Chapter 3

Wicked Problems and Evil Empires: positivism, complexity and the origins of an information society

The preceding chapters have outlined the information infrastructure of the current form of globalisation on one hand and the institutional infrastructure of the nation state on the other. Both of these determine the space in which developing countries can develop their responses to their global context, alignment between them is necessary for coherent and inclusive development. These issues will be further developed in the remainder of Part I and this chapter looks at the historical origins of the communication technologies central to the current mode of globalisation, and the underlying positivist assumptions about technology and development.

The influence of modernism and related theory from architecture and planning on current implementations of physical infrastructure, urban development and industrialisation is described. A view of complex systems that engages the social complexities which undermine determinist projects is introduced.

As argued in Chapter 2, the information and communication technologies underpinning the current mode of globalisation are not the first spatially significant technologies. Headrick (1981) demonstrates the key role of technologies ranging from transportation to medical prophylaxis in the extension of the influence and sovereignty of the European powers and the globalisation of their model of the nation state. Chapter 1 and 2 examined how continued developments in technology and economic scale have led to the internationalisation of economic activity and to the emergence of consequences beyond the capacity of individual states to manage. The emergence of trans-national corporations (TNCs) and the internationalisation of both financial and labour markets have created a rapidly evolving world system. Currently this is characterised by progressive integration at a world scale. Camilleri and Falk (1992) argue

that power and authority have become diffused with national states participating in a variety of multilateral arrangements covering not just trade, production and finance but also increasingly inter-related environmental and security issues. Paradoxically, the model of nation state central to international relationships is both undermined and constrained by the commitments, explicit and implicit, created by such international ties.

The previous chapters examined how the imperatives of an emerging global market have led developed economies to shift their focus towards the end of the production chain where product differentiation and customer support can maintain demand for goods and services. This has provided an opportunity for the inclusion of new contributors whose capabilities lie at other points in the production and consumption chain. However, segregation and exclusion are producing an unevenness of development both within and between economies and this unevenness impacts on regions, communities and individuals. Whether such exclusion is socially or geographically based, it threatens the prospects of achieving economic development which is environmentally or socially sustainable. Natural resources exploited by external actors may be developed in order to deliver high extraction rates at low cost rather than longer term sustainable exploitation. With human resources, skill-bases may be developed to serve the external priorities of imported capital, instead of around a more balanced strategy for the development of a host economy[1].

Two issues raised so far merit further consideration. The first is the scepticism of newly industrialising countries engaged in catching up with the dominant established economies. Governments are unwilling to adhere to higher standards than those applied to their competitors when they were at the same stage of development, but by ignoring improvements in practice they run the risk of undermining their own longer-term interests. The second issue is the partial nature of an allegedly "global" system. A significant proportion of humanity is excluded from both the catch-up process itself and the policy making processes which determine the nature of the emerging global production system. In Chapter 5 it will be argued that imminent shifts in the information and communication infrastructure offer a window of opportunity for players marginalised by the status quo to make a meaningful contribution to the social shaping of an emerging techno-economic paradigm. This chapter traces the origins of the framework which currently underpins that paradigm.

Engines of Development: Modernism in Architecture and Planning

The roots of the determinism implicit in modernism in architecture and planning, its relationship to "scientific management", and its influence on the design of the physical infrastructure and the information infrastructure of the global system are central to the thesis of this book. The application of a pre-war modernist project to post-World War II reconstruction, coincided with developments in information technology which ultimately transformed the range of spatial configurations available to organisations. Urban studies and organisation research have both been influenced by general systems theory. This influence is critical to both definitions of modernism, and to developments underpinning post modernism.

In the last quarter of the twentieth century post modernism appeared as both a reactionary and progressive influence. Esher (1981) talks of British post-war reconstruction as a "broken wave". In architecture and planning post-modernism first gained ground, paradoxically because of its critical continuity with modernist sentiment in terms of the democratisation of design and the claims to a shared understanding of aesthetic and technical expression between designers and users. However, the critique of the inadequacies of modernism in architecture and planning voiced by Venturi (1966) foreshadows the narrowly stylistic interpretation of post-modernism that followed.

During the same period, however, new definitions of community in urban theory emerged which challenged the determinist assumptions of the modern movement in architecture and planning and which voiced the concerns of those whose space for action was being determined by design professionals. Participative design (Cross, 1972) was advanced as the means to overcome the deficiencies of the implementation of the modernist project.

International Style - Global Intent

The International Style, in the form of the Bauhaus aesthetic, stood for the determination of form by machine production, yet the archetypes promoted through international publications were in fact hand crafted prototypes, at some remove from the reality of mass-produced products in the marketplace (Banham, 1960). The Soviet constructivist movement demonstrated the greatest gulf between aspiration and available infrastructure in its attempt to create built forms to support the socialist transformation of society (Kopp, 1970).

