Life and Energy

Howard Caygill

Theory Culture Society 2007; 24; 19
DOI: 10.1177/0263276407078710

Life and Energy

Howard Caygill

THE ASSOCIATION of life and energy is culturally ubiquitous, pervading breakfast cereal packages, ecological politics and a host of energy/life enhancing products and programmes. The nexus of life and energy is moreover axiomatic for contemporary research in biology and the neurosciences which are developing extremely sophisticated accounts of life and consciousness in terms of energy transfers, conservation and degradation. Yet in spite of the centrality of energy to the contemporary cultural and scientific *doxa*, the concept itself remains strangely unanalysed in contemporary philosophy and theory. Here, work continues to be pursued in terms of such archaic concepts as force and power. While such concepts may serve to introduce a dynamic element into contemporary theory – evident in such theoretical couplings as 'corporeal force' or 'bio-power' – they are historically anachronistic and conceptually limited in comparison with the concept of energy. Philosophy, however, very rarely reflects directly on the concept of energy, let alone the nexus between the concepts of energy and life.

One of the exceptions to the philosophical oblivion of energy is the series of works produced by Alfred North Whitehead between 1920 and 1934. *The Concept of Nature* (1920), *Science and the Modern World* (1925), *Process and Reality* (1929) and *Nature and Life* (1934) criticize the conception of nature as a sum of objects and their relations (conceived in terms of force and power) and outline a new concept based on the notion of a set of events. In *Process and Reality* Whitehead begins very tentatively to link the 'event' with quantum expressions of energy, while in *Nature and Life* he proposes that 'the deficiencies in our concept of physical nature should be supplied by its fusion with life' (1934: 58) – in other words, that the physical concept of energy should be supplemented by the physiological concept of life. This audacious and necessary proposal remains largely unexplored in Whitehead's own work and was largely ignored by posterity. His own conclusion that 'the energetic activity considered in physics is the emotional intensity entertained in life' (1934: 96) does not fully escape from the

■ *Theory, Culture & Society* 2007 (SAGE, Los Angeles, London, New Delhi, and Singapore), Vol. 24(6): 19–27
DOI: 10.1177/0263276407078710

reliance on analogy in *Process and Reality*, where the physical transformation of energy into quanta is related to 'its analogues in recent neurology'. The reliance upon parallels and analogies between the expressions of energy in physical nature, life and consciousness is testimony, even in the radical work of Whitehead, to the difficulty of framing a unified philosophy of energy.

Whitehead's attempt to bring together the physical account of energy in nature and the physiological account of it in life and consciousness is provocative even if unrealized. His challenge still remains open, but the obstacles facing any attempt to meet it are formidable. Here a few preliminary steps may be ventured respecting the historical conditions for the emergence of a discourse of energy and its division into physical and physiological dimensions. If the historical basis of the separation is better understood it might then become possible to appreciate the nature of the difficulties facing any attempt at unification. A pivotal figure in any such consideration is Hermann von Helmholtz, one of the pioneering contributors to the invention of the concept of energy in the 19th century. Beyond its acknowledged debt to the philosophical tradition and in particular to the work of Kant, Helmholtz's work was also remarkable for its preoccupation with both physical and physiological approaches to the problem of energy. It has recently been argued most forcefully and elegantly by Peter Harman that the physical side of Helmholtz's theory of energy has precedence over the physiological, that his concept of energy is overwhelmingly a physical hypothesis. Harman's account for the precedence of physics is philosophically and scientifically sophisticated but I do not intend to scrutinize it in detail at this point. I would, however, like to reflect more generally on the validity of separating the physical and the physiological reflections of energy, especially since it is this separation that Whitehead attempted to overcome in *Nature and Life* (1934).

