— (1987) 'Studying managerial work: a critique and a proposal', *Journal of Management Studies*, 24, 3: 249–70.
Woodward, J. (1965) *Industrial Organization: Theory and Practice*, London: Oxford University Press.
Wynne, B. (1988) 'Unruly technology: practical rules, impractical discourses and public understanding', *Social Studies of Science*, 18: 147–67.
Zuboff, S. (1988) *In the Age of the Smart Machine*, New York: Basic Books.

4

Environmental and Medical Bioethics in Late Modernity: Anthony Giddens, Genetic Engineering and the Post-Modern State

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Introduction: modernity or post-modernity?

A controversial question among contemporary scholars is whether advanced industrial societies are still in modernity, or whether they are on the threshold of, or even have entered, a new post-modern order (see, for example, Bell, 1973; Lyotard, 1986: 14; Lash and Urry, 1987). In *The Consequences of Modernity* Anthony Giddens writes: 'Beyond modernity, we can perceive a new and different order, which is "post-modern", but this is quite distinct from what is at the moment called by many "post-modernity"' (Giddens, 1990: 3). However, he does recognize that there is something perceptibly different about the present, which he characterizes as 'late modernity' (or 'high modernity'), an era in which the consequences of modernity are more radicalized and globalized than before (Giddens, 1990: 3, 51).

For Giddens, the essence of modernity is its dynamism – a dynamism of such pace and scope as to be discontinuous with traditional social orders. One of the images Giddens uses to describe the dynamic experience of living in modernity is that of riding a juggernaut – 'a runaway engine of enormous power which, collectively as human beings, we can drive to some extent but which also threatens to rush out of our control and which could rend itself asunder' (Giddens, 1990: 139).

The rapid global change which is characteristic of modernity derives from the dynamism which is inherent in four key modern institutions, which are (a) capitalism, (b) industrialism, (c) surveillance and

(d) military power. The conception of the first three is substantially informed by the works of, respectively, Marx, Durkheim and Weber. Military power, the fourth characteristic institution of modernity, is an institution which, as Giddens observes, was comparatively neglected by these founding fathers of sociology. In addition to the dynamism deriving from the institutional dimensions of modernity and their inter-relations, Giddens characterizes three other dynamic sources, or 'facilitating conditions', which are 'time-space distanciation', 'disembedding mechanisms' and 'reflexivity' (Giddens, 1990: 63).

In this study we attempt to give content to some of the schematic metaphors and abstractions Giddens has written about in *The Consequences of Modernity*, by applying his typological characterization of late modernity to genetic engineering. In so doing we hope not only to test Giddens' theory of modernity, but also to elucidate a hermeneutics of the social relations of modern genetic engineering. We describe the contribution of genetic engineering to the dynamism which defines modernity, both as a major component of modern institutions and as an embodiment of each of the types of facilitating conditions which Giddens characterizes. Finally, we conclude that the process of continuous reflexivity between the proponents and opponents of modern genetic engineering is radicalizing environmental and medical bioethics. Our thesis is that this interactive socio-technical process is playing a leading role in transforming late modernity along the contours of a realizable post-modern order.

Trust and disembedding mechanisms

Symbolic tokens: nucleic acid sequence data

'Disembedding mechanisms are abstract systems which prise social relations free from the hold of specific locales, recombining them across wide time-space distances' (Giddens, 1991: 2). Giddens distinguishes two types of disembedding mechanisms – the creation of 'symbolic tokens' and the establishment of 'expert systems'. In this section we describe the creation of a symbolic token, namely, the transformation of nucleic acid molecules into dimensionless, timeless information, and the establishment of the 'bio-industrial complex' as an expert system.

Symbolic tokens are media of interchange which can be 'passed around' without regard to the specific characteristics of individuals or groups which handle them at any particular juncture, an example of which is money (Giddens, 1990: 22).

Since the elucidation of the Watson and Crick double-helix structure of DNA and the deciphering of the genetic code, the gene has been atomized and deconstructed. No longer the fundamental unit of heredity, it is now common for genes to be characterized and denoted in terms of the sequence of their nucleic acid bases. Thus rendered as pure information, the three-dimensional molecules of DNA and RNA are reduced to two-dimensional linear symbols, and transformed into 'symbolic tokens', a semiotics which constitutes the international *lingua franca* of molecular biology. Genetics as 'bioinformatics' is the information technology *par excellence*.