In constructing a retrospective narrative of modernism the architectural historian Nicholas Pevsner (1949) included designers such as Eric

Mendelsohn, firmly rooted in German expressionism, and Charles Annesley Voysey from the British Arts and Crafts movement in the Modernist pantheon. This indicates a post-priori justification of modernism in Darwinian terms as the climax of design evolution. Venturi (1966), echoing Sir John Summerson, argues that the programmatic approach of modernists tends to stake a claim for architecture rather than produce architecture. Subsequently a new narrative has relocated individuals such as James Stirling or Isozaki Arata and sub-movements such as Brutalism, or Metabolism, to take European and Japanese examples respectively, from late modernism to early post-modernism. This indicates that a similar process of justification operated in the nineteen-seventies and eighties as post-modernism began to be identified retrospectively in architecture and design (e.g. Jencks, 1989).

As Banham (1969) and Russell (1981) demonstrate, there were tangible technical, social, and economic pressures influencing the development of planning and construction during these periods, but not in the physically deterministic fashion assumed by the promoters of modernism.

Banham (1960) argues that technical and aesthetic innovations were not strongly coupled in the period that saw the emergence of the modern or international style. The most innovative buildings technically were often aesthetically conservative while aesthetic innovations, pursued through technically obsolescent means, were presented as demonstrations of a technical determinism in which form followed function.

Globalisation was implicit in the modernist agenda. In 1927 the French architect and polemicist Le Corbusier advocated a world wide internal temperature standard of 18 degrees Celsius (Corbusier, 1946). In the United States, the engineer, Richard Buckminster Fuller proposed the global distribution of factory-built prefabricated houses by airship.

In a comprehensive study of the development and implementation of the concept of industrialised building, Russell (1981) demonstrates that large-scale convergence of social and technical forces were needed to bring about substantial changes in design and construction practice. The availability of pre-war and wartime innovation, coupled with relative labour shortages and a government sponsored policy of increased capitalisation in the building industry produced a coincidence of interest during the nineteen-fifties and sixties which led to large scale industrialised building programmes in the U.K. and elsewhere. The drive towards standardised volume production also led to the direct application of information and communication technologies in the form of computer aided design (Little, 1988).

Russell (1981) provides a detailed analysis of the dynamics of the discourse within the technical design community and their institutional clients. These led to what generally became regarded as massive social and

technical failures. By the late nineteen-sixties large scale social housing projects were being cited as examples of spectacular systems failure (e.g. Webber, 1968). These perceptions prompted the crisis of confidence from which post-modernism emerged as a dominant architectural aesthetic.

The modern movement architects were happy to pursue the detail of design down to the micro level. A striking example is the design of St Catherine's College, Oxford by the Danish architect Arne Jacobsen. His interpretation of an Oxford college was designed down to the furniture in the students' study-bedrooms, and the cutlery used at High Table. At the more mundane level the design standards for U.K. public housing from the nineteen-sixties to eighties were articulated in design manuals portraying, hour by hour, the "typical" day in a household (Roberts, 1991). Specific items of furniture had to be indicated in each room of a house plan to qualify it for housing subsidy. The standard itself, originating in a 1961 report (Parker Morris Committee, 1961), did not reflect subsequent social and technical developments which affecting space usage. For example, the diffusion of domestic freezers during the seventies was ignored. Instead the presence of a radiogram, a key aspiration of the fifties, was preserved in every living room until the abandonment of the design standard in the early nineteen-eighties.

The detailed implications of this level of attention are examined in Part II. It is worth noting both the totalising approach and the heavily gendered understanding of domestic labour institutionalised in the design of domestic architecture. This totalising view of human activity was derived from the technocratic sensibility which is examined below.

The critique of the modernist narrative was a partial and selective one, from within the determinist framework. Biased towards physical implementations rather than underlying social drivers, it focussed on the interests of the design professions. By the nineteen-eighties, in the U.K., for example, high rise housing became unacceptable all circumstances, low rise housing was an unalloyed public good, regardless of socio-economic context. Two decades earlier the established wisdom was that sufficient accommodation to replace unfit low rise housing could only be provided by high rise construction. Neither set of assumptions had any basis in reality. To go beyond such simplifications it is necessary to look at the origins of the positivist view of technology and design implicit in a form of modernism, both mandated by government policy and funding regulations and supported by public discourse.

Beyond physical spaces: Technology, Technocracy and Modernism

The output of the modern movement in architecture and planning was physically obvious. The equivalent discourse in the design and development of organisations and institutions produced less tangible but equally significant outcomes. It is therefore worth tracing the origin of the corresponding philosophy in management and administration.

