

Causality and Motivation Workshop
MittelEuropa Foundation, Bolzano, Italy, 20-21 April 2006

Teleology Without Telos: Deleuze and Jonas on the Living Future

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We forget that we are no longer part of the real world of modern metaphysics and that time as a measurable continuum – the dividing line of the present moving in regular and solemn silence from the dead past into the unborn future – is a notion whose ultimate metaphysical validity is conditioned upon making our exclusion permanent. If we are a part of the world, then the *t* of physics must become but a partial element in real time, and a more inclusive philosophy thus won might again consider the evidence in favour of attributing movement to the future rather than to the present, while the idea of the past as dead and vanished might be consigned to oblivion with other curious relics of an over-mechanical age.¹

1. Introduction

The relationship between contemporary industrialised societies and the future contains a troubling paradox. Their technological capacity means that they are highly competent at creating futures, yet they find themselves increasingly unable to predict the future results of the innovations they produce. This in turn means that the more they see the future as an unoccupied space into which their technological ingenuity can reach, the less they are able to take responsibility for the futures they create. In short, the greater the increase in the power to make futures, the less they can be known; the less they can be known, the harder it becomes to establish accountability for the shape they take.

Among the factors contributing to this situation are the conceptual tools that underlie the scientific, technological, political and economic practices with which these societies approach the future. Perhaps one of the most widely used of these tools, prevalent in all spheres of private and public life, is the assumption that to understand process and change requires us to conceive of the future as an empty space located somewhere in front of us, out *beyond* the present. This space is presumed to be intrinsically open to infinite manipulation by self-interested agents in the present. In this paper, I trace some of the metaphysical assumptions which support this concept, which I call an *abstract future*, before examining concepts of process and change in the work of Hans Jonas and Gilles Deleuze that make possible an alternative way of conceiving of the relationship between present and future, the idea of a *living future*. This would be a future which possesses a latent but nonetheless material reality within the present and exerts a *pull* on it, unfolding from within it novel forms and structures. This implies a quasi-teleological concept of time, whilst doing without the concept of a pre-given or emergent final goal of becoming. It demonstrates why uncertainty is

a constitutive part of the creation of novelty, but also opens up the possibility of rethinking responsibility as being intrinsically bound up with a situation of active creation and unknowing, rather than as only being assignable when the future is predictable.

2. Linear time and prediction

Some of the conceptual underpinnings for the idea of an abstract future are the metaphysical assumptions of the worldview of classical mechanics, as established by Galileo, Boyle, Newton and others in the 16th and 17th centuries.

- *Change and process are understood quantitatively, not qualitatively.* The rationality of the cosmos no longer lies, as for the Aristotelian tradition, in the harmonious motions of the bodies composing it, but in the uniformity of motion of their elementary constituents.²
- *Atomism.* Galileo advanced the hypothesis that these elementary constituents are atoms ('corpuscles').³ These atoms are the sole bearers of the primary qualities of matter, qualities which could be defined in quantitative terms alone.
- *Universal mechanism.* Robert Boyle affirmed that change is nothing but an alteration in the quantity of motion belonging to a body or collection of atoms, and that the only thing that causes such alteration is collisions between atoms.
- *Quantitative commensurability of space and time.* The measure of change is therefore nothing but the number of units of space traversed by a body in units of time. Space is the medium that is occupied by bodies, whereas time is the medium in which change occurs.⁴ Time is therefore the 4th dimension of space, a line divided into t-coordinates. There is no qualitative variation within space and time themselves. All that changes is the position of bodies, with time being a linear succession of slices or snapshots of the changes in the arrangement of these bodies.
- *Absoluteness of space and time.* Newton identifies absolute space and time as the fundamental presuppositions of any mechanistic and atomistic theory of change and process. Any such theory must therefore presuppose a point of view which is not placed within the processes which it describes.