Nucleic acid sequence data constitute an international information system about our past, present and future, both as individuals and as a species. Illnesses, handicaps, behaviours and other qualities which, in modernity, are associated with genes are characterized as resulting from the presence or absence of genetic information (or misinformation). The various genome sequencing projects are founded upon faith that a species can be abstracted and reduced to 'pure' information.

Symbolic tokens are inherently 'globalizing'. A DNA sequence deposited in a computerized databank has the same meaning wherever and whenever it is read using the genetic code. The semiotics of genetics is a language – a social system in Luhmann's sense (Luhmann, 1986, 1989). It is a language system outside space and time, whose meaning is independent of subjectivity.

Expert systems: the bio-industrial complex

Giddens defines expert systems as 'systems of technical accomplishment or professional expertise that organize large areas of the material and social environments in which we live today' (Giddens, 1990: 27). The science of genetics is a powerful belief system in modernity which underpins a new 'expert system' which we have called the 'bio-industrial complex' (see Wheale and McNally, 1988a: Part II). The bio-industrial complex comprises new techniques, new knowledge, new systems of classification, new vocabularies, new professions and professional specializations, and new organizational structures whose systems of technical accomplishment and professional expertise are involved in, as well as conditioned by, the institutional dimensions of modernity. It is a world-wide complex of scientific expertise, technological capabilities and transnational capital accumulation operating in international markets. It interfaces with all industrial sectors including chemicals, food, agriculture, energy, resource-recovery, environmental control, healthcare and pharmaceuticals, and these in turn interface

with the military and with numerous bureaucratic agencies. This new 'technological system' (see Clark et al., 1984) is having profound effects upon our social and physical environment.

Given that no one can become an expert in more than a few small sectors of the immensely complicated knowledge systems which now exist (Giddens, 1990: 144), in a similar way to other expert systems, the products and services of the bio-industrial complex are commissioned by consumers who lack full information and who therefore must place trust in the expertise of the system. It is only because the bio-industrial complex is trusted to meet expectations that it is able to disembed social relations. Trust in the bio-industrial complex is an expression of faith in genetics as a science and technology. Thus the maintenance of the bio-industrial complex as a disembedding mechanism is dependent upon continued faith in the abstract principles of genetics.

Time-space distanciation and the four modern institutions

Time-space distanciation through recombinant DNA technology

Giddens defines 'time-space distanciation' as 'the separation of time from space and their recombination in forms which permit the precise time-space "zoning" of social life' (Giddens, 1990: 16–17). Critics of Giddens' use of 'space-time' metaphors argue that these concepts are merely notional abstractions without substance and therefore do not constitute a testable theory (Gregory, 1989; Saunders, 1989; McLennan, 1990; Urry, 1991). In this section we use recombinant DNA technology as a case study in an attempt to give content to these metaphors.

Recombinant DNA technology is a new set of *micro*genetic engineering techniques which manipulate heredity at the *molecular* level rather than at the level of whole animals and plants (see Wheale and McNally, 1988a: ch. 2). It derives its name from the fact that it recombines genetic material, thereby altering the time-space relationships of nucleic acids, mobile genetic elements, genetically engineered organisms, genomic ecosystems and ecosystems in general. *Spatial* dislocation is brought about by the manipulation of nucleic acids outside of living cells and their reinsertion into foreign cells. Genetically recombinant organisms are also *temporally* dislocated from their own genesis through somatic cell manipulation, and from their own heredity through germ-line manipulation.

Below we describe how the alternation of time-space relations in biological systems through recombinant DNA technology is involved in, as well as conditioned by, the four institutional dimensions of modernity.

(a) Capitalism

Giddens defines 'capitalism' as a system of commodity production, centred upon relations between private ownership of capital and propertyless wage labour (Giddens, 1990: 55). Proponents of recombinant DNA technology claim this new technology has the potential to satisfy world markets at competitive prices. They argue that major savings will accrue to consumers through improved efficiency and reduced prices, and from entirely new products and services. Optimistic market predictions for the products and services of the genetic engineering industry have engendered a cluster of enabling technological innovations for genetic engineering research (see Wheale and McNally, 1986). The patentability of recombinant products and processes has proved to be as powerful an economic incentive to substantial corporate investment in molecular biology as the claimed technical merit of the technology (see Wheale and McNally, 1990a: Part I).