Some idea of what might be questionable about giving the physical discourse of energy priority over the physiological may be gained from a brief reflection upon the concept of work. If the physical definition of energy as the 'ability to do work' is translated to the physiological, then 'life' is defined as the 'ability to do work', and indeed, the assumption that to live is to do work informs modern economic, social and political institutions.[1] Yet it may be objected that such a translation from the physical to the physiological depends on the sophism of equivocation – that the term 'work' in thermodynamics is not the same as the term 'work' in wage labour. However, there are historical grounds for insisting on the univocity of the term, and that work understood in terms of the product of force, mass and distance does not differ in essence from work as the accomplishment of wage labour.[2]

The example of work is important for illustrating some of the issues facing a philosophy of energy and a genealogy of its sources. The physical account of energy forms a largely discrete tradition emerging from the theoretical reflection upon engineering problems encountered by early 19th century capitalist production. These problems involved the inefficiency – that is, the relative unproductivity – of heat engines, quite literally the steam-powered engines of the industrial revolution. The 'losses' that occurred in the transformation process of matter, heat, liquid, gas and motion that made up steam power (coal heating water to produce vapour to produce motion) stimulated a number of important reflections on the theory of heat in the early decades of the century by Carnot, Davy, Joule and Watt.[3] The emergence of the idea of the conservation of heat, in the context of a concern to minimize the loss of heat in the transformation process and thus maximize the efficiency or 'ability to work' of the steam engine, provided an important condition for its theoretical elaboration into the concept of energy in the 1840s and 1850s. The minimization of heat loss maximizes the translation of heat into mechanical motion – i.e. work – which in turn maximizes productivity and profit. Thus the work of the definition of energy emerged from the same context as industrial wage labour and is not inconsistent with the productivism of the capitalist mode of production and with the view of the body as an analogue of the engine understood above all as a vehicle for the performance of work.

It is at this point that it might be useful to point to a contrast between the context for the emergence of the physical concept of energy and the physiological perspective. The differences between them may be highlighted by their differing conceptions of heat. For the physical argument, heat signifies loss of work – energy that is not translated into motion – while for the physiological tradition, of which I will say more below, heat is identified with life. For the one, the maximization of heat is the minimization of work, while for the other it is maximization of life. The physical tradition understands heat in largely mechanical terms drawn from the context of practical engineering problems, while the physiological tradition understands it as a source of vitality, with Lavoisier, for example, working in the physiological tradition at the beginning of the 19th century, regarding heat as the 'material soul' or animating principle of life. It may not be too exaggerated to see the concept of energy as driven by these contrasting perspectives on heat.[4]

The differences between the physical and the physiological traditions may be illustrated by their interpretation of a key concept from Leibniz – *vis vita* – living or vital force. This is a concept used not only by contemporary historians of science[5] but also by the main protagonists in the invention of the concept of energy – Helmholtz, Thompson and Maxwell. It forms a part of Leibniz's dynamics where it serves as an element in his explanation of the possibility of motion. Newton answered the question of why objects move under conditions of gravity by postulating a contrary force – *vis insita* – inherent force which is then defined as *vis inertiae* or inertial force. In a cancelled insertion Newton defines this as the 'power of resisting' but none of this satisfied Leibniz who proposed instead *vis vita* as an active source of movement.[6] What was meant by this was the subject of considerable controversy – one in which the 24-year-old Immanuel Kant made his philosophical debut in 1746 with the massive *Thoughts On the True Estimation of Living Forces* (forthcoming [1746]). The purely physical understanding of *vis vita* emphasized the *vis* or force capable of resisting the tendential stasis of gravity while the vitalist understanding emphasized the *vita* or its living character.

Leibniz was very well acquainted with the physiological tradition that can be traced to Paracelsus, Telesio and Campanella in the 16th and early 17th centuries which had developed a theory of life as heat.[7] The physiological tradition inaugurated by Campanella as a modern revision of Aristotelian philosophy had an important influence upon the development of experimental and medical physiology, which nevertheless continued to identify life with heat.[8] This tradition understood heat as *vis vita* or the animating force that resisted the force of gravity, an understanding that Kant extended in his *Metaphysical Foundations of Natural Science* (1985 [1786]) – a crucial influence on Helmholtz – into the distinction between the attractive force of gravity and repulsive force, identifying the latter in the *Opus Postumum* (1993) as cosmic heat (caloric) and vital heat.