Weber's definition of bureaucracy is regarded as a major underpinning of modernism in organisation theory and sociology[2]. The claim to superiority over traditional forms of authority and control made by bureaucracy was based on the notion of a rational means of evaluation of individuals and their capabilities. The scientific management movement which arose in the first half of the twentieth century built upon this understanding of rationality. This generated a positivist narrative which underpinned both the rapid advances in management and production of the Second World War and the Cold War period. Climaxing with Robert MacNamara's incumbency as U.S. Secretary of State this period was one of rational analysis of quantified data, placing scientific management at the centre of national survival.

The foundations for the "military-industrial complex" identified by US President Dwight Eisenhower in his farewell address (Eisenhower, 1961) were laid in the period leading up to World War II. Rearmament, mobilisation and the associated managerial methods formed the basis of those used in the Cold War. The strategic distribution of production during the war laid the basis for post-war policies of "complementarity" in which production resources were both distributed and replicated (Little and Grieco 2003), and the same logic of distribution of production applied to the subsequent period of nuclear confrontation.

The modern movement in architecture had been articulated during the inter-war depression, but implemented on a large scale in the renewed activity of post-world war reconstruction. The U.S. military-industrial complex is a product of the impact of World War II and the Cold War on science and technology policy, but it too reflects a pre-war technocratic sensibility. This had been given a formal expression in the political flux immediately before the implementation of the Roosevelt administration's "New Deal" programme. A Technocrat Movement rose to short-lived national prominence in the United States on a political programme of technical rationality. The Movement aimed to place engineers in charge of all facets of society, claiming that the economy would prosper in the hands of engineers. Developing Veblen's (1904) conception of the role of technical workers, the Technocrat Movement adopted energy consumption

as a single unifying metric through which the rational management of economy and society could be achieved.

Ultimately, according to Akin (1977), the movement withered precisely because its narrow technicism precluded the formulation of a programme of political action. The Technocrat agenda lost momentum in the face of the success of the New Deal, but the Second World War gave an added impetus to the underlying view that any problem, however complex was amenable to quantitative analysis, provided that analysis was sufficiently sophisticated.

The continuity of technocracy pre and post World War II needs to be emphasised. Belief in the power of technical rationality to deal with almost any economic or social problem has proved enduring. It received reinforcement through the comparative success of the New Deal policies in the U.S. and the successful application of new management techniques during the Second World War. The rapid advances in military and other technologies ensured a continuing acceptance of such views in the post-war period. One former Technocrat Society member, the engineer Richard Buckminster Fuller, mentioned earlier in connection with the aerial delivery of standardised housing, promoted the original Technocrat principles up to the end of the nineteen-sixties. As noted, the career of Robert MacNamara, narrated by Halberstam (1971), offers a paradigm of this post-war flowering of technocratic consciousness. MacNamara's career in the automotive industry, government and the World Bank reflects the movement of these sensibilities from industry to governance and to development.

It could be argued that Cold War strategy elevated technocracy above democracy. Chalmers Johnson's study of post-war Japan illustrates the continuity of personnel between the post-War Ministry of International Trade and Industry (MITI) and the pre-war technocrats of the administration of Manchukuo, Japanese occupied Manchuria (Johnson, 1983). U.S. influenced constitutions were imposed on Japan and Germany, but the former Japanese colonies of Taiwan and South Korea benefited primarily from the attention of US advice in technical development and productive capacity with democratic development coming only late in the Cold War period.

Cold War Traces: Information Systems and Surveillance

The information and communication technologies facilitating the global distribution of Western models of production were created in the same wartime and post-war milieu. However, the continuity of Cold War

concerns for secrecy with wartime security meant that the narrative of this crucial period of development was determined without reference to some key components. In particular, the wartime creation by British code-breakers of the Colossus electronic computer used to calculate settings on the German Enigma encryption machines was left out of the narrative of the introduction of computer-based information systems to governance and commerce.

The work was only revealed fully by the publication of F.W. Winterbotham's 'The Ultra Secret' in 1974. In the following decades a number of documentary and fictional accounts of the work undertaken by the Government Codes and Cypher School (GCCS) appeared, providing the basis for a revisionist narrative of World War II. These accounts contradicted many assumptions implicit in the established view of a British victory based around Churchillian "Blood toil sweat and tears" plus the judicious use of operations research techniques. Instead it was revealed that at key points in the war allied commanders had access to German high command orders before their intended recipients, via the use of captured or purloined Enigma coding machines and the computational analysis of intercepted signals traffic.

