8
Innovative Dialogue

Two kinds of innovation

Sometimes one hears over-simple distinctions made between high technology and supposedly more appropriate forms. The point usually is that appropriate technology is employed to serve human needs directly, whilst high technology is concerned with high performance and complexity for its own sake; it is motivated by prestige and virtuosity, and seems sometimes only to produce 'toys' for scientists or politicians (p. 113).

Something of this view has been implied by previous pages, but as a warning against taking such distinctions too far, this chapter classifies technology in a different way. It links together real toys produced at the level of appropriate technology (figure 9) and techniques which are certainly concerned with basic needs, but which have all the complexity and sophistication of high technology (figure 8). The diagrams themselves are symbolic.

My concern in coupling together these sharply different examples of innovation – toy automobiles and a futuristic power plant – is to pursue a paradox left unresolved by the previous chapter. Modern technology is nothing if not innovative, yet bureaucracy – especially if it is any sense 'totalitarian' – would hardly seem to provide the right atmosphere for original, inventive thinking. Given the growth of bureaucracy in the modern world, how is it that innovation continues to flourish?

One answer is that a wide range of innovations arise outside bureaucratic institutions – which is partly where figures 8 and 9 come in. Another answer, though, is that some forms of innovative development do prosper within a bureaucratic context. Where institutions seem to have a restrictive effect, or individuals are narrowly single-minded, few radically new ideas may arise, but there can still be impressive and sustained improvements in established techniques. Modifications to equipment can be built up on one another in a systematic, logical way, conforming with the linear view of technological development. And with large resources devoted to research and development, this approach will undoubtedly get results. Wernher von Braun's work on rockets is a classic example.

By contrast, though, it is often pointed out that many of the most significant new ideas in technology have come from small firms and even from individuals working on their own, such as Chester Carlson (inventor of xerography) and Christopher Cockerell (the hovercraft). Certainly, the lone inventor will often need the resources of a large firm to turn invention into marketable innovation, but the key point is that his initial creativity worked best outside bureaucratic limits. It has similarly been argued that the most creative phase in space technology and nuclear energy was characterized by a stimulating interaction between enthusiastic individuals. As the large institutions which manage these technologies grew more bureaucratic, the most enterprising inventors 'were driven out', according to Freeman Dyson. In rocketry and space research, 'professionals have never been willing to give a fair chance to radically new ideas',[1] and several possibilities for inexpensive space vehicles have been neglected by the big bureaucracies. Similarly, in the nuclear energy industry, Dyson claims that opportunities for safer and cleaner nuclear power plant have been, in effect, suppressed. Several unconventional reactor designs 'disappeared and with them any chance of . . . radical improvement beyond our existing systems'.

The discoveries about the structure of matter which made nuclear reactors possible also led indirectly to the invention of the photovoltaic cell, which is capable of turning solar energy into electricity. But as Anthony Tucker points out, it was inevitable that nuclear power received greater attention during the next few war-stricken years. 'What was not inevitable . . . was the way the imbalance created by war became institutionalized.' That did happen, however, with the consequence that we have seen a linear development of nuclear energy systems, and a relative neglect of photovoltaic technology. Even as a power source for artificial satellites, where solar energy has great advantages, the technique was neglected for a time; during the 1960s, NASA spent twenty times more on developing nuclear devices for this purpose than on solar cells.[2]

In a rather similar way, it has often been argued that the institutional structure of automobile manufacture has led to a linear development based on internal combustion engines, and a neglect of alternatives such as electric vehicles or cars with Stirling engines.

In Britain, the behaviour of some nationalized industries in relation to technology has tended towards the totalitarian model, while others have seemed more open and responsive. Among the latter, the National Coal Board (NCB) has pioneered highly efficient coal-burning boiler plant based on the concept of fluidized bed combustion. In response to trade union pressure for better safety standards, it has developed new mine machinery whose performance has earned some export successes as well as use in British mines. And responding to the needs of a city council, the NCB has helped develop a district heating scheme at Nottingham which actually burns garbage as fuel, with only relatively small quantities of coal. Thus the NCB has been innovative on several fronts, partly as a result of fruitful interaction with other organizations.

By contrast, the Central Electricity Generating Board (CEGB) has been very resistant to innovations marginal to its main interests. It has pursued a linear development of very large power plants linked together by one of the world's largest grid systems. This has allowed electricity production to be optimized using high-performance turbines operated in 'merit order', but at the cost of inefficiency in consumption of primary energy, and arguably a neglect of responsibilities regarding pollution (and especially 'acid rain'[3]).