For the physical tradition, *vis vita* is a force that tends to movement, and the attrition or loss of that force – its useless expenditure – is heat (that which is neither conserved nor translated into motion or mechanical work). For the physiological tradition, *vis vita* is vital force that animates matter by means of heat – it is always conserved and never lost. From the two traditions emerged the discourse of energy or 'thermodynamics', but within it the physical tendency was dominant and the physiological recessive. It is not possible here to describe fully the development of the two sources of the concept of energy – nature and life in short – but some idea of its complexity may be gained indirectly by some comments on François Jacob's *The Logic of Life* (1973), a classic account of the history of heredity – and biology – during the 19th and 20th centuries.

In many respects the sub-text of Jacob's history of biology is the transformation of the broader physiological tradition into biology, narrowly understood as the attempt to apply physical concepts to the understanding of life.[9] The momentous force of this transformation is elegantly summarized in Jacob's description of the emergence of the biological field. Departing from the concept of *vis vita*, he explains that

> If vital force became a concept of such importance at the beginning of the nineteenth century, it was because it then played a role subsequently assumed by two new concepts. Today, living organisms are seen as the site of a triple flow of matter, energy and information. In its early days, biology was able to recognise the flow of matter, but, lacking the other two concepts, it had to postulate a special force. (1973: 95)

In many ways this statement is both rich and strange. The triple flow of matter, energy and information is in fact a single flow, matter and information being but modes of energy. The emergence of the science of biology, in other words, depends on replacing the concept of vital force with that of energy. This replacement was by no means straightforward, as Jacob goes on to show. Jacob considers three ways in which the concept of *vital force* is replaced by energy, thus underlining the complexity of the passage from one to the other. The first consists in a parallel that Jacob draws between the emergence of the concept of population in Darwin's evolutionary biology and Boltzmann's statistical thermodynamics. The parallel is suggestive, but only works if its terms are inverted: evolution tends through natural selection towards the increasing organization of a population while thermodynamics through entropy tends towards the increasing disorder of a population of molecules. Jacob's second and third routes out of physiology and its central concept of vital force point to the persistence of the concerns of the physiological tradition. The first is centrality of cell theory to 19th century biology. Jacob is unequivocal in his assessment of the significance of this development:

> With the advent of cell theory, biology was given a new foundation, since the unity of the living world was no longer based on the essence of beings, but on their common materials, composition and reproduction. (1973: 128)

The cell thus provides a molecular unit according to which all living beings can be unified – it provides a basis for the unicity of life. Yet it is not quite what it seems, since it too is situated within the triple flow mentioned above: it has a common material, its composition is governed by the laws of energy exchange and its reproduction by information (genetics).

The central figure in the elaboration of the cell doctrine was Rudolf Virchow, whose role is understated in Jacob's account of the emergence of the cell doctrine.[10] Virchow was a pathologist and a political revolutionary who, while sternly criticizing the concept of *vis vita* and its extravagant development in Romantic medicine, nevertheless remained close to the physiological tradition. He was very careful to distinguish the cell from the atom, and indeed the distinction points to the distance between the physical and the physiological traditions. For Virchow, the cell possesses properties that were not characteristic of physical atoms, properties that made it into a vital rather than a mechanical phenomenon. Jacob, however, attempts to establish the emergence of a parallel between the cell and the atom – and their sciences biology and physics – during the 19th century, claiming that

> The cell theory drew the living world closer to the inanimate world, since both were constructed on the same principle: diversity and complexity built up of combinations of simple components. The cell became a 'centre of growth' in the same way as the atom represented a 'centre of force'. (1973: 128)

The analogy that is drawn here to underline the similarities equally serves to emphasize the differences between the cell and the atom. For the parallel between 'growth' and 'force' is by no means apparent, and conjures up the ancient tension, evident in Aristotle, between motion and generation. While the parallel is intended to point to the proximity of biology and physics to the advantage of physics, it might equally work in the opposite direction, to the advantage of biology.