This conception of time divides it into three ontologically distinct modes. The *past* is the storehouse of events or slices of becoming which have happened, and which is thought of as mechanistically determining present and future. The future is those events which can occur but have not yet occurred, and are the object of prediction based on the past. For its part, the present is a vanishing limit between past and future in which possibility is converted to actuality, and yet also the site of experience, in which empirical reality is presented through the senses. The future retains only a subordinate ontological status, remaining an empty space on the line of absolute time, out beyond what is already recorded

and experienced. This empty space, it is assumed, will repeat within it the same patterns of change which are already known, with any unpredictability being nothing more than an effect of ignorance of other undiscovered regular patterns of change. Another consequence is that any rearrangement of the component parts of the machinery of nature will have entirely predictable results.

Of course, within science itself the idea that scientific explanation should be ultimately be reducible to a theory of macro-scale physics has been undergoing almost constant revision since the 18th century.⁵ Chemistry, evolutionary biology, thermodynamics, quantum mechanics, the general and special theories of relativity, and especially the study of non-linear systems in complexity theory and chaos theory: all have brought into question the metaphysical –and increasingly, the methodological – presuppositions of the classical model. The idea of absolute space and time, together with the model of scientific subjectivity they imply, are perhaps the most significant of the resulting casualties.

Despite this, the model of change enshrined by the classical model, together with the concept of the future it implies, has become deeply rooted within the cultures of industrialised societies. Two examples of how its influence continues to persist are the instrumental mobilisation of science for industrial technologies, and the use of science as the primary means of legitimation for decision-making processes undertaken by political and economic elites.⁶ In the case of industrial technology, the enduring power of the classical model of change and process rests on scientific successes in the isolation and explanation of phenomena at the macroscale, leading to the manipulation and transformation of selected natural processes.⁷ In the case of the legitimation of decision making, the assumptions of the classical model endure despite, or rather because of, the contemporary context of uncertainty in which policies are made and new technologies developed. This context is itself the result of the unintended consequences of the successes of industrial science.⁸

The capacity of science to create new technologies results in a demand from policymakers for an equally successful effort in predicting the outcomes of the application of these technologies. The lack of such success, and the contributory role played by predictions themselves in exacerbating both uncertainty and actual undesired outcomes, has been a notable feature of many recent socio-environmental problems.⁹

So although the emergence of non-reductivist and non-linear logics of explanation may have undermined the metaphysical basis of the classical world-picture in the sciences themselves, this metaphysics continues to guide social practices. These practices still picture the future as an abstract space beyond the present, one that will be composed of predictable events and which is therefore open to endless transformation through the rearrangements of the parts that give rise to these events. In the contemporary situation, where the capacity to create futures becomes forcibly uncoupled from the power to know them, it is apparent that these practices are operating with assumptions that undermine themselves. It is here that a rethinking of the role occupied by the future in

theories of change might intervene to reconfigure the relation between creation, knowledge and responsibility.

3. Hans Jonas and the Organism as Self-Valuing Entity

Hans Jonas has challenged the mechanistic understanding of past, present and future by arguing that teleology, in the specific sense of an immanent purposiveness within living organisms, has to be thought of as more than just a heuristic fiction.¹⁰ Typically, teleological explanations are assumed to imply that an anterior purpose pre-exists the emergence of the individual organism, and governs its subsequent development. This concept of an anterior purpose, however, is for Jonas an incorrect understanding of teleology, one mistakenly derived from our understanding of human artefacts.¹¹ His idea of immanent purposiveness implies, I will suggest, a novel concept of natural temporality, one in which the pattern of the organism's living present is shaped by its anticipation of its future, meaning that the organism is possessed by an always latent, ceaselessly emerging *living future* – the ways in which it anticipates tendencies within its environment and within itself, and improvises responses.