For a different approach to these issues, one may turn to the Midlands Electricity Board, whose business is chiefly to sell power drawn from the CEGB national grid rather than to generate electricity on its own account. However, it branched out in 1980 by building a small power plant of its own at Hereford. This uses the principle of cogeneration, whereby reject heat from electricity production generates the steam and hot water required to run processes in two nearby factories. This system is common in Europe and the United States, but has been discouraged by the CEGB. In its version of the idea, Midlands Electricity has demonstrated that small, flexible schemes can be more economical than the conventional wisdom assumes, especially if diesel generators are used. Looking to the future, when oil may become scarce or costly, an outline of other options envisages using coal, with a liquefaction process (figure 8). Solid residues from this could then be combined with garbage in fueling a fluidized bed boiler to supplement the heat output. The diagram shows a supply of crushed limestone to the

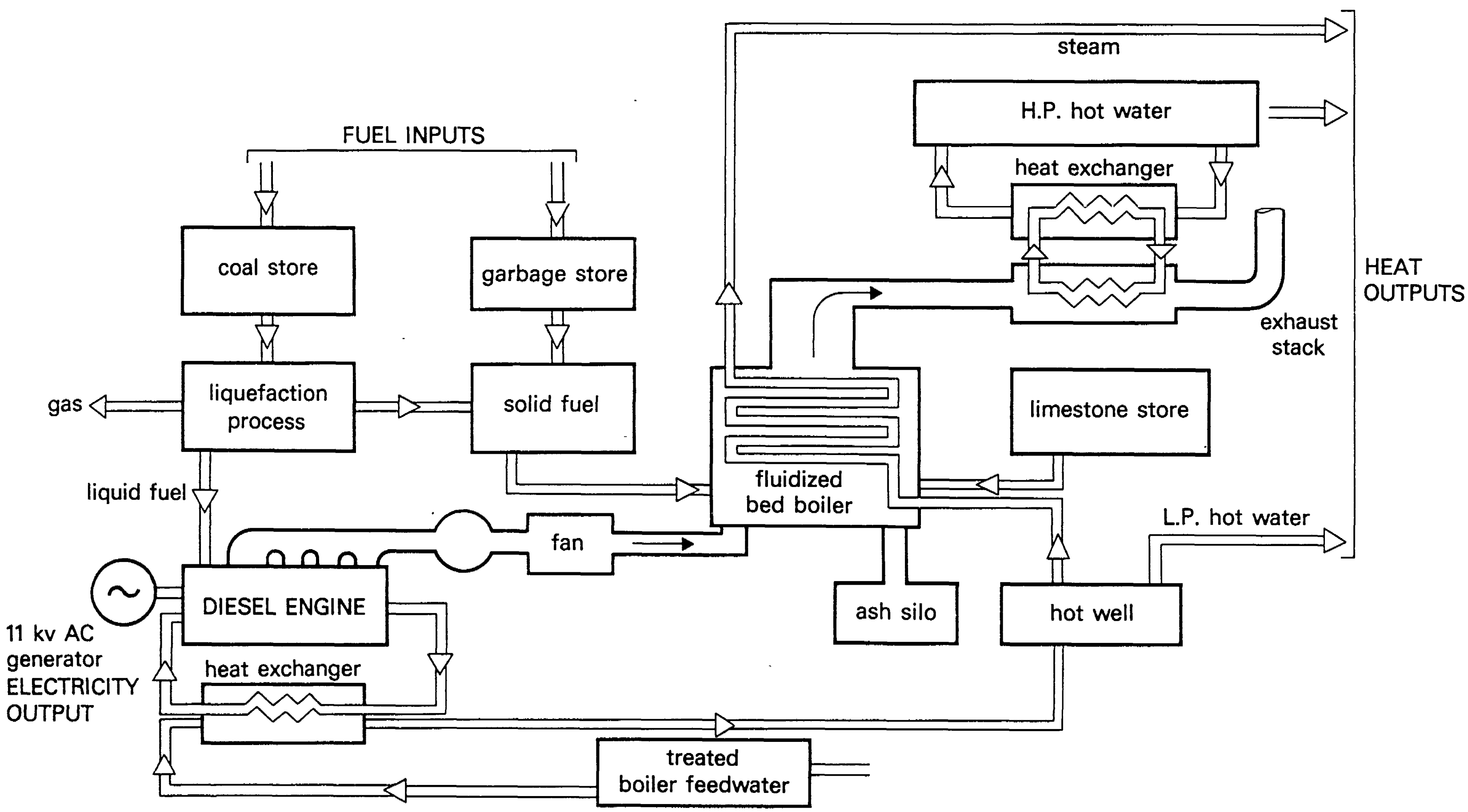

FIGURE 8 *Interactive innovation as it might occur in the future development of cogeneration (or combined heat and power): a diagram indicating long-term options opened up by the Midlands Electricity Board's work*

Source: G. T. Shepherd, 'Combined heat and power', paper given to the Parliamentary Liaison Group for Alternative Energy Strategies, House of Commons, London, 17 March 1980.

fluidized bed to ensure that the sulphur content of the fuel is retained in the ash rather than causing atmospheric pollution.

Figure 8 also shows how a flexible interaction with customers' energy requirements is possible; the plant can be designed to supply heat to factories in the form of steam, pressurized (HP) hot water at a high temperature, and/or low pressure (LP) hot water at temperatures suitable for central heating. Thus the concept developed by Midlands Electricity is capable of flexible development in response to customer demands and environmental constraints. Such responsiveness may, indeed, be said to carry the idea of a dialectical approach into a practical context.