Alan Turing, a key figure in assembling the core team, was cast as the central heroic and eccentric genius. In the best British tradition, fictionalised accounts of the work of Turing and his colleagues emphasised a small group of boffins in a remote country house and the documentary accounts of survivors of the key groups at Bletchley Park tell of inspirational breakthroughs by individuals and small teams. However, the Taylorist organisation for the volume production of information from a vast range of intercepted messages contradicts the carefully cultivated image of lonely genius and individual inspiration. Much of the site, fifty miles north of London, is still covered by temporary and permanent buildings occupied by the 8,000 workers, many female, who made use of state-of-the-art business data processing technologies in the form of Hollerith tabulators and card indexes. The creation of massive databases of signals traffic and the development of increasingly sophisticated traffic analysis techniques, not the discovery of the content of individual messages, led to many of the significant results produced.

By the time work of Bletchley Park became public, Turing's fame had already been established by his early specification for a generalised computational machine (Turing 1936/7) and as the "father" of artificial intelligence through his formulation of a test to determine whether a machine was exhibiting intelligence[3].

The post-war deployment of computer-based information systems in commercial organisations diffused a particular model of strategic and

operational management. Individuals who passed through Bletchley Park played a leading role in the post-war development of electronic computing, both at Manchester University in Britain and in the MIT Whirlwind project in the U.S. The sharing of intelligence and knowledge between the U.K. and the U.S. meant that with the destruction of the British records, the reconstruction of the Colossus computer, the star exhibit of the Bletchley Park museum, was expedited by archival information only available from U.S. Sources (Sale, 1998).

By the time the gaps finally were filled in the U.K.'s wartime narrative, however, a history of electronic computing had been constructed from U.S.-based activities, including a range of successor projects to the secret British efforts. Ironically, despite the close relationship of these activities to defence in general and the U.S. nuclear weapons programme in particular, these had long been in the public realm[4].

In the U.K. Churchill had ordered the physical destruction of key equipment and files at Bletchley Park on the cessation of hostilities in 1945, effectively concealing the wartime contribution of code breaking. However, the Government Communications Headquarters (GCHQ) was established in 1946 as the post-war successor of the Government Code and Cipher School. In the U.S. the Signals Intelligence Service, based in Arlington Hall, Virginia, and comparable in its origins to GCCS re-emerged in 1952 as the National Security Agency (NSA).

Bamford (1983) provides a history of the NSA which characterises its Cold War resource levels as computer capacity measured by the acre. According to its website[5], the NSA is currently the second largest user of electrical power in Maryland with an annual bill in excess of $21 million.

A range of significant innovations in computational capability followed from the capacity required by both code breakers and the developers of nuclear weapons. York's narrative of the post-Manhattan project technologies and politics (York, 1976) was noted above. During and after the Cold War the NSA led significant initiatives in the development of computing. It promoted joint development with IBM of second generation general computers with features such as the high speed tape drives, prominent in every nineteen-sixties movie featuring computers. They also sponsored the first Cray supercomputers and in 1990 established a Special Processing laboratory for in-house fabrication of highly specialised micro-electronic devices.

Innovations such as finite element analysis in engineering calculation and the related practice of constructing production aircraft without physical prototypes (Sabbagh, 1995) as well as the mathematical modelling which allows "in-silico" pharmaceutical development all make use of massive

computational power first developed either for code breaking or for the mathematical simulation of nuclear explosions.

Technocracy, Systems and Solutions

The confluence of scientific and military resources and the effect on the wider arena of technical design is a major theme of Part II. The continuing role of the signals intelligence community at the cutting-edge of computing developments in the post-war period has ensured that the information economy emerged in step with the surveillance state.

In the U.K. the post-war reactivation of GCHQ, was closely followed by civilian scientific and commercial applications of electronic computers. The Lyons Electronic Office (LEO) implemented the key concepts of management information systems at a stroke. However the low profile of Bletchley Park allowed an alternative narrative to be constructed. As recently as December 2000, John King of the University of Michigan provided a key note address to the International Conference for Information Systems in Brisbane which traced the post-war history of commercial computing with no mention of the critical LEO innovations (King, 2000).

The established narrative is a Cold War one, leading from the SAGE[6] real-time system developed for aircraft interception, to the critical innovation of the SABER real-time airline reservation system. This was as much the key to affordable mass air travel as the wide bodied jet and, disintermediated through the Internet, real-time booking systems remain the core technology of budget airlines.

The Cold War ARPANet origins of the Internet are well known[7], as are the survivability and web characteristics which were in part a response to the physical vulnerability of the SAGE system. The computer centres of this system were located at Strategic Air Command (SAC) bomber-bases, prime targets for any enemy nuclear strike. Allegedly this was for staffing reasons since, under General Curtis Lemay, SAC had secured the best quality officers' facilities, in the U.S. military and SAGE relied on the attentions of highly skilled and highly sought after technical personnel.