(b) Industrialism

'Industrialism' is the use of economic resources and mechanization to produce goods (Giddens, 1990: 56). It is the transformation of nature, and the development of the 'created environment'.

Genetic engineering aims to transform nature by exploiting nature. The potential claimed for this new technology is that it can take genetic resources, tailor them and then use them to design and construct molecules, microbes, cells and organisms to meet human demands and needs. A new industry – the genetic engineering industry – is developing for the manufacture and sale of genetically manipulated organisms, cells, enzymes, vectors and genes which produce goods and perform services in scientific research, health care, the chemicals industry, the food industry, agriculture, energy, environmental control, resource recovery and for military purposes (see Wheale and McNally, 1986, 1988a).

(c) Surveillance

Surveillance is fundamental to all the types of organization associated with the rise of modernity as it is the unavoidable consequence of the attempt to attain rationalized control of information through the use of technology and the bureaucratic organization of human activities (see Giddens, 1990: 12, 59).

The knowledge constructed from research on the human genome is biometric. It comprises new measurements of population norms and deviations, information which constitutes a new system of

classification, new definitions of normal and abnormal, and new ways of distinguishing them from each other. Nucleic acid sequences are credited with providing information about our past, present and future, both as individuals and as a species. Nucleic acid sequence data lend themselves to applications which require the classification of people into groups for the purpose of institutional decision-making. Parents, police, health, education and immigration authorities, insurance firms, finance institutions and employers are each anxious to avail themselves of the new 'DNA fingerprinting', genetic screening and diagnostic technologies. Indeed, bioinformatics – computerized nucleic acid sequence information – is a burgeoning industry in its own right.

(d) Military power

'Military power' is the control of the means of violence by the nation-state and the 'industrialization of war'. The agents of biological warfare are bacteria, viruses, fungi and toxins which can be targeted at people, livestock or crops (see Wheale and McNally, 1988a: ch. 8). The rhetoric of the technological capability of recombinant DNA technology – that it is precise and controlled – has engendered the belief that it can be used to make biological weapons which are more efficacious, reliable and predictable than previously, and which potentially have a limited survival time in the environment. It is also considered to be a technology whereby one can develop vaccines against one's own biological agents. Because each of these features increases the utility of biological agents as strategic agents, recombinant DNA technology has reinstated biological weapons as a potential threat to national security, as a result of which a large amount of biological research, both classified and unclassified, funded by the military is undertaken in universities and other non-military public and private research institutions in the USA and the UK.

Reflexivity, the double hermeneutic and self-identity

Reflexivity is the 'reflexive ordering and re-ordering of social relations in the light of continual inputs of knowledge affecting the expectations and actions of individuals and groups' (Giddens, 1990: 17). Giddens describes the relation between sociology and its subject matter as the 'double hermeneutic': 'sociological knowledge spirals in and out of the universe of social life, reconstructing both itself and that universe as an integral part of that process' (Giddens, 1990: 15–16).

There are some correspondences between the Giddensian conception of sociology and the Foucauldian notion of the 'human sciences'

(Foucault, 1973, 1975). Human genetics is a 'human science' in the Foucauldian sense (see McNally, 1993). In recent years illnesses, handicaps and other traits considered to be 'undesirable' and which are considered to have a genetic basis have been constructed as a 'social problem' (the 'genetic problem') for individuals, for their families and carers, and for society.

One suggested 'solution' to the 'genetic problem' is to map and sequence the human genome in order to identify the loci which confer genetic susceptibility and develop diagnostic tests with which susceptible individuals may be identified; another is the expansion of the clinical and community genetics services which serve the reproductive population. If the human genome research 'solution' seems ambitious, the second is no less so: the Royal College of Physicians, for example, advocates the routine screening of the entire pregnant population (Royal College of Physicians, 1989).

The discourse on the 'genetic problem' and its 'solutions' not only transforms modern institutions, it alters both the objective statuses and the subjective states of individuals. As a human science, human genetics and its subject matter display the 'double hermeneutic' described by Giddens, characterized by the reflexive appropriation by lay people of expert knowledge, and their resistances to it. The double hermeneutic constitutes a further source of dynamism in modernity.