Flexibility of this sort is exactly what the big bureaucracies are bad at, and the example shows what initiatives may be taken by a regional Board which has close contact with its customers. Yet it is still sometimes suggested that the British electricity industry should be further centralized. It is said that government policy would be more readily formulated if the industry spoke with a single voice. But this is the very reverse of what is required. If there is to be a real dialectic on the policy level, we need 'multiple voices', and 'multiple public views'.[4]

When it comes to the development of renewable energy, there has again been little response in Britain to what customers can use, or what British firms might sell. Almost the only official interest has been in prospects for large-scale electricity production by the CEGB. Thus while the Japanese are selling small wave-powered devices for powering lamps in lighthouses and navigation buoys, and while firms such as Lockheed, General Electric, and Saab-Scania are developing commercial wind-energy machines, the British government's chief scientific adviser on energy has reportedly dismissed any similar research with the comment that 'any fool can build a windmill'. What interests him is real engineering, and what the CEGB wants is only large-scale power. This is a virtuosity-oriented attitude if ever there was one, and as a British commentator observed: 'We have a history of vaulting post-war engineering ambition combined with poor manufacturing sense'.[5]

Thus the smaller and more realistic wind and wave-power systems have joined the long list of commercial opportunities that Britain has missed, along with the manufacture of plant for cogeneration (where there are good export markets). In such branches of technology, it is easy to feel that there has been a fairly systematic suppression of innovation in Britain. But it is not only public bodies that are guilty of this. Many instances have been documented from private industry where suggestions made by freelance designers or trade unions have been rejected partly because the ideas do not come through the proper bureaucratic channels. Examples include designs for heat pumps, aircraft passenger seating, washing machines, and telephone equipment, many of which were displayed in London's Design Centre in October 1981. Other instances relate to a new type of replacement valve for use in heart surgery, and a novel petrol-electric road vehicle.[6] All these innovations, rejected by British companies within the last decade, have been taken up by firms in Germany, Italy, Japan or America.

British ineptitude in dealing with novel design or unorthodox invention compares sharply with sustained British progress in a few narrowly defined areas of high technology, such as the design of military aircraft and of very large power stations. The contrast brings out clearly that two kinds of innovation are involved: large bureaucracies, I have already argued, tend to be good at *linear innovation* along established paths. But there is also the quite different type of innovation which bureaucracies tend to suppress and which much of British industry discourages. This depends on the imagination of the creative individual, on interaction among enthusiastic scientists or technicians, and often on interaction between experts and users, designers and potential clients. I shall refer to this as *interactive innovation*.

Cultural exchanges

Sometimes interactive innovation originates in specialist enthusiasm and the exchange of technical information. Sometimes, however, conflicts of values are also involved, and innovation can be seen as the outcome of a dialectic such as the previous chapter described. Transactions at all these levels are most clearly seen in the technological relationships between markedly different cultures: between Japan and Europe, for example, or in western technical assistance to Africa. In some instances, techniques and equipment are simply transferred to a new cultural setting and an attempt is made to impose them where they do not fit. In other instances, however, an innovative process occurs, and techniques or tools are transformed by being incorporated into the recipient culture.

When white men first penetrated into the arctic areas of North America, they were few in number and needed to learn from local people the techniques of shelter, clothing, hunting and travel that were essential for survival in a harsh environment. Thus when white men introduced new equipment – notably firearms – and began to trade industrial products for fox furs and beaver pelts, there was a two-way exchange of technical information with the local Dene (Indian) people, and later with the Eskimos. Local people were not suddenly overwhelmed by the new culture, but were often able to make organizational innovations at their own pace in order to fit the hunting of fur-bearing animals and the associated use of guns and new traps into an evolving lifestyle. The process continued through the last century into this, and as we have seen, it has extended to the point where snowmobiles became part of the local scene. It would be quite wrong to regard this as an idyll, or free of the exploitation that goes with commercial development, but it is also wrong to ignore the positive aspect: many communities were able to incorporate imported technology into their culture by a process of interactive innovation. Thus, in order to use snowmobiles efficiently, Dene and Eskimo people had to invent servicing and maintenance procedures suited to local conditions, where were more rigorous than the designers of the machines had envisaged (chapter 1); they had to adopt a new approach to planning their journeys relative to fuel supplies and the crossing of frozen lakes in seasons when a vehicle heavier than a dog-sledge might not always be secure.

Meanwhile, white men learned in a more technically-oriented way from local experience of the strength of ice alloys, and from Eskimo protective clothing. The latter included waterproof garments for use when fishing from kayaks, and slit goggles or visors to give protection from the glare of sun on water or ice. Their usual winter clothing had better insulating properties than that used by many arctic explorers, even now. Evidence that Europeans have learned from this is provided by the word anorak, which has passed into English from the Greenland Eskimo language.