In his 1966 work *The Phenomenon of Life*, Jonas argues that there is a fundamental difference between living entities and physical structures, namely that an organism actively distinguishes itself from its environment, whilst at the same time maintaining a bond with it. This activity is how he defines metabolism in general, the continuation of the unity of the entity with itself through a process of exchange of matter with the environment.¹² The identity of the organism is not therefore defined by some unchanging substrate. Instead, the organism *is* nothing other than the unitary and non-linear organisation of numerous processes of energetic exchange and self-reproduction. It is a special case of the kind of system Prigogine and Stengers have described as dissipative.¹³ On the one hand, it takes in matter that adds to the organisation of the system. But on the other, the activity of the organism is not a mere transition of energy through a physical system; the way this transition is organised actively distinguishes the organism, as an ensemble of processes, from its environment.¹⁴ From individual bacterial cells on up, life builds membranes around itself, separating self and other, and thus forming a cellular identity that supports basic metabolic functions. Jonas' account of organismic identity clearly bears comparison with the concept of autopoiesis.¹⁵

Consequently, the cellular identity of an organism differs from the identity of a physical system in three ways: firstly, the identity of the parts of a physical system is merely a case of simple spatial self-coincidence. Secondly, the overall unity of the system itself is only phenomenal, i.e., merely the way another perceives it. Thirdly, and by contrast, the unity of the organism is its being-for-itself. Its self-production and autonomy is its own immanent purpose, and its form or dynamic organisation of parts is essential to the activity that constitutes it.¹⁶ This also means that the relationship between organism and environment is dialectical: the organism finds itself in a state of 'needful freedom' with respect to the materials that it needs to produce itself.¹⁷ The more individuated the

organism, and the more autonomy it has by virtue of its behavioural repertoire, then the more intimately it is involved with its environment.¹⁸ The more independent it is, the more insecure its existence, and so the more it is concerned with finessing its responses to perturbations intruding from outside it.

This inherent precariousness of organic life is why Jonas describes the unity of a living being as a manifestation of *conatus* or self-concern.¹⁹ As we shall see, it is this which constitutes the living future of plants and animals. Jonas argues that to think of the organism as an immanent purpose, as *self-valuing*, is vital to any understanding of it as an organised whole. As a self-valuing entity, the organism does not just encounter the environment, it experiences it. That is, the environment is full of significant traits which have meaning for the organism in relation to its self-concern. Organisms are therefore sense-making systems: whether plants or animals, they have the capacity to trace differences in their material environment, distinguish things with beneficial characteristics from those with bad or indifferent, and orient themselves within their environment to strive after these beneficial things. In this way, even non-conscious organisms have a simple *cognitive identity* alongside their cellular unity, which forms a higher level of the metabolic relationship between organism and environment.²⁰

The cognitive identity of the organism is another point where Jonas' account can be compared with that provided by autopoiesis, given that Maturana and Varela's description of organic identity also presents it as constituted by a meaning-creating perspective that is taken by the organism on the external world.²¹

Although the transfer of energy through the organism is a product of encounters between it and its environment that are governed by physical laws, its perspective on its environment, which orients it towards aspects of that environment which are salient for its survival, is not itself intrinsic to any such encounter.²² The organism is therefore always to an extent *outside* the networked physical processes that circulate energy through it and its environment. As such, the environment is always mediated for the organism through the processes that maintain its own identity-in-difference. This mediation is much more pronounced for animals, from which the significant aspects of their environment, such as food sources, are always divided by spatial and temporal distances. The cognitive identity of animals is further mediated by their nervous systems, which allow behaviour to recursively modify perception.

We can therefore say that, as a self-valuing cognitive identity, both menaced and nurtured by its environment, the organism experiences its environment because what is beyond its outer skin bears a 'surplus of signification' for it.²³ What it encounters via the sensory tools it has evolved is not just *present* to it in the sense in which two inert bodies might be simultaneously present to each other in adjacent spaces. Instead, the content of the external environment is haunted by past and future, in the way the organism relates it to past encounters and projects its significance for future ones. This temporal wavering means that what is outside the organism is not just an *environment* in which its cellular identity is embedded, but is in addition a *world* that is saturated with meaning. The meaning of this world for the organism is constituted in relation to the basic

rhythms of its self-production: the cycles of hunger and satiation, of activity and rest. The world has a signficatory surplus because the organism seeks there what it lacks: food to satisfy hunger, shelters in which to sleep, open spaces to allow pent-up energy to be expended in running and chasing.