Risk and dystopian realism

The risks of recombinant DNA technology

Modernity is perceived by many thinkers to be by nature a risk culture (see, for example, Giddens, 1990, 1991; Beck, 1992). This of course does not mean that social life is *de facto* inherently more risky than it used to be. For Giddens it is the *intensity* of risk which has changed and which is the basic element in the 'menacing appearance' of the circumstances in which we live today (Giddens, 1990: 125; 1991: 3). Recombinant DNA technology engenders a new array of risks, awareness of which also transforms modern institutions.

In respect of capitalism, the perceived profitability of recombinant DNA technology in conjunction with the patentability of its products and processes has enticed transnational corporations into plant breeding, thus creating conditions conducive to economic concentration of the world's genetic resources. European Union (formerly Community) policy intended to improve the competitiveness of the biotechnology industry tends towards a form of corporatism (see Wheale and

McNally, 1993), and the patentability of biotechnological inventions could result in reduced worldwide trade and increased transaction costs, the high risk consequence of which could be the collapse of economic growth mechanisms.

In respect of industrialism, as a result of recombinant DNA technology, more organisms of novel genetic composition are being produced and introduced – accidentally and deliberately – into the environment than would ever have been possible in an equivalent period of time using conventional breeding practices. Recombinant organisms can reproduce, migrate and mutate and could become 'biogenetic pollution – a growing, moving, changing form of pollution. Recombinant DNA technology is also considered to be harmful to animal welfare. The potential of recombinant DNA technology is also considered to constitute a moral risk because of the choices and responsibilities it creates (see McNally and Wheale, 1986; Wheale and McNally, 1988a, 1988b, 1990a, 1990b; National Anti-Vivisection Society, 1987).

In respect of surveillance, there is the risk that genetic data will be detrimental to the interests of specific individuals and groups. The existence of genetic data on populations and individuals may lead to discrimination against those judged by genetic standards to be less desirable for the purposes of employment, borrowing money, immigration, reproduction, and even, in the case of prenatal diagnosis, unfit for life itself.

In respect of military power, the advent of recombinant DNA technology resurrected the military threat of biological weapons and consequently stimulated large-scale military investment on research into defences against them, and, it is alleged, on the development of offensive biological agents (Wheale and McNally, 1988a). Confidence in the ability to immunize one's own troops and civilians against biological weapons could precipitate biological warfare. The high-consequence risks of a biological war could be even more terrible than those of a nuclear war because biological weapons may replicate uncontrollably and can go on killing indefinitely.

Post-modernity 1: dystopian realism

'If we are moving into a phase of post-modernity, this means that the trajectory of social development is taking us away from the institutions of modernity towards a new and distinctive social order' (Giddens, 1990: 46).

At this point, we shall develop a 'trajectory of social development' from the above account in order to derive a glimpse of what might lie on the other side of modernity. Driven by faith in the science and technology of genetics, the four characteristic institutions of modernity are undergoing rapid transformation. Such transformation is underpinned by the expectation of social benefits – profitable products and processes, unique ways of transforming nature to meet human needs and demands, improved knowledge for the efficient bureaucratic organization of human activities, and effective methods of defence against biological weapons. However, it also engenders a new array of high-consequence risks which threaten the very existence of the four modern institutions. These high-consequence risks could result in the end of capitalism through the collapse of economic growth mechanisms; the end of industrialism through ecological decay or disaster; the end of surveillance through the growth of totalitarian power; and the end of military power as a result of large-scale warfare. Each of these would mean, in Giddens' terms, the end of modernity, and the start of a dystopian post-modern order. 'On the other side of modernity ... there could be nothing but a "republic of insects and grass", or a cluster of damaged and traumatized human social communities ... Apocalypse has become trite, so familiar of day-to-day life: yet like all parameters of risk, it can become real' (Giddens, 1990: 173).

Thus 'dystopian realism' predicts a post-modern order in which the characteristic dynamism of modernity is ended through the realization of the high-consequence risks of modernity. However, the above characterization of modernity, which largely identifies faith in science and technology as the source of modern dynamism, is incomplete. In the remaining sections we shall undertake a further consideration of 'reflexivity' as a source of dynamism and consider its potential, through 'utopian realism', to generate an alternative 'trajectory of social development' which could lead to a utopian, rather than dystopian, post-modern order.