Those who have studied the specialized environmental knowledge possessed by non-European peoples are sometimes tempted to misrepresent it. One author, referring to arctic clothing, described the Eskimos as 'the great pioneers of micro-climatological bioengineering'. This is inappropriate, because Eskimos clearly do not work with engineering concepts. Theirs is a form of craft knowledge, based on craft technology, and the rather ugly term indigenous technical knowledge (ITK) has served better in recent publications to describe what is involved.[7]

Such compromise as may once have existed in the Arctic between white man, Dene and Eskimo has been damaged in recent decades by a decline in the fur trade, by military radar construction work, and by oil drilling. In Canada's Mackenzie Valley, many of the most critical issues came to a head when oil and gas companies proposed to build a gas pipeline along the valley and southwards into the United States. The Canadian government appointed a judge, Thomas Berger, to conduct an inquiry into the wider implications of the pipeline, and the careful way in which he exposed the conflicts of values involved is a model of its kind. Firstly, he pointed to the (virtuosity-oriented) 'frontier values' of the dominant North American civilization; then there were the values of the existing Dene and Eskimo populations, who saw the Arctic as their homeland, and who feared the social impact and damage to hunting that the pipeline might bring. Need-oriented values were part of this, but more than that, there was a sense of identification with the land as a source of identity as well as of subsistence. Finally, there were the nature-conserving 'values of the wilderness' held by many of the white community who wished to protect the wildlife and the unspoiled beauty of the landscape.[8]

One argument which Judge Berger had to face was that the traditional lifestyle was already dying because of the acquisition by local people of modern rifles and snowmobiles. This had led some observers to argue that local people were willingly committing themselves to the cosmopolitan, technology-based lifestyle, and thus to pipelines and the oil industry. Judge Berger's report, however, explains how there is a very important continuing reliance upon traditional resources. Indeed, without modern equipment, including rifles and snowmobiles, local people would find it 'virtually impossible to continue their traditional land-based subsistence activities'. In some instances, this was because government pressure had caused them to settle in villages far removed from their traditional hunting grounds, so they needed snowmobiles for transport.

'The evidence heard at the Inquiry has led me to conclude that the selective adoption of items of western technology by the Dene and the Inuit [Eskimo] is, in fact, one of the most important means by which they continue to maintain their traditional way of life. These items . . . have become *part of the life* that native people value.' The words which I have italicized here express very precisely two aspects of this kind of interactive innovation. Selective adoption is followed by innovation in the organizational dimension so that new techniques become part of a way of life. This was well illustrated by the organizational changes which the introduction of the snowmobile entailed, but if we use the word interaction to describe this, we should bear in mind how one-sided the process was. Individuals interacted with machines and invented new systems, but few manufacturers have taken note and modified their products to meet local needs.

This is a familiar difficulty in other parts of the world as well. In 1977, a survey of US corporations with branch factories in Africa, Asia, or Latin America commented on how loath they were to put funds and engineering effort into changing product designs to suit local conditions.[9] All the same, some Third World communities do succeed in transforming imported technology to meet their needs, and despite many failures, there has sometimes been effective organizational innovation enabling pumps, tractors and new crops to be incorporated into local cultures.

However, interactive innovation is not always restricted to organization. Sometimes hardware is produced. Sometimes also innovations appear whose significance is chiefly symbolic. Among the latter are the wire toys made all over southern Africa (figure 9). They reflect a local craft tradition, in that African coppersmiths have for centuries produced wire to make bracelets and ornaments – archaeologists have found the draw-plates and other wire-making tools.[10] But these toys adapt wire to the representation of automobiles, often with discarded lids from screw-top jars as wheels, and so represent an innovative response to imported technology. Figure 9 shows a model made by a village boy in eastern Zambia; examples from Malawi, Zimbabwe and Swaziland are based on the same idea. The model is both steered and propelled by means of an extended steering column, and although little attempt is made to represent the vehicle's bodywork, specific details are sometimes reproduced, such as a Mercedes logo and bevel gears made from bottle tops in one Swaziland model. A different kind of wire toy is made for sale to tourists, avoiding the use of bottle tops, without the steering column, and more usually representing bicycles, scooters or even wheelchairs whose tubular framing lends itself to a more realistic form of modeling in wire than the diagrammatic style used for automobiles.

A very different kind of inventiveness was to be seen in Bangladesh during the 1970s, when the bitter struggle for independence seemed to stimulate new awareness of local needs. The result was a stream of ideas for pumps, surveying instruments, transport, and building board