At end of the Cold War the NSA's mission statement[8] distinguished between external foreign signals intelligence and “classified and unclassified national security systems” In the post 9/11 environment, the civil dimension is represented by a separate Information Systems Security Organization (ISSO)[9]. The NSA promoted their own “Clipper” encryption chip as the answer to commercial security problems on the information superhighway[10].

Joint development and commercial programmes provide a direct link between military and diplomatic concerns and the world of commerce. Despite measuring its computing resources in acreage, the NSA outsources data processing to commercial organisations such as TRW, also a major credit data agency, as illustrated in the nineteen-eighties film "The Falcon and the Snowman" (see also Bamford, 1983). Yet another link between military and commercial projects is through technique. The continued refinement of signals traffic analysis has led to the emergence of what Roger Clarke (1989) terms "dataveillance" in which sets of data collected for a variety of disparate purposes can be processed to reveal unanticipated information and associations. Both governments and private organisations like TRW are able to assemble revealing pictures of organisations and individuals through the correlation of individually trivial data. In the nineteen-eighties Clarke campaigned against the introduction of a national identity card - the "Australia Card" - on these grounds. Again, in the post-9/11 environment fresh demands for the introduction of electronic identity cards for citizens are being made in the U.K. and elsewhere.

At the workplace level, equivalent electronic surveillance has been described in a Japanese electronics factory, where data derived from production equipment was used to discipline work teams (Sewell and Wilkinson, 1992, see Chapter 4). Such coercive practices are now an accepted part of the call-centre economy. The electronic version of the panopticon (Foucault, 1979) involves constant monitoring of workers, consumers and customers.

Technocracy offers a deceptively simple solution to the cultural problems which a globalising economy presents. Rather than responding to local needs, variety of response is replaced by a range of top-down standard solution which can be promotes as technologically ordained.

Systems analysis became synonymous with technicist initiatives in the nineteen-fifties and sixties. The general systems theory perspective on which it is based provides a relatively rigorous framework in which to advance the claims of modernity. However, the same perspective can also expose the partiality and post-constructed nature of the modern movement in architectural design and the closed-system logic of its axioms

General systems theory emerged in the nineteen-forties, as a means of comprehensive explanation in the natural sciences. The formulation of a general systems theory by von Bertalanffy (1950) provided a hierarchy of levels, each providing the environment for the subsystems on the level below, and the notion that internal differentiation reflects the complexity of transactions across the boundaries between systems.

A determinist and literal reading of general systems theory is reflected in the first generation design methods and theories that emerged in

engineering and design during the nineteen-fifties. These attempted normative explanation of optimum design practices and procedures. They enjoyed acceptance among practitioners because they utilised familiar and straightforward techniques, such as the check-list.

Scott (1987, 1992) classifies the evolution of all the major strands of organisation theory as a progression of increasing sophistication from a closed rational systems view associated with classical management theory to an emergent open natural systems view, closer to von Bertalanffy's position.

The natural systems view incorporates the perspective of the human relation school of management theory which accounted for the complexity of the behaviour of human actors within their system view, in contrast to the rational systems view that regarded job titles and descriptions as the determinants and predictors of behaviour. However, the classic Hawthorne studies encapsulating this approach (Roethlisburger and Dickson, 1939) and which first theorised informal relationships within the workplace remain controversial. The findings suggested that worker behaviour reflected the manipulation of the physical environment of the plant, without reference to the external, hostile economic environment. There were lay-offs and redundancies taking place during the studies[11].

Contingency theory (Lawrence and Lorsch, 1967) most clearly reflects the open systems view by relating the internal state of an organisation to the environment with which it has to interact and the means of that interaction..

"Wicked Problems"

Post-modernism can be characterised by a move away from hierarchical determinist structures and the unified rationality of a single metric as exemplified by first generation design methods.

The type of strictly hierarchical decomposition derived from classical general systems theory was incorporated in first generation design methods, typified by Alexander (1964). Alexander himself quickly modified this approach through the use of semi-lattice networks to account for the rich and subtle social and physical interactions he associates with "natural" as opposed to "artificial" cities (Alexander, 1965). There exists a critical lag in the diffusion of his ideas, however, such that even Alexander's revision of his original position has yet to reach many of those influenced by him and who utilise his work. Venturi (1966) also argues for "complexity and contradiction" in his early formulation of what was soon to became post modernist architecture. However, Goodman (1972) argues that complexity

is acknowledged only through physical appearance in what remains a traditional architectural approach, the design process itself is not modified.