The organism cannot therefore be alive without both memory and anticipation: it is never just what it is, but is always moving beyond its current state in opposed temporal directions to re-situate itself in relation to its environment. Of these two directions, the organism's precarious existence is most bound up with the future, which means that it needs to be adaptive to survive.²⁴ To adapt to a world which is full of potential shocks to its system, the organism must be capable of anticipating tendencies of change within its own states as well as outside it, and then of altering its behaviour so as to change the direction in which its own states are moving so as to remain within a range of viability: for example, the way in which most reptiles move from sun to shade to regulate body temperature. Crucially, the generation of this purposiveness is entirely immanent to the organism. The range of viable states, and what will count as unsustainable perturbations for the organism, is determined by the specific nature of its metabolic processes, but the organism is also capable of recursively redefining what is to count as a viable state in response to unpredictable situations where previously viable states prove to be non-viable.²⁵ The organism therefore both discovers the significance of salient features of its environment and creates this significance, as its projection of its own internal tendencies alters what it defines itself as lacking and also changes what will count for it as signs that lead it towards an as yet unattained goal. Its capacity for cognition is 'a continual bringing forth of a world through the process of living'.²⁶ By its capacity to read these signs, it anticipates encounters, and begins adjusting to them, long before they actually occur. Just as Heidegger defines human existence as a projective potential-for-being, Jonas sees organic life as necessarily always in advance of itself. If its projective capacities were absent, an organism would become like the archetypal inert physical body of classical mechanics, and would therefore cease to be alive at all.²⁷

Whereas the metaphysics of classical mechanics views all change and process as the deterministic and summative product of past changes, Jonas articulates a metaphysics of living systems that views becoming as the immanently purposive product of non-linear phenomena. The lived present of an organism is conditioned by its sensitivity to its own future tendencies, and is therefore always a process of improvising adjustments to the anticipated results of interactions with a changing environment. Jonas gives us a phenomenology of the organism that characterises its situation as one of relative autonomy that increases, along with the precariousness of its existence, the more complex the organism becomes. As such, an organism is what it is because it incarnates a *living* future, which is contrasted with the *abstract* future of classical mechanics. The organism's metabolic processes are governed by rhythmic oscillations that give rise to its projective cognitive interactions with its environment. Time, for such a system, is an intrinsic quality rather than an extrinsic measure, an experience of processes of differing durations with inherent projective reach.²⁸

Overall, Jonas's contribution might be said to be primarily to a phenomenology of the organism as the *subject* of the emergence of behavioural novelty. The emergence of novelty at this level is a product of the anticipatory modes of sensing that the species has evolved in interaction with its world. An organism's living future is therefore always *imminent*, one in which coming environmental shocks are avoided or the conditions of the approaching encounter modified so that it is as favourable to the organism as possible. Within this context, the problem of uncertainty is only posed within temporal limits constituted by the life-span of the organism. For example, sensing a predator perturbs the functioning of the organism, and produces a surplus of uncertainty that demands a suitable response, but the future evolution of a species is outside the individual organism's domain of action and concern. The scope for novelty within the life-cycle of the organism is limited by the degree of rigidity of its adaptive behaviour. To have a hope of broadening the concept of a living future to cover the contemporary context of novelty-driven uncertainty mentioned at the outset, in which social systems and their technologically-mediated relationships with their environment are the object of investigation, other conceptual tools are needed.

4. Deleuze and the Quasi-Causality of the Virtual

Deleuze's concept of virtuality offers one way of approaching this problem, forming as it does the key to his articulation of an ontology of process that aims to entirely do without a concept of unchanging substrates that contain process. From early on in his career, Deleuze locates virtuality within the individual organism, whilst also indicating that this dimension of its existence reaches out far beyond it. The basis of this distinction is the difference between the forms of relationship between past, present and future that are implied by organic time and virtual time. For Deleuze, the living future of an individual organic metabolism is ontologically limited, in that it is essentially cyclical, determined by the overriding structural necessity of survival, which Jonas calls *conatus* or self-valuing.