The first two explanations provided by Jacob for the emergence of biology out of physiology rely on parallels and analogies that are by no means self-evident. The third argument differs in so far as it addresses the revolution in scientific thinking represented by the concept of energy and points to the pivotal significance for both physics and biology of the work of Helmholtz. Jacob sums up the 19th century revolution in biology in an extremely crisp formulation: 'At the beginning of the nineteenth century, an organism expended vital force in order to perform its work of synthesis and morphogenesis; at the end of the century it consumed energy' (1973: 195). The description of the replacement of vital force by energy no longer relies on analogy, but instead focuses on the figure of Helmholtz. Jacob once more:

> There were two generalisations that brought biology nearer to physics and chemistry: the same elements compose living beings and inanimate matter; conservation of energy applies equally to events in the living and inanimate worlds. Those who, like Helmholtz, grasped the universality of these principles, drew a simple conclusion: there is no difference between the phenomena occurring in living beings and in the inanimate world. (1973: 194)

Thus Helmholtz's texts signify a point of decision respecting the nature of the 'no difference' between the physical and the vital. Is the choice simply between subordinating the vital to the physical, or the physical to the vital, or are there other possible options? Helmholtz himself tended to vacillate on this question. His seminal text from 1847 'The Conservation of Force: A Physical Memoir' reflects on *vis vita* and heat and presents itself as a physical hypothesis for physicists (1971: 3–55). The essay moves toward the reduction of vital to physical phenomena – animate bodies consume 'chemical tensional forces' and produce heat and movement. However, in a later address to the Royal Society in 1861 on 'The Application of the Law of the Conservation of Force to Organic Nature' (1971: 109–121), Helmholtz makes the parallel between the human body and a steam engine only to claim that the human body is a far better machine than a steam engine, so much so that the laws of the conservation of force demand a different understanding in the context of vital phenomena. They may not simply obey the laws of work and the efficient transformation of heat into motion (1971: 121).

In the address Helmholtz leaves open the question of the relationship of life with what was being recognized as the concept of energy. It remained so in spite of enormous advances in physics and biology until Whitehead. Since then, the theme has not been properly explored, leaving the question of the nexus of life and energy still philosophically unresolved. Perhaps this should be recognized by eliding the two terms – life/energy – and trying philosophically to understand what the implications are of their relationship without reducing one to another. It is perhaps necessary to discover a perspective on life/energy that is neither a revival of vitalism nor an endorsement of a purely physical understanding of life. This perspective can be sought first of all in a genealogy of the concepts and the recognition of their mutual tension.

Notes

1. Such a definition was central to National Socialist bio-politics and its murderous campaign against 'unproductive' life, but it remains a powerful source of values in contemporary societies.

2. The Marxist critique of wage labour is remarkably close to physical and physiological considerations. Indeed, a fascinating point of proximity between physiology and the critique of political economy can be located in Marx's critique of Feuerbach, who in the 1840s moved increasingly towards a physiological definition of matter and action.

3. See the historical accounts of the links between steam technology and the discourse of energy in Angrist and Hepler (1967) and Cardwell (1971). Smith (1998) offers a divergent perspective, focusing upon the cosmological and theological contexts of the emergence of the 'science of energy'.

4. Enrico Bellone's (2004) recent history of physics situates energy discourse as a second scientific revolution, continuous with the concerns with heat and caloric that emerged from the first. Bellone is among the few contemporary writers who attempt to describe the entirety of Helmholtz's project and to bring into proximity physical and physiological discourses; see Bellone (2004: 5–6), with its explicit acknowledgement of debt to Helmholtz.

5. Harman (1982) makes considerable use of the concept, developing a powerful argument for its exclusively physical relevance. I will try to show that it also involves other considerations drawn from the physiological tradition.