In contrast, Rittel and Webber typify the second generation of design methods in that they forsake a simplistic view of systems theory. Rittel and Webber (1973) tackle the context of complex design decision making head on. They argue that they are responding to growing dissatisfaction with the performance of professionals among their clients, particularly the "general public" despite an apparent growth in professionalism, training and qualification, and the development of an increasing range of supporting technologies.

By the early seventies the American and European public were becoming more vocal and discerning, but the classic professional approach to decision-making was seen as increasingly ill-suited to "conceptions of interacting open systems" and "contemporary concerns with equity". Ten distinguishing properties of "wicked problems" were identified by Rittel and Webber:

> 1: There is no definitive formulation of a wicked problem
> 2: Wicked problems have no stopping rule
> 3: Solutions to wicked problems are not true-or-false but good-or-bad
> 4: There is no immediate and no ultimate test of a solution to a wicked problem
> 5: Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
> 6: Wicked problems do not have an enumerable (or exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
> 7: Every wicked problem is essentially unique
> 8: Every wicked problem can be considered to be a symptom of another problem.
> 9: The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.
> 10: The planner has no right to be wrong
> (Rittel and Webber pp.161-166)

These properties take the problem space beyond Simon's formulation of bounded rationality (Simon, 1969). Jones (1980) points out, in support of Simon's notion of satisficing, that a ten component system with ten alternatives for each component has a solution space of 10^{10} configurations, but in Rittel and Webber's formulation, the system boundaries will always be subject to re-formulation and the introduction of more or different variables.

The first and second properties acknowledge the complexity of solutions to wicked problem and the difficulty of consensus among those affected by them.

The third and fourth argue that the evaluation of wicked problems is ultimately a question of judgement.

The fifth, sixth and seventh properties indicate why formal decision support systems have met with limited success at strategic planning levels.

The eighth property: each problem existing as a symptom of another problem, reflects the interconnectedness implied by a systems framework for the task of modern technical design (e.g. Jones, 1980). Treatment of a wicked problem in isolation implies the risk of suboptimization within the larger system context.

The ninth property is suggestive of a post-modern frame: the selection of a particular framework of analysis or explanation is seen as a significant determinant of acceptable outcomes. Rittel subsequently produced the concept of an "issue-based information system" as the vehicle for providing a second generation systems approach to planning decisions, by allowing the implications of differing viewpoints to be incorporated into the analysis of a problem (Rittel, 1982).

The tenth property indicated that, unlike a Popperian scientist who can be satisfied with the disconfirmation of a hypothesis, the prescriptive planner could not regard the falsification of premises as a useful outcome. Action research may be viewed as one response to a commitment to deliver some resolution for the designer's client (e.g. Clark, 1972), and the first generation of design research in the nineteen-fifties and sixties led many designers to view practice as a form of research with the experience of each project being utilised in its successors. Even here, however, the fifth and seventh properties question the value of past experience. The modernist project of universal rational design and development systems is severely compromised when analysed with this framework.

Conflicting formulations of planning, design and development

In 1970 Chris Jones both summarised the first generation of design methodologies from the fifties and sixties, and opened the debate on the nature of second generation methods which was to occupy much of the seventies (Jones, 1980). He applied a general systems theory hierarchy to open up design decision making to community and political levels of discussion above the traditional arena of the technical core. This represented a generally non-determinist reading of systems theory, but, as explained above, the determinist strand from the Technocrat Movement had

survived the second world war and flourished in post-war conditions. Indeed, the conflict had enhanced the reputation of quantitative analysis and numerical decision-making methods. Thus, the mundane but significant applications of operations research at a technical level were elevated to the glamour of the strategic arena and a post-war generation of managers typified by Robert MacNamara attempted to solve "wicked" problems with rational, numerical methods (Halberstam, 1971).

A paradox emerges: general system theory in the hands of Jones (1980) is used to reveal the limited, deterministic frame of traditional technical decisions in the face of more complex socio-technical design problems, while in other hands applications of general systems theory ultimately supported a resurgence of technocratic, de-politicising assaults on modernist assumptions of social equity. For example, Forrester (1969) argues for the elimination of poor peoples' housing as a component of urban economic revival, the poorer inhabitants simply decamp across the system boundary to another town with less "enlightened" policies, and the real estate they vacated becomes available for inward investment and industrial development[12].

In systems thinking the devil is on the boundaries and where they are drawn defines what is inside and outside the system under consideration. Unfortunately Forrester's argument that complex systems require counter-intuitive responses has led to, among other things, decisions leading to the destruction of British mining communities in the nineteen-eighties, Chilean democracy in the nineteen-seventies and Vietnamese villages in the nineteen-sixties. Weather patterns, nuclear explosions or complex engineering structures may be amenable to such a deterministic approach to mathematical modelling, but political and economic systems are not.