Reflexivity and utopian realism

Reflexivity, trust and risk-assessment

Modern genetic engineers are often surprised by the lack of public trust in the safety and morality of their endeavours, and, in general, are dismayed by the extent to which they are called upon to justify their experiments and innovations (see Krimsky, 1982; Gershon, 1983). In this section, we attempt to explain how the loss of trust is a consequence of a combination of the perception of risk and reflexivity.

While acknowledging that reflexivity is a defining characteristic of all human action (Giddens, 1990: 36), Giddens argues that it has taken

on a different character in modernity. In modernity, intellectuals have become increasingly cognizant of the ungrounded nature of scientific epistemology and the contingency of scientific knowledge (Lakatos and Musgrave, 1970; Mulkay, 1979; Barnes and Edge, 1982). This is having the effect of reducing the status of scientific communications. If faith in the epistemology used by the expert system declines, then the public's trust in it cannot be sustained and the future of the expert system itself is jeopardized.

Let us take, for example, risk-assessment. Alongside the expectation that abstract systems will provide certain social benefits, there is an awareness that they engender risks. Trust in abstract systems includes trust that they are able to assess such risks. Risk-assessment is a future-oriented activity which requires the calculation of 'harm' and the calculation of the 'probability' that such harm will arise (see McNally and Wheale, 1991; Wheale and McNally, 1993). When there is a loss of faith in the epistemology which underpins *all* science-based knowledge claims, the public no longer trusts expert systems to apprise it of the risks of technology because it knows that the theory underpinning the identification and measurement of harm and the likelihood of its occurrence is under-determined, and therefore, unknowable. 'Widespread lay knowledge of modern risk environments and awareness of the limits of expertise accurately to assess risk constitutes one of the "public relations" problems that has to be faced by those who seek to sustain lay trust in expert systems' (Giddens, 1990: 130).

Social movements: the bioethics expert system

According to Giddens, social movements have an important role in the process of representative democracy. Social movements can be superimposed on the four institutional dimensions of modernity. Labour movements are associated with the development of unionism as a defence against the controlling power of capitalism. Free speech and democratic movements champion political participation and attempt to counter the surveillance of individuals and the bureaucratic operations of the modern state. Peace movements struggle against state control of the means of violence by both the military and the police, while ecological movements have as their site of struggle the 'created environment' (Giddens, 1990: 159–61).

Modern genetic engineering occupies a pivotal position in the institutions of late modernity as it is implicated in virtually every major debate preoccupying modern society, including control of reproduction, law and order, worker health and safety, discrimination, consumer safety, environmental pollution, and warfare.

Since its advent, recombinant DNA technology has stimulated the proliferation of social movements which articulate what they consider to be the unacceptable risks of this new technology. Their formation is a consequence of the inherent reflexivity of modernity which generates a loss of faith in the science and technology of genetics, which in turn undermines trust that the bio-industrial complex will produce expected benefits and will accurately assess risk.

In modernity it is recognized that scientific truth-claims are contingent and do not, of themselves, provide a method for discriminating between competing values. Consequently, sectional interests which rely on the traditional authority of science can now be challenged with greater conviction by alternative knowledge claims such as 'alternative medicine', 'alternative food' and 'green consumerism'. Reflexivity also manifests itself in the appropriation of technical expertise by lay agents as part of their routine dealings with abstract systems (Giddens, 1990: 144). Consequently, rather than being lay recipients, the various counter-culture movements also wield technical expertise and constitute a new set of expert systems which define themselves as defenders of the public interest from the risks of capitalism, industrialism, surveillance and military power. In respect of genetic engineering, we have called this set of expert systems the 'bioethical expert system'. Clustered around the four institutional dimensions of modernity, the social movements of the bioethics expert system argue for the protection of workers, consumers, the environment and animal welfare, the safeguarding of civil liberties, freedom from the threat of biological weaponry, equitable distribution of the world's genetic resources, and sustainable development as proposed by the Brundtland Report (World Commission on Environment and Development, 1987).