Let us consider first the place which the virtual occupies within the behavioural milieu of the organism, and thereby its living future, before examining how it exceeds this level of organic temporality. An organism's intrinsic temporality remains largely bound to the cyclical repetition of patterns of activity that it adjusts in response to its conditions of viability. Each living present occupied by the organism implicates within it both the lived past of its cycle and an anticipated future thereof, but remains located on a timeline of living presents, which can itself be shown to be part of a living present of longer extension, and to comprise within it still shorter durations.²⁹ The circadian rhythms of an animal comprise many billions of the fluctuations of an atomic oscillator like Caesium-133, and billions upon billions of the animal's sleep-wake cycles go to make up the life-cycle of a star. For the animal, both these levels of intrinsic temporality are beyond the bounds of sense: the one far too fast, the other too slow to be perceived. Nonetheless, the mathematical relationships between these durations

are calculable, and so the living present of a physical system, of whatever duration, remains an extended, measurable and knowable moment of time.

Drawing on Jonas, I would suggest that the living future of an organism is its current potential for improvisation, embodied in the totality of the activities by which it adjusts its functioning in response to actual and anticipated external shocks. As such, the organism has, for Deleuze, an actual and virtual existence in space and time. The self-regulating rhythms of activity that constitute the cellular and cognitive identity of the organism make up its physical actuality in its living present. The tendencies of these activities, projected back and forward in time, constitute its virtuality. As virtual, they are nothing apart from the actual process of life, but nonetheless, they mark out limits to which the behaviour of the organism is constantly adjusting. The virtual aspect of the organism, seen from its own perspective as it were, is thus the range of states that mark out the current definition of viability. These states circle around a singular point that acts like a centre of gravity for the regulative activity of the organisms.³⁰

The idea of a centre of gravity provides a useful image for the organism-centric level of virtuality as such.³¹ An organism's centre of gravity is not an actual part of its physical system, and cannot be 'realised' in a specific present moment in the same way as a particular configuration of its physical parts can be. It constitutes a singular point in relation to which all the elements of the body must adjust themselves so as to avoid maladaptive outcomes (such as losing one's footing while being chased). All the parts of its body possess tendencies which approach or recede from this point. The centre of gravity, however, is always beyond the tendencies themselves, as it is the attraction point for the boundary of a region beyond which the interactions between the parts of the system render it unstable in relation to its environment. This means that it has a paradoxical temporal status. While the organism is alive, the centre of gravity remains an attractor for a relationship between the parts of its body that is always still to be realised, given that the organism is constantly anticipating how its structure must change in response to its environment and is improvising responses accordingly. Yet this relationship simultaneously *has* always already been realised, as the trajectory of the organism through its world up to this point has been organised in relation to its centre of gravity. A hypothetical moment in which all of the organism's tendencies would finally converge at this attractor never actually occurs; instead, this convergence is always just past and still to happen.³² The centre of gravity is therefore what a Deleuze calls a 'destiny', a singular point that governs the functional patterns of interrelated physical processes.³³ This virtual point thus acts as the condition of the living future of the organism described by Jonas, whilst remaining entirely immanent to the physical system of which it is a virtual aspect, and thus nothing like a metaphysical telos that pre-exists the system.

Turning now to consider the virtual as it extends beyond the temporality of the individual organism, we can see that shocks deriving from encounters with the environment in Jonas' account have two outcomes. The shock might mobilise a set of factors that are too much for the organism's regulative capacities, and it

reaches a critical point of instability in one or more dimensions of its activity, resulting in death: an animal starts in fright and in its haste to get away, loses its balance and is seized by a predator. Alternatively, the shock produces a change in state which moves the organism's metabolism away from its customary pattern of functioning to a greater or lesser extent, but which then gradually relaxes back to stability: having escaped the predator, the animal's breathing and heart rate gradually restore themselves to their customary cycles.