A pluralist view is inherent in Rittel and Webber's check-list of criteria for wicked problems, and pluralism was a focus of nineteen-seventies concerns in planning and development. Goodman (1972) mounts a sustained critique of the values concealed by the implementation of both modernist and emergent post-modernist planning and design practices. A range of participative design and advocacy planning concepts emerged as an alternative. Design participation generally left ultimate control with the professionals, and shared the strengths and weaknesses of the socio-technical systems approach to job design. Advocacy planning corresponded in many ways to the substitution of markets for hierarchies emerging in organisation theory during this period (Williamson, 1975). Marketplace rhetoric neglects the issue of ability to participate and to voice concerns meaningfully. Participation and advocacy in such limited forms have in effect de-politicised issues such as housing provision and employment

opportunity which have been among traditional working class political demands by moving decision making into a technocratic framework.

Paradoxically planning in the nineteen-seventies and eighties also saw the promotion of the key features of a deterministic modernism under the guise of critiques of modernism. Oscar Newman (1973) and Alice Coleman (1985) combine elements of behaviourism with environmental psychology and perceptual modelling in the service of the political status quo. They focus on a behaviourist interpretation of the physical characteristics of the built environment, suppressing discussion of underlying social relations through the use of a non-political "scientific" discourse. Newman however, takes time to berate post-war planners for attempting to create social diversity, arguing that strict separation of classes and land-use was the only means of arresting urban decline through the creation of defensible socially homogeneous enclaves. Jencks (1989) compares such "New Right" positions with Marxian critiques to demonstrate the collapse of the previous modernist consensus.

The reallocation of key modernist components to the post-modernist canon, noted above, suggest that the change from modernism to post-modernism is a Kuhnian paradigm shift (Kuhn, 1962), wherein existing marginal evidence becomes central to the new thesis. Just as categories of artefacts such as Brutalist architecture were shifted from late modern to post modern canon, so individual architects substituted neo-classical post modern forms via for the modernist aesthetic they had previously embraced. In the U.K. an intermediate "neo-vernacular" style was briefly associated with the aesthetic conservatism of clients of the welfare state empowered through process-oriented participative design methods. It also accommodated the process-oriented Long Life, Low Energy, Loose Fit design strategies prompted by the energy crisis of the mid nineteen-seventies. However, these genuine innovations and the style itself were swamped by the High-tech aesthetic which appeared in response to the subsequent economic upturn, where, just as in the nineteen-twenties, the image of high-technology construction was pursued in preference to any serious concern for resource consumption over the lifetime of buildings.

It is significant that both modernism and post-modernism in architecture and planning were formulated at the bottom of an economic cycle. Implementation took place in the subsequent upturn, to a programme established in the absence of direct practical experience and constraints. Even more marked transformations can be seen in a journal such as Architectural Design. Following a change in ownership in 1976 serious examination of process-oriented technical innovation was replaced by purely stylistic exercises. When changing economic circumstance led to a direct economic as well as "moral" threat to the standing of the professions

involved, ranks were closed and a traditional, physically-oriented view of design reclaimed the centre of architectural discourse.

Modernism, post modernism and information systems design

By the end of the twentieth century the domains of information systems design and physical design had coalesced. Systems analysis provides the instantiation of general system theory in a form suitable for city planning, warfare or information systems development. Cost-Benefit Analysis was promoted as the means to compare complex variables on the basis of an equivalent to Technocracy's energy metric: in this case a financial bottom line. As computer-based information systems have become ever more pervasive, there has been a differentiation of technical skills into information systems development, software engineering, and computer science, in rough analogy to planning, architecture, and building science in urban construction.

In information systems the role of the systems analyst is analogous to that of the architect. The social support requirements of users must be interpreted into technical requirements for system implementation by the software engineers who apply principles derived from computer science. Information systems are the most socially embedded technical artefacts. Galbraith (1977) first indicated how the task of information systems design inevitably involved organisation design, since the consequent organisational changes could only be regarded as effects, not side-effects.

The socio-technical systems approach which originated in work carried out in the U.K. in the late 1940s and early 1950s supports this view of the social formation of technology and the influence of technology on organisations. Research into new work methods industry looked at the social consequences of changes in work methods (Trist and Bamforth, 1951). This work represented a significant change from the view that the introduction of technology was a neutral process leading to predictable outcomes. These views saw technology as determining these outcomes. However, the subsequent notion of social shaping of technology (Mackenzie and Wacjman, 1995) led to a position in which technical outcomes were determined by social actions. This collection of studies into the development of technologies ranging from military equipment to consumer durables demonstrate the predominance of human intention, over technical constraints.