At the same time as technical expertise is being appropriated by ethical expert systems, the converse is also happening: sectional interest groups which have traditionally relied on the legitimacy of science are attempting to regain the moral high ground from their critics by transparently appropriating their value-based arguments, and using them to support (and shape) their enterprises. The result is that the conflict of different knowledge claims and the reflexive appropriation and re-appropriation of knowledge between technical and ethical expert systems are salient features of late modernity (Lyotard, 1986; Giddens, 1990). The creation of a 'counter-culture' has produced a dialectic, reflexive rather than materialist, in late modernity.

In the next section we describe how the reflexive dialectic of the bio-industrial complex and the bioethics expert system is generating the contours of a realizable utopian post-modern order.

Post-modernity 2: utopian realism

If dynamism is constitutive of modernity, then, paradoxically, the end of modernity is the end of dynamism. As we described above, one realizable end to modernity is dystopia following the collapse of economic growth mechanisms, ecological disaster, the growth of totalitarian power or large-scale warfare.

An alternative end to modernity would be if the dynamism of the institutional dimensions of modernity were to be limited through utopian transformations which replaced capitalism with a post-scarcity system, industrialism with humanized technology, surveillance with multi-layered democratic participation, and military power with demilitarization.

The question then is how to 'harness the juggernaut, or at least direct it in such a way as to minimize the dangers and maximize the opportunities which modernity offers to us?' (Giddens, 1990: 151). 'What is needed', suggests Giddens, 'is the creation of models of *utopian realism*' (Giddens, 1990: 154). The argument is that the alternative futures envisaged through utopian realism can transform the future because their very propagation might help them to be realized.

Key players in the creation of models of utopian realism are the social movements, which, Giddens claims, are able to provide us with glimpses of possible futures and are in some part vehicles for their realization (Giddens, 1990: 161). It is they who criticize what they perceive to be unacceptable risks and lobby for alternative institutional formations. And in the reflexive dialectic, as this discourse is appropriated and re-appropriated by other expert systems, the pace and scope of the dynamism of modern institutions in the present is directed towards more utopian futures. This process can be illustrated using examples of how the radical bioethics dialectic is limiting the scope of the 'facilitating conditions' discussed above:

- The potential for time-space distanciation has been curtailed by regulations which prohibit certain forms of genetic recombination which are considered to present 'unacceptable' risks.
- Expert systems which embody bioethical values are being established by the state, for example, recombinant DNA advisory committees, animal experimentation and farm animal welfare committees, and environmental risk-assessment committees. Such expert systems are often formally empowered to restrict the activities of other expert systems, for example, the activities of the bio-industrial complex.

- The dynamic potential of nucleic acid sequence data as symbolic tokens has been reduced by a successful challenge to their reliability as forensic evidence.

The imposition of limits on the dynamic potential of facilitating conditions has the effect of reducing the dynamism of modern institutions. In addition to altering the pace of change, such limits also alter the scope of future transformations, by guiding them away from high risk contours. One example would be the 'greening of biotechnology' whereby, as a result of the appropriation of the aims of the bioethical expert system, the enterprises of the bioindustrial complex are being redefined as solutions to the high-consequence environmental risks of modernity (see, for example, Bishop, 1990). While the motivation for this reflexive appropriation is regarded with some cynicism, this new discourse on biotechnology as sustainable development generates different expectations of the bio-industrial complex, which in turn transform modern institutions, guiding them towards a more utopian future.

In summary, Giddens' idealized typology of modernity and its consequences takes us to the point where social movements are making guidelines for the future transformation of modern institutions, guidelines which define the contours of a post-modern order. Our application of this typology to modern genetic engineering indicates that it is at the heart of an interactive socio-technical process which could transform the four institutions of modernity along the contours of a realizable utopian post-modern order.

Genetic engineering in the post-modern order

In *The Consequences of Modernity* Giddens provides a persuasive ideal typology of the nature of late modernity together with an explanation of how the 'juggernaut-like' experience of living through it is a consequence of the dynamic processes which are intrinsic to modernity. In this study our purpose has been to undertake a substantive test of Giddens' schematic metaphors and to use his descriptive and explanatory framework as a heuristic device with which to conceptualize the social relations of genetics and genetic engineering. For the purposes of this analysis we have accepted Giddens' definition of the distinction between modernity and post-modernity, that is, modernity is characterized by an unprecedented scope and pace of change, while the post-modern order would be defined by an end to modernity's dynamic character.