Deleuze offers us a third alternative, which opens the concept of the living future onto the horizons of greater complexity and uncertainty central to the problem with which we began. This has to do with the enmeshing of the virtual destinies of two or more systems, creating a new system and destiny in the process. A good example still within the behavioural milieu is the biological phenomenon of entrainment, whereby the intrinsic oscillations of one system speed up or slow down to enter into a synchronous relationship with those of an external system, as when an animal's sleep-wake cycle matches itself to the periodicity of day and night.³⁴ In this phenomenon, the multiple processes of the animal's metabolism respond to 'shocks' or perturbations from the environment to which its sensory capacities make it vulnerable, these shocks consisting of intensive signals such as variations in light and temperature. They respond by modifying the rates of change of certain internal processes, making them slow or fast relative to others, so as to reorganise themselves into a system that operates in parallel with the cycle of day/night.

What defines this event of entraining is simply the adjustment of speeds of metabolic oscillation,³⁵ an adjustment that is a movement forced by the differences in rates of variation between the two systems.³⁶ This movement creates a new relationship between the two systems, animal and environment, and thus changes the internal structure of the animal's metabolism. It arises solely out of the communication between two different systems with intrinsic temporalities, but what creates the potential for this communication is the fact that both systems possess their own virtual destinies, boundary points that constrain and channel their energetic processes.

Causal determination here operates on two levels: firstly, there is physical causality, the transmission of signals between systems across a field of intensive difference, which sets in motion the process of entrainment. But how this process itself develops depends on relationships of consistency between the virtual potentials of the two systems, i.e., between the sets of boundary points and associated tendencies which define their 'destinies'. This development of a consistent co-potential is referred to by Deleuze as 'quasi-causality'.³⁷

Crucially, this virtual quasi-causality can operate between systems of widely differing degrees of intrinsic temporality, to create trajectories with still longer temporal reach. An example is symbiotic evolution, such as occurs between the digestive systems of multicellular animals and the bacteria that inhabit them and help them digest otherwise indigestible food. This entraining of heterogeneous metabolisms over the course of uncounted living presents represents a simultaneous convergence and divergence of the destinies of the two organisms,

forming a relationship that possesses its own destiny in turn. The intrinsic temporality of the animal's metabolism and those of the bacteria operate at vastly different scales, but in coming together they create a new potential for transformation, by forming a system with a still vaster temporality, one which encompasses the unpredictable future emergence of a multitude of complex forms.

In this way, the living future of behavioural improvisation as imagined by Jonas is supplemented by Deleuze with an ontology that locates this living future, as a local eddy of precarious stability, within an infinitely complex living future that is undecided and unstable, yet remaining latent in the present. The future is no longer separated from the present as the as-yet unrealised but necessary outcome of the past. Instead, it is the potential possessed by existing entities for producing transformative relationships with others, and thereby engendering unforeseen processes that can vary hugely in duration, having periodicities of milliseconds to millions of years and further. This infinitely expanding dimension of the living future arises from the capacity of the virtual aspect of two or more systems to become consistent with each other, and thus to enable the co-evolution of physical systems in ways that cannot be causally explained solely by the present or past structure of the systems.

Further, the picture of complexity this generates leaves no entity out: from inorganic compounds, through living organisms, to human societies and their technologies, Deleuze's metaphysics places everything on the same plane, capable of cross-cutting through it to form unpredictable viable and non-viable combinations. The shocks that are transmitted between systems are the medium through which the virtual is made to communicate, but it is the virtual dimension, in all its complication, which determines what the destiny of this communication can be.