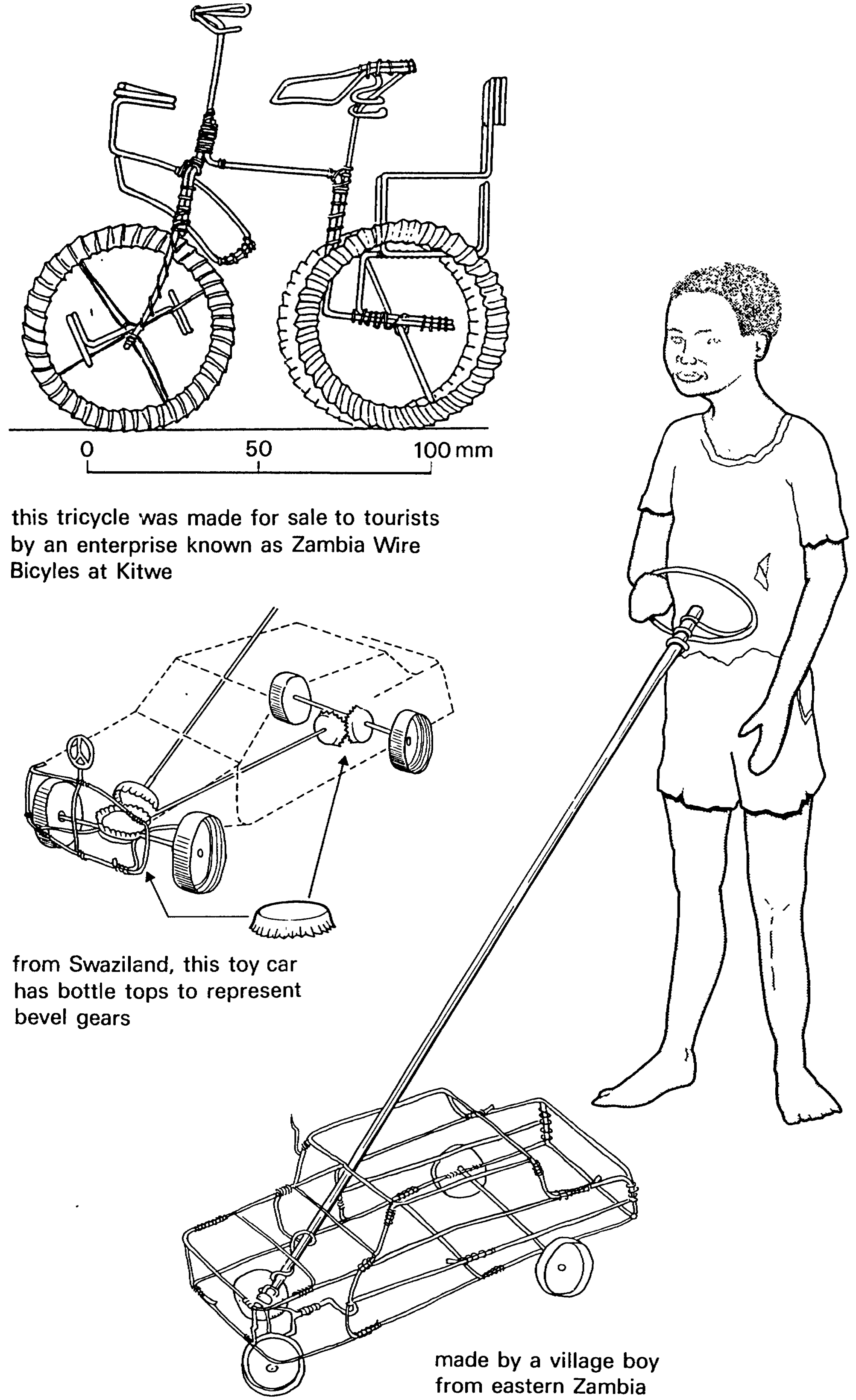

FIGURE 9 *Interactive innovation involving the combination of technical ideas from different cultures: craft interest in wire, and elements of industrial technology*

Sources: photographs by Linda Richardson; information from David Farrar, Chris Howes and author's observations. See also *New Civil Engineer*, 19 September 1982, cover illustration which shows an example from Malawi.

from local resources. Two of those responsible, S. S. Ahmed and Najmul Haque, formed a Bangladesh Innovators Association, and Ahmed achieved considerable success with a low-cost duplicating machine using Gestetner stencils. This has all the hallmarks of interactive innovation. It brought together a wide range of ideas based on local needs (e.g. in schools) plus knowledge of locally available materials (including scrap), and understanding of the imported Gestetner equipment. It was subsequently (1980) manufactured in Bangladesh by Lipikar Industries.

In the world view that predominates today, we tend to ignore opportunities for this kind of interaction, because of linear perspectives that differentiate only between advanced and primitive technology. Innovation, we tend to feel, should follow a logical, forward path, and should not be casting back to simpler forms of existing products (as with the duplicator), nor to older traditions, such as survival technology in the Arctic or wire ornament in Africa.

Our linear preoccupations also cause us to ignore the way in which every culture has its own distinctive style in technology-practice, often related to differing organizational procedures and values. Technology is supposed to be universally valid and culturally neutral, and in order to conform with this presupposition, where we do notice differences, we find ways of dismissing them – as most African technology is usually dismissed as of no significance. But there are no easy ways of dismissing the distinctive style of technology that may be observed in much of East Asia. Several nations in that region have an approach that is too successful to be ignored, but too different to be understood by a simple linear distinction between levels of sophistication.

The supremacy of East Asia in manufacturing (as opposed to engineering) is no recent development. In 1700, Europeans were attempting to discover how to make porcelain that could match the quality of Chinese and Japanese products. Quality silk and cotton textiles were another challenge difficult to meet. So was paper, and in 1870, a British manufacturer had to devote a considerable research effort to matching the quality of very thin, opaque paper imported from East Asia.[11]

Today, the tradition of quality manufacture and attention to detail is reinforced by other factors. In Japan, the brightest graduates go into production engineering and the consumer goods industries, because there is no NASA and no large defence sector to swallow them up. In other words, there is less scope for the expression of technological virtuosity, but bigger emphasis on economic values. But the Japanese themselves sometimes voice a fear that while they have a good record in innovation, they are less good in original research and invention. Few Japanese have won Nobel prizes. The first transistor radio may have been designed and made in Japan, but the transistor itself originated in the United States. In microelectrics, the Japanese led the way with microprocessor chips of 64K RAM capacity, but feel less confidence about maintaining their lead into the next stage of refinement, the 256K RAM, or with work on the so-called fifth generation computer.