Two explanatory variables emerge from this exploration of Giddens' account of dynamism in modernity. Firstly, the importance of conceptualizations of science and technology to modern dynamism. For example, the construction of nucleic acid sequence data as symbolic tokens, the establishment of the bio-industrial complex as an expert system, and the maintenance of the expectation that recombinant DNA technology alters the time-space relationships of living agents in socially beneficial ways, are each based on faith in genetics as a science and a technology. The diffusion of recombinant DNA technology into the four key institutions of modernity both transforms them and engenders risks, the ultimate outcome of which could be the realization of a dystopian post-modern order.

The second major source of explanation of the dynamism of modernity in Giddens' analysis derives from 'reflexivity'. In one sense, reflexivity is used to explain the dynamic nature of both the social and self-identity in modernity as ideas about the self and knowledge of social norms reflexively constitute and reconstitute each other in the 'double hermeneutic'. In another sense, reflexivity is linked to the loss of faith in genetics as a science and a technology, a loss of faith which undermines trust in the bio-industrial complex to deliver social benefits and accurately to assess risks, and which stimulates the formation of social movements – the bioethics expert system – which can successfully challenge the legitimacy of the bio-industrial complex.

The above duality – dynamism deriving from science and technology on the one hand, and from reflexivity on the other – is congruent with Giddens' 'structuration theory' in which he attempts to synthesize deterministic theories, which see human agency as being shaped by structural forms, with voluntaristic theories, which see reality as the product of human agency (Giddens, 1979; see also Clegg, 1989: 138–48; Bryant and Jary, 1991). Overall, we are inclined to conclude that the balance of Giddens' analysis of late modernity is voluntaristic: technology derives its dynamism from the *expectations* that it will produce benefits, and that dynamism is constrained when loss of *faith* in scientific epistemology undermines *trust* in expert systems and symbolic tokens. In other words, it is the perception of the human agent which confers or constrains the dynamic potential of science and technology. That said, in the final event science and technology may be the ultimate shaping power: the high-consequence risks of genetic engineering can be realized and, as Giddens states, Apocalypse can become real (Giddens, 1990: 173).

To conclude on a more optimistic note. Openly embracing the idea of utopias as necessary to the constitution of preferable post-modern futures, Giddens argues that given the counterfactual character of modernity, 'a rigid division between "realistic" and utopian thought is uncalled for' (Giddens, 1990: 155; see also Smart, 1993: 106). The utopian prescriptions or anticipations which restrict modernity's endlessly open character and which could lead to a utopian post-modern order are the result of human agency. As Heller and Feher argue: 'The association of Utopia with unfeasibility is completely unjustifiable' (Heller and Feher, 1988: 35). The reflexive dialectic between the bioethics expert system and the bio-industrial complex could result in the imposition of limits on the pace and scope of the dynamism of modern institutions, resulting in their transformation along the contours of a future realizable utopian (rather than dystopian) post-modern order.

References

Barnes, Barry and Edge, David (1982) *Science in Context*, Milton Keynes: Open University Press.

Beck, Ulrich (1992) *The Risk Society: Towards a New Modernity*, London: Sage.

Bell, Daniel (1973) *The Coming of Post-Industrial Society: a Venture in Forecasting*, New York: Basic Books.

Bishop, David (1990) 'Genetically engineered insecticides: the development of environmentally acceptable alternatives to chemical insecticides', in Peter R. Wheale and Ruth McNally (eds), *The Bio-Revolution: Cornucopia or Pandora's Box?*, London: Pluto, pp. 115–34.

Bryant, Christopher G. A. and Jary, David (eds) (1991) *Giddens' Theory of Structuration*, London: Routledge.

Clark, John et al. (1984) 'Long waves, inventions, and innovations', in Christopher Freeman (ed.), *Long Waves in the World Economy*, London: Frances Pinter, pp. 63–77.

Clegg, Stewart R. (1989) *Frameworks of Power*, London: Sage.

Foucault, Michel (1973) *The Order of Things: an Archaeology of the Human Sciences*, New York: Vintage.

— (1975) *The Birth of the Clinic*, New York: Vintage.