5. Conclusion

In Aristotle's philosophy, the concept of teleology gave to the time of organic life an intrinsic and creative directionality, in which the form of an organism contributes to the realisation of the *telos*, the pre-formed essence of a natural kind. Jonas and Deleuze counterpose to the abstract future of classical mechanics concepts of a living future which reinsert an intrinsic creative directionality into the concept of time, without resurrecting the *telos*. In the context of this directionality without *telos*, the idea of responsibility would have to be given a new meaning, which was hinted at by Deleuze and Félix Guattari, in writing that the relationship between subjects and their world is more like that between artisans and an already virtualised matter than that between architects and a dead 'stuff' ready to receive form.³⁸ If I carve a piece of wood, I have to respect what the wood offers me: the way its fibres twist together, and the position of knots and how these alter the 'flow' of wood. I need to develop a Jonasian 'sense' for the world of wood, and to fully participate within this world, using all my powers of sensitivity and perception. In this context of action, a concern for what we might call the sustainability of action is inherent. If we return

to the social context where this paper began, and acknowledge that a highly complexified ecological, technological, political and economic living future is inescapably the context of social action, we must also recognise that a homologous but hugely expanded concern for sustainability must be cultivated in this sphere.

Notes

¹ Edwin Arthur Burtt, *The Metaphysical Foundations of Modern Physical Science* (London: Routledge and Kegan Paul, 1959), p. 86.

² Hans Jonas, *The Phenomenon of Life: Towards a Philosophical Biology* (Chicago; London: University of Chicago Press, 1982), p. 68.

³ Burtt, *The Metaphysical Foundations of Modern Physical Science*, p. 77-8.

⁴ Ibid., p. 84

⁵ Reductionism has been defended as the only truly viable general model of scientific methodology. For the classic statement and defence of the reductivist model of the relationship between physics and the other natural sciences, see Ernest Nagel, *The Structure of Science: Problems in the Logic of Scientific Explanation* (London: Routledge and Kegan Paul, 1961).

⁶ On the legitimising role of 'expert science', see for example André Gorz, *Ecology as Politics*, trans. Patsy Vigderman and Jonathan Cloud (Montréal: Black Rose Press, 1980), pp. 99-111, and Paul Nicholas Anderson, "What Rights Are Eclipsed When Risk Is Defined by Corporatism?," *Theory, Culture and Society* 21, no. 6 (2004).

⁷ For an account of how this tendency is manifested in genotechnology, see Craig Holdrege, *A Question of Genes: Understanding Life in Context* (Edinburgh: Floris Books, 1996), pp. 107-113 and pp. 120-125. Pharmacogenetics represents one of the latest attempts to mobilise science to this end, in the wake of the mapping of the human genome. However the rush to expansion in this field has been tempered by the realisation that reductionism may actually be a barrier to research in genetics, and that 'genetic information may not be sufficient in the absence of much greater knowledge of the interaction of genes with one another and with the environment during development', Steven Rose, "Brain Gain," in *Better Humans? The Politics of Human Enhancement and Life Extension*, ed. Paul Miller and James Wilsdon, *Demos Collection* (London: Demos, 2006), p. 72,

⁸ On this context, see Ulrich Beck, Anthony Giddens, and Scott Lash, *Reflexive Modernization : Politics, Tradition and Aesthetics in the Modern Social Order* (London: Polity Press, 1994), and Ulrich Beck, "From Industrial Society to Risk Society: Questions of Survival, Social Structure and Ecological Enlightenment," *Theory, Culture and Society* 9 (1992).

⁹ See for example Barbara Adam, *Timescapes of Modernity: The Environment and Invisible Hazards* (London: Routledge, 1998), pp. 166-7 on BSE and pp. 119-120 on genotechnology.

¹⁰ Andreas Weber and Francisco J. Varela, "Life after Kant: Natural Purposes and the Autopoietic Foundations of Biological Individuality," *Phenomenology and the Cognitive Sciences* 1 (2002), p. 98.

¹¹ Jonas, *The Phenomenon of Life: Towards a Philosophical Biology*, pp. 117-22. This point is also crucial to Jonas' criticism of the application of cybernetics to living systems.