What is especially striking about Japanese industry, of course, is the harmonious working atmosphere; as compared with America, workers 'do not appear angry at superiors and actually seem to hope their company succeeds'.[12] This corporate environment and spirit of consensus makes for efficient production. It makes equally for effective research and development in certain directions. But in a society where, it can seem to westerners, 'nothing is done without arriving at consensus', and individualism is not marked, innovation may more readily follow a linear rather than an interactive pattern. Too ready an acceptance of consensus can inhibit the vigorous discussion on which interaction often depends. Indeed, it is sometimes said that Japanese innovation has been most successful where there have been agreed objectives to work for. It is precisely when development is linear that objectives can be most readily agreed. Thus in Japan, both the value-conflicts and the virtuosity-oriented imperatives which have been so important in the West seem to have less scope.

Whatever may be said for or against this very different style of technology-practice, it does mean that there is immense opportunity for fruitful interaction between Japan and the West. When people talk about microelectronics as the technology of the Pacific rim, they are usually thinking about an economic division of labour, and it is only slowly being appreciated that the mutual stimulus between different styles of technology may be even more significant. The interaction between California's silicon valley, Japan's robotic and computer applications, and the mass production of microprocessors on the Singapore-South Korea seaboard can contribute insight as well as performing an economic function. Even British commentators have begun to talk about the encouraging prospects for 'marrying Japanese manufacturing skills with our strong research and development', mentioning a Japanese link with the ICL computer firm as one strand in an innovative dialogue.

If one difference in the style of technology-practice between Japan (and China) and the West lies in a greater awareness of the organizational and work aspects, another difference concerns the quality of production and attention to detail. An American electronic components manufacturer might be happy if the number of defective items in his output is kept below one per cent of production, whereas a Japanese corporation will not be content with 0.1 per cent, nor even 0.01 per cent defective. Similarly, where Japanese-owned factories in Britain have bought in components from local firms, an unusually high proportion are rejected. Within these factories also, workers are regularly involved in meetings for the discussion of quality control.[13] In this and many other areas, we can recognize, not just problems of competition, but the value of dialogue and interaction.

A very different example of this sort of dialogue was to be seen in 1974 when a group of American medical men, with US Government backing, asked themselves whether anything could be learned from medicine in China that would help them better 'serve the escalating medical requirements of the American people'.[14] They quickly saw that the Chinese style of medical practice was too distinctive for much to be directly transferred to another culture. This was particularly true of the emphasis on organization and social discipline in the prevention of disease. Efforts to control malaria, for example, involved holding numerous meetings in every community to discuss the local problem and what people could do about it. The whole approach was very reminiscent of the meetings held in some Japanese factories to alert workers to problems in quality control.

Thus the discussion about how American medical practice could benefit from Chinese experience led to a sceptical conclusion about any direct borrowing of techniques. However, the challenge offered by the different approaches to be seen in China was readily acknowledged. For example, it was noted that a synthesis between technical knowledge and an affective, caring approach seemed far more common than in America, where 'technology gets in the way of caring'. Chinese medicine was seen to be less virtuosity-oriented and more need-oriented in another way also: achievements are measured in terms of the general health of the population, and there is less emphasis on progress in specialized treatments and techniques.

Dialogue and the 'new professional'

In development projects in the poorer nations of Asia and Africa, the clash of western and local styles in technology-practice often serves to accentuate the divergence between professionals and lay people, experts and users, which was discussed earlier (chapter 3). Very often, the technical experts working on a project will have had a western-style training, and will be separated from the local community not only by professional knowledge and status, but by broader cultural values also. In addition, the disparity in education between professionals and villagers will tempt the former into believing that existing local technology is of little worth, and that their knowledge as experts is a better basis for planning for the future. Interactive innovation is not likely to occur where such attitudes prevail.

An even worse situation arises where technologists, who have no contact with the village, design equipment in distant research institutes, or even in American or British universities, hoping thereby to create appropriate technology. As Michael McGarry says, 'the innovator of the West all too often develops a technology in answer to an imagined problem first, and then proceeds to search overseas for a situation to apply it in'. Such experts necessarily work in ignorance of the people they seek to help; they 'concentrate on hardware, at the expense of social, cultural and organizational aspects. This is a practice proven to be highly susceptible to failure.'[15] As another engineer points out, a successful solar cooker cannot be based only on research concerning solar energy without some study of how people might use it. Yet the user sphere of technology is nearly always neglected or under emphasized in professional research.

The most ironic aspect of the many technological projects that fail because of a lack of any real understanding or dialogue between professionals and people is that the failure is often blamed on the people. They are said to lack willingness to change, and sometimes sociologists are brought in to study the cultural blockages or vested interests that are assumed to be opposed to progress. Yet the real problem is often with the technologist, who has never sat down with people to discover what their lives are about and what they want and need.