6. See Harman (1982), Chapter 3.

7. In Campanella's work this almost went so far as the identification of the sun – as source of heat and life – with divinity. See for example his most famous work, the physiological utopia *The City of the Sun*. For a statement of Campanella's physiological position see Campanella (1999).

8. Read in this context Harvey and Descartes are extremely clear examples of medical and experimental physiologists working in this tradition, Harvey with respect to his work in embryology and Descartes with his understanding of the role of the heart in the circulation of the blood. For the beginnings of a comparative analysis of Campanella and Harvey, see Brissoni (2002).

9. This perspective was anticipated by Everett Mendelsohn (1964) in *Heat and Life: The Development of the Theory of Animal Heat*:

> The whole history of biological thought can be outlined as a transition from a period when men were willing to attribute a living phenomenon to a 'vital force' to that stage when they demanded a description of the conditions and a search for the material causes of all living activities.

Jacob, however, is far more precise in identifying such conditions and causes in the discourse of energy.

10. Jacob confines his assessment of Virchow's contribution to the development of the cell doctrine to the latter's critique of Schleider and Schwann's views of the spontaneous generation of cells, a neglect paralleled in Georges Canguilhem (1965 [1953]).

References

Angrist, Stanley W. and Loren G. Hepler (1967) *Order and Chaos: Laws of Energy and Entropy*. Harmondsworth: Penguin.

Bellone, Enrico (2004) *Caos e Armonia: Storia della Physica*. Torino: UTET Libraria.

Brissoni, Armando (2002) *Il De Pulsibus nella Teoria Medica di T. Campanella*. Rome: Internation AM Edizioni.

Campanella, Tommaso (1999) *Physiologiae Compendium, Compendio di Filosofia della Natura*, ed. & trans. Germana Ernst and Paolo Ponzio. Santarcangelo: Rusconi libri.

Canguilhem, Georges (1965 [1953]) *La Connaissance de la Vie*. Paris: Vrin.

Cardwell, D.S.L. (1971) *From Watt to Clausius: The Rise of Thermodynamics in the Early Industrial Age*. London: Heinemann.

Harman, P.M. (1982) *Metaphysics and Natural Philosophy: The Problem of Substance in Classical Physics*. Hassocks/Sussex: The Harvester Press.

Helmholtz, Hermann von (1971) *Selected Writings of Hermann von Helmholtz*, ed. Russell Kahl. Middletown, CT: Wesleyan University Press.

Kant, Immanuel (forthcoming [1746]) 'Thoughts on the True Estimation of Living Forces, and Criticism of the Proofs Propounded by Herr von Leibniz and Other Mechanists in their Treatment of this Controversy, along with Some Preliminary Observations Concerning the Force of Bodies in General', in Cambridge Edition VIII, *Natural Science*, ed. H.B. Nisbet. Cambridge: Cambridge University Press.

Kant, Immanuel (1985 [1786]) *Metaphysical Foundations of Natural Science*, trans. James W. Ellington. Indianapolis, IN: Hackett Publishing Company.

Kant, Immanuel (1993) *Opus Postumum*. Cambridge: Cambridge University Press.

Mendelsohn, Everett (1964) *Heat and Life: The Development of the Theory of Animal Heat*. Cambridge, MA: Harvard University Press.

Smith, Crosbie (1998) *The Science of Energy: A Cultural History of Energy Physics in Victorian Britain*. London: Athlone.

Whitehead, Alfred North (1920) *The Concept of Nature*. Cambridge: Cambridge University Press.

Whitehead, Alfred North (1925) *Science and the Modern World*. Cambridge: Cambridge University Press.

Whitehead, Alfred North (1929) *Process and Reality*. New York: Macmillan.

Whitehead, Alfred North (1934) *Nature and Life*. Chicago: University of Chicago Press

Howard Caygill is Professor of Cultural History at Goldsmiths College, University of London. He is author of *Art of Judgment* (1989), *A Kant Dictionary* (1995), *Walter Benjamin: The Colour of Experience* (1998) and *Levinas and the Political* (2002).