¹² Ibid., pp. 75-6. See also Fritjof Capra, *The Hidden Connections* (London: Flamingo, 2003), pp. 6-9.

¹³ Ilya Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (New York: Bantam Books, 1984), pp. 143-4.

¹⁴ Weber and Varela, p. 116.

¹⁵ "An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in space in which they (the components) exist by specifying the topological domain of its realization as such a network", Humberto Maturana and Francisco J. Varela, *Autopoiesis and Cognition: The Realization of the Living*, *Boston Studies in the Philosophy of Science* (Dordrecht: D. Reidel Publishing Co., 1980), p. 78. Such a comparison has been undertaken: see for example Weber and Varela, "Life after Kant: Natural Purposes and the Autopoietic Foundations of Biological Individuality."; Ezequiel di Paolo, "Autopoiesis, Adaptivity, Teleology, Agency," *Phenomenology and the Cognitive Sciences* 4, no. 4 (2006).

¹⁶ Jonas, *The Phenomenon of Life: Towards a Philosophical Biology*, pp. 79, 81.

¹⁷ Ibid. p. 80.

¹⁸ Ibid., p. 84.

¹⁹ Hans Jonas, *The Imperative of Responsibility* (Chicago; London: University of Chicago Press, 1984), pp. 72-3.

²⁰ Francisco J. Varela, "Patterns of Life: Intertwining Identity and Cognition," *Brain and Cognition* 34 (1997), pp. 82-3.

²¹ Weber and Varela, "Life after Kant: Natural Purposes and the Autopoietic Foundations of Biological Individuality.", p. 102. See also Varela, "Patterns of Life: Intertwining Identity and Cognition.", p. 74.

²² Varela, "Patterns of Life: Intertwining Identity and Cognition.", p. 79.

²³ Ibid.

²⁴ It has been argued that the adaptivity of the organism is implied within Jonas' account, but is missing from the standard articulation of the theory of autopoiesis. See di Paolo, "Autopoiesis, Adaptivity, Teleology, Agency.", pp. 6-7.

²⁵ Ibid., pp. 10-11. As di Paolo notes, the necessity of including adaptivity in the understanding of organism would suggest that the emphasis in autopoiesis on structural determinism is misplaced.

²⁶ Capra, *The Hidden Connections*, p. 32.

²⁷ Martin Heidegger, *Being and Time*, trans. John Macquarrie & Edward Robinson (Oxford: Blackwell, 1998), p. 67; Jonas, *The Phenomenon of Life: Towards a Philosophical Biology*, pp. 82-3.

²⁸ On the concept of intrinsic temporality and its connection to irreversible development, see Prigogine and Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, pp. 272-3.

²⁹ Gilles Deleuze, *The Logic of Sense*, trans. Mark Lester and Charles Stivale (London: Athlone, 1990), p. 62.

³⁰ At this level, the concept of the virtual refers to that dimension of virtuality which presents it as already *captured* by actual systems to facilitate their self-organisation: the self-production of actual systems proceeds by 'imprisoning' singularities within the 'limits of worlds, individuals and persons' (Ibid., p. 167).

³¹ See Brian Massumi, "Event Horizon," in *The Art of the Accident*, ed. Joke Brouwer and Andreas Broeckmann (Rotterdam: Nederlands Architectuurinstituut, 1998), p. 160.

³² Deleuze, *The Logic of Sense*, pp. 146-7.

³³ *Ibid.*, p. 170.

³⁴ Manuel Delanda, *Intensive Science and Virtual Philosophy* (London: Continuum Books, 2004)., p. 93.

³⁵ Gilles Deleuze, and Félix Guattari, *A Thousand Plateaus*, trans. Brian Massumi (London: Athlone, 1988)., pp. 260-1.

³⁶ Gilles Deleuze, *Difference and Repetition*, trans. Paul Patton (London: Athlone, 1994)., pp 117-8.

³⁷ Deleuze, *The Logic of Sense*, p. 33.

³⁸ Deleuze, *A Thousand Plateaus.*, p. 361.

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