But of course, not all experts are like this; some can be identified with the new professionals about whom Robert Chambers writes (chapter 6). Among these, there are people who have worked in a particular locality for so many years that they have inevitably grown into a constructive relationship with the local community, and have evolved an increasing openness to dialogue. Peace Corps volunteers have often been very quick to establish an interactive relationship with local people, seemingly because they are young enough to have a flexible view of professional convention. Sometimes, though, the new professional will be somebody from a research institute who has discovered only by a painful process of trial and error that techniques originating in the laboratory are not always very relevant in the field.

One example concerns grain storage on farms and at village homesteads in Africa. Many different types of traditional granary or silo exist, most of them built with mud walling. However, in some places there has been a heavy loss of grain through the depradations of rats, insects, dampness and mould, and this has contributed to food shortages and malnutrition. Initially it was assumed that such inefficiency was an inevitable part of the traditional technology, which was dismissed as almost worthless. Much effort was therefore devoted to design and trial of concrete or metal silos. In the end, though, granaries built with these materials proved to have few advantages over the traditional ones. They were too costly, and the metal silos tended to over-heat. Meanwhile, the experts had become more aware of the way people used their granaries; where grain was lost, they found, this was due to poor maintenance. What the experts finally did was to accept the merits of the indigenous African designs but suggest detailed improvements that would make maintenance easier.[16]

This is a particularly good example of interactive innovation, with its synthesis of western science, indigenous technology, and expert sensitivity to problems in the user sphere. In the West African state of Mali, the same approach was taken even further. One group of villages in a semi-desert area needed a better water supply. Rainwater could be collected from house roofs, but could not be stored through the long dry season. However, visiting experts were intrigued by the large mud-walled grain bins used in the area, and realized that if ferrocement – that is, cement plastered onto wire reinforcement – were used to strengthen and waterproof them, they would be ideal for water storage.[17] This led to interactive innovation, certainly, and to a dialectical process in an even fuller sense. The men who introduced the ferrocement concept worked out the details with local craftsmen in a collaborative effort. That led them to rethink some of their western values, so that they came to see their work not as modernization but as part of 'the organic development of a traditional society'.

The merit of this approach has been recognized in public health programmes, if nowhere else. The literature on community health discusses at some length how interaction or dialogue may be initiated. The most common approach is to set up village committees in which lay people sit side by side with professionals. The hope is that in such committees, there will be a 'pooling of the expert's knowledge of . . . disease transmission, with the local person's knowledge of local circumstances and behavioural habits'.[18] The success of this depends greatly on the attitudes of the professionals. They may be highly trained for the investigation of narrowly defined problems in medicine or nutrition, but ill-prepared for listening to what may seem just village gossip. They will have a command of highly effective problem-solving skills, but may also be victims of a variety of assumptions and 'blind spots'. Some of the latter may be summarized as follows:

(a) assumptions based on academic specialisms and on boundaries between professions;
(b) the assumption that traditional communities outside the industrialized world have no technology of their own;
(c) a tendency to overlook opportunities for detailed improvements in maintenance and use and to go for technical fixes;
(d) failure to recognize the invisible organizational aspects of technology invariably developed by users of equipment;
(e) failure to recognize the conflicts of values and social goals which specific technological projects may entail.

Robert Chambers suggests two ways in which these obstacles may be overcome by his new professionals. Firstly, existing specialized methods of investigating problems would be combined with a more wide-ranging but non-detailed approach which has variously been described as 'rapid appraisal' and 'taking soundings'. This is a survey method that forces specialists to look beyond their customary disciplinary boundaries; it involves them in collaboration with people from other disciplines as well as with laymen; and it helps to create awareness of the organizational and cultural context of the work.[19]

Secondly, the new professionalism would involve the discipline of reversal mentioned in a previous chapter – that is, deliberately attempting to understand a situation from a point of view opposite to one's normal stance. This sounds vague, but Donald Curtis[20] has suggested an exercise which a professional could undertake to alert himself to what a reversal of values and viewpoints might involve in any particular context; it consists of filling out a matrix that compels one to question accustomed expert views at the same time as lay views and the user sphere are investigated through discussions, surveys and soundings.

However, I would add a third point, for the new professional will not see the sense of either of these approaches unless he has an appropriate view of his role as an expert in society. One suggestion is that the proper role of scientists and technologists is to help draw the maps which society needs in order to steer its future course, but it is not their job to do the steering. This ought to be said of the professional who works with individuals also: when I go to my doctor, I want to know what options are available for dealing with my ailment, but the choice between options I want left in my hands.[21] The difficulty is that all professions involving specialized knowledge are dangerous trades, in that the expert can always present knowledge selectively and manipulate people by pre-empting decisions. He can find himself giving instructions when he should be imparting understanding. Most of us who have professional roles sincerely want to be of service, but we also want recognition and status. Thus, 'many have felt a call to "service" without any idea of becoming "servants".' We are tempted to use our professional knowledge in exercising overlordship over others; yet the less like servants we are, the less real the service we succeed in giving.[22]

These temptations can present the professional with some of his most deeply-felt dilemmas. An expert on public health may observe that an illness which kills many people in a particular community could be easily prevented if improved latrines were built and used. He may feel such urgency about this that he seeks to impose the technology, 'for the people's own good'. But that is not how a servant of the community should behave, nor in the end is it likely to be of much service. The expert forgets that his sense of urgency arises from a view of life that may have been narrowed by professional training. The people will certainly be concerned about the disease on which he focuses, but they will also be concerned with other problems, related perhaps to unemployment, low income and bad housing. They have to try and cope with all these problems simultaneously, while the expert is concerned with only one of them. And however sensitive and need-directed the expert's primary purpose, he will also have a technical interest in the equipment he proposes, and an inescapable bias towards what seems to him technically sweet. Either way, he is in no position to decide for the people that his solution is the right one for them. All he should do is to put it forward for discussion, advocating his point with all the urgency he feels, but open to counter-suggestions.