Gershon, Elliott S. (1983) 'Should science be stopped? The case of recombinant DNA research', *Public Interest*, 71: 3–16.

Giddens, Anthony (1979) *Central Problems in Social Theory*, London: Macmillan – now Palgrave.

— (1990) *The Consequences of Modernity*, Cambridge: Polity Press.

— (1991) *Modernity and Self-Identity*, Cambridge: Polity Press.

Gregory, David (1989) 'Presences and absences: time-space relations and structuration theory', in David Held and John B. Thompson (eds), *Social Theory of Modern Societies: Anthony Giddens and his Critics*, Cambridge: Cambridge University Press, pp. 185–214.

Heller, Agnes and Feher, Ferenc (1988) *The Postmodern Political Condition*, Cambridge: Polity Press.

Krimsky, Sheldon (1982) *Genetic Alchemy: the Social History of the Recombinant DNA Controversy*, Cambridge, MA: MIT Press.

Lakatos, Imre and Musgrave, Alan (eds) (1970) *Criticism and the Growth of Knowledge*, Cambridge: Cambridge University Press.
Lash, Scott and Urry, John (1987) *The End of Organised Capitalism*, Cambridge: Polity Press.
Luhmann, Niklas (1986) 'The autopoiesis of social systems', in R. Felix Geyer and Johannes van der Zouen (eds), *Sociocybernetic Paradoxes: Observation, Control and Evolution of Self-Steering Systems*, London: Sage, pp. 171–92.
— (1989) 'Law as a social system', *Northwestern University Law Review*, 83: 136–50.
Lyotard, Jean-François (1986) *The Post-Modern Condition: a Report on Knowledge*, Manchester: Manchester University Press.
McLennan, Gregor (1990) 'The temporal and the temporizing in structuration theory', in Jon Clark, Celia Modgil and Sohan Modgil (eds), *Anthony Giddens: Consensus and Controversy*, London: Falmer Press, pp. 131–39.
McNally, Ruth (1993) 'A Foucauldian analysis of abortion for foetal handicap', unpublished MA dissertation, Brunel University.
McNally, Ruth and Wheale, Peter R. (1986) 'Recombinant DNA technology: reassessing the risks', *Science, Technology and Society Association Newsletter*, 25: 56–69.
— (1991) *The Environmental Consequences of Genetically Engineered Viral Vaccines*, Brussels: Commission of the European Communities, DG XI, Contract No. B6614/89/91.
Mulkay, Michael J. (1979) *Science and the Sociology of Knowledge*, London: Allen and Unwin.
National Anti-Vivisection Society (1987) *Bio-Hazard*, London: National Anti-Vivisection Society.
Royal College of Physicians (1989) *Prenatal Diagnosis and Genetic Screening: Community and Service Implications*, London: Royal College of Physicians.
Saunders, Paul (1989) 'Space, urbanism and the created environment', in David Held and John B. Thompson (eds), *Social Theory of Modern Societies: Anthony Giddens and his Critics*, Cambridge: Cambridge University Press, pp. 215–34.
Smart, Barry (1993) *Postmodernity*, London: Routledge.
Urry, John (1991) 'Time and space in Giddens' social theory', in Christopher G. A. Bryant and David Jary (eds), *Giddens' Theory of Structuration*, London: Routledge, pp. 160–75.
Wheale, Peter R. and McNally, Ruth (1986) 'Patent trend analysis: the case of microgenetic engineering', *Futures*, 18: 638–57.
— (1988a) *Genetic Engineering: Catastrophe or Utopia*? London: Wheatsheaf.
— (1988b) 'Technology assessment of a gene therapy', *Project Appraisal*, 3: 199–204.
— (eds) (1990a) *The Bio-Revolution: Cornucopia or Pandora's Box*? London: Pluto.
— (1990b) 'Genetic engineering and environmental protection: a framework for regulatory evaluation', *Project Appraisal*, 5: 23–37.
Wheale, Peter R. and McNally, Ruth (1993) 'Biotechnology policy in Europe: a critical evaluation', *Science and Public Policy*, 20: 261–79.
World Commission on Environment and Development (1987) *Our Common Future (The Brundtland Report)*, Oxford: Oxford University Press.

Part III
Self-Identity, Late Modernity and Globalization