely theoretical and interpretive, but attempts were made to put these ideas into psychiatric practice within the established mental-health system in Britain in the early 1960s. In the event, however, the mismatch with existing clinical regimes created frictions to the extent that in 1965 R D Laing and his colleagues in the Philadelphia Association set up a Batesonian psychiatric community functioning entirely outside the state system, at Kingsley Hall in London. Kingsley Hall was a commune, in which doctors and sufferers (and others) lived together in a relatively non-hierarchic relationship. No shock or drug therapy took place; the psychiatrists simply helped the sufferers in their 'inner voyages' in situated ways as best they could, at the same time expecting to be changed themselves (Laing's argument was that modernity is a form of madness, in its disconnection from the inner self: Laing 1968).

In this instance, therefore, the socially pressing problem of how to cope with mental illness provided a zone of contestation in which the ships of modernity and nonmodernity collided head on rather than passing in silence. The Bateson-Laing wing of the anti-psychiatry movement, as it became known, constituted both a thoroughgoing and inherently political critique of modern psychiatry and a practical alternative to it.[14]

This is as far as I can go with this discussion of non/modern interdisciplinarity. I have tried to show that the modern and the nonmodern can indeed be brought into relation with one another, and even fused together. In Ashby's work a hybrid ontology supported a modern gestalt in which cybernetics and modern science and engineering could happily co-exist. Within this gestalt, cybernetics could take its place as one of the royal sciences, as Deleuze and Guattari (1987) called them, that preserve social order and prop up the state. But when that gestalt was not adopted or simply unavailable, the situation changed. A simple incommensurability of the modern and the nonmodern reigned in practice, which could turn into contestation over shared ground. In this respect, cybernetic anti-psychiatry appears as one

[14] Kingsley Hall was also an epicentre for the broader social contestation of the 1960s. It was an institutional base for the British counterculture and a model for other onto-institutional initiatives (note 11 above).

of Deleuze and Guattari's nomad sciences that, far from achieving any non/modern interdisciplinary accommodation, sweep in from the steppes to play onto-political havoc with established orders (Pickering 2009c).

ACKNOWLEDGEMENTS

I am grateful to Andrew Barry, Georgina Born, Antonio Carvalho, Regenia Gagnier and Gisa Weszkalnys for insightful comments on the first draft of this essay, and to Christine Aicardi for access to her unpublished PhD dissertation.

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