Indeed, experience of this kind of situation in countries as diverse as Botswana and Brazil has shown that when latrines are built just on the initiative of professionals, they are not always used for the purpose intended; but where discussion has taken place and the latrines form part of a programme for dealing more broadly with inadequate living standards as the people perceive them – especially housing – individuals will sometimes seize the initiative and build latrines ahead of the programme.

This takes us back to the exercise in reversal which the new professional may undertake to help him see problems from the lay person's point of view. Table 7 represents a greatly modified version of the matrix which Donald Curtis suggested for this purpose. The first question it presents is about the benefits looked for in the project. This encourages the expert firstly to recognize that his own goals refer to very specific benefits, and then secondly to understand the more general but very definite views that local people are likely to have.

Similar questions should be asked about the costs and risks involved, bearing in mind especially the costs which lay people may face in use and maintenance of equipment such as latrines. Adequate cleaning, for example, may absorb time that a busy mother can ill afford, or may entail purchase of cleaning materials. Questions of status will also be important, and not only to the expert who looks forward to the recognition he will gain when the completed project is written up for his professional journal; in some communities, possession of a shiny modern latrine is as much a status symbol for the householder as a new automobile may be in the West.

In many instances where development projects in Africa or Asia fail to make progress, we have already seen that the fault is as likely to be with the expert promoters as with the people. One advantage gained by filling out table 7 is that the promoter is forced to question whether the problems are really due to uncooperative attitudes, or whether the people see the project as irrelevant to their needs. The promoter is also invited to question his own attitudes – that is what reversal is all about. Perhaps 'lack of willingness to change' is something that can be said of his narrowly specialist outlook.

However, Chambers suggests that the most important questions are those that ask: who gains and who loses? These are questions that are affected 'by many decisions which appear technical and neutral'.[23] The green revolution in Asia has taught us that decisions taken in agricultural research affect who benefits. The more prosperous farmers

TABLE 7 Matrix for assessing different points of view on any new technological development (e.g. a public health project)

The columns representing expert and lay (or user) views are initially blank and are filled in by promoters of the project as a means of testing its appropriateness in the community concerned. The matrix is here shown partially completed; in practice, both questions and answers will usually need to be more detailed.

Queries	Expert views	User views
Practical benefits and costs		
What benefits are sought?	Very specific benefits (e.g. control of a particular disease)	Better living standards in general, including health, amenity, housing, jobs
What costs, what risks, and what environmental impacts are perceived?	Cost of implementation; risks as a statistic to be weighed against benefits	Costs in time, cash, amenity, organization, risk, seen in personal and family terms
Who gains which benefits? Who loses?		Lowest income groups cannot afford the cash costs
Status and political advantage		
What is the impact of the project in terms of status and prestige?	Visible progress, good for national prestige Professional advancement for the experts concerned	Status associated with possession of new household amenity
Who gains or loses status, power or influence?	Some strengthening of central government authority	Some loss of control over lifestyle; fear of bureaucratic power
Basic values		
What is the cultural context?	Scientific/technical; the expert sphere	Domestic/traditional; the user sphere
What are the dominant values?	Technical interest and virtuosity; economic values	Need or user values, family welfare

'can afford and obtain fertilizers, pesticides, irrigation water, and hybrid seeds. To many smaller and poorer farmers these are out of reach.' An individual scientists' decision to work on biological nitrogen fixation may ultimately help small farmers, but if he works on responses to chemical nitrogen, he must know that he helps only those farmers who can afford to buy fertilizer. However, trends in linear innovation, reinforced by the institutions of the chemical industry, tend continually to give greatest emphasis – and reward the scientist more – for work on the chemical option.

Scope for dialogue

Although the divergence between professional technical interests and the lay person's point of view may be more obvious in Asia or Africa, many of the points made here apply equally in the West. Table 7 represents an exercise in reversal which could be undertaken by the promoters of a nuclear power station in Europe or America as much as by the promoters of latrines in Africa. Indeed, the two columns have been filled out in such general terms that many of the comments could apply equally to a public health or a nuclear project. With both, there is the problem that experts see the goals of programmes in much more specific terms than the public, and with both, basic values differ.

Table 7 is also useful in illustrating how dialogue on such matters is frequently curtailed. When new highways, chemical works or power plant are proposed, many very detailed questions about benefits, costs, and risks are asked in technology assessment exercises, and in environmental impact assessments. These questions cover some of the same ground as the top