Mumford and Wier (1979) bring socio-technical systems to information systems design and Checkland (1981) defines the concept of soft systems, each an attempt to incorporate a broader social component in design

considerations. The "Multiview" approach (Wood-Harper et al, 1985) is a conscious attempt at an eclectic use of available methods in the early stages of design, but reverts to the established "life-cycle" sequence for the technical phase of design and implementation. Multiview 2 (Avison et al 1998) adheres more closely to the "garbage can" approach to decision-making (Cohen et al, 1972) by retaining a choice of perspectives throughout the design process.

While Goodman (1972) condemns the asocial nature of post-modernist historicism, there is an analogy with emerging software engineering techniques supporting information systems development. Alexander, having started out with a direct application of systems decomposition to architectural design, eventually turned to a radical conservatism in which buildings were designed on site, drawing on a range of pre-existing and socially significant design elements (Alexander, 1977; 1979).

Object-oriented development techniques are intended to allow pre-existing modules of computer code to be readily re-used. The aim is to improve reliability and economy by developing a library of tried and tested components over a range of projects. In this respect they mirror the intention of Alexander's "pattern language".

Rapid prototyping and other so-called fourth generation information systems design technologies have raised the prospect of "end-user computing" becoming a genuinely post-modern design methodology, driven by users in their own terms. However, by incorporating both social and technical elements, actor-network theory provides a seamless representation of socio-technical systems.

Actor-network theory can be traced to work in the area of social studies of science (Latour and Woolgar 1979) and of the study of technical innovation. The actor network itself is a heterogenous network of actors and interests that may include people, organisations, standards and artifacts. Callon and Latour (1992) coin the term "actant" to cover both human and non-human "actors". Their treatment of people and machines as equivalent may seem simply a deliberate provocation and an attempt to court notoriety.

"Quasi-objects" are introduced by Latour to express the influence of social processes and collective understanding on certain classes of constructed object. The "black box" is a key term in general systems theory. It is applied to a sub-system which is modelled in terms of its inputs from and its outputs to the larger system while its internal processes are not the immediate subject of investigation. Latour uses the term to imply that an element of the network may incorporate a set of conditions and decisions that have in effect been concealed within the box. These decisions determine the behaviour of the "black box" within the larger

system. In this sense the behaviour of the box can exhibit the intentionally of those who contributed to its design yet at the same time conceal it.

Technocracy and Development

This chapter traces the origins of a philosophy which drove technological development during much of the twentieth century. It links the emergence of computer-based information systems with the theoretical underpinnings of modernism and bureaucracy and provides a definition of "wicked problems" not amenable to solution through the positivist assumptions of hierarchical models of design and development.

The technocratic focus of the first generations of design methods has been softened by the inclusion of social considerations of both design and use of artefacts and systems. However, a hard technocratic view still influences the design of both technologies and the organisations which are increasingly dependent upon them.

Approaches such as actor-network theory offer an equal role for the social and technical components of systems, and the opportunities provided by such views of design are examined in Part III. Chapter 4 raises issues of space, place and identity for communities and individuals seeking alternative understandings of a globalising system.

Notes

1 Both Headrick (1981) and Dicken, (1998) provide a historical perspective for such patterns of development.
2 See for example Beetham (1985), Clegg (1990), Elwell, (1999).
3 Turing's famous test for machine intelligence (Turing 1950) initially speculated on the ability to distinguish between male and female respondents via teletype communication, and only then discussed a human versus machine distinction, the gender blindness of most accounts of Bletchley Park is intriguing. For example, it was a low ranking Wren who alerted the Admiralty to an imminent sortie by the battle-cruiser Scharnhorst on the basis of signals traffic analysis on Christmas Eve 1942, allowing its destruction.
4 See York (1976) for a detailed account of this programme in the relevant period.
5 http://www.nsa.gov
6 The Semi-Autonomous Ground Environment pioneered real-time control of interceptor aircraft supported by fault-tolerant dual computer systems
7 ARPANet was eventually splint into the secure Milnet and the public Internet.

8 available at http://www.nsa.gov/about_nsa/mission.html
9 See http://www.nsa.gov/isso/bao/index.htm
10 The Enigma machine, the focus of the attentions of Bletchley Park was itself originally a commercial product touted at pre-war trade shows and used by German state railways for commercial communications, as well a by the German Wehrmacht. In effect the NSA is returning technologies distantly descended from a German commercial patent to the world of business. In this context it is not surprising that there are claims that the U.S. signals intelligence community has from time to time acted in support of U.S. commercial interests through the interception of foreign business communications (European Parliament, 2001).
11 See Parsons (1974) and Gillespie (1991) for two analyses of these studies conducted decades after the original observations.
12 Edwards (2000) provides a sympathetic account of Forrester's work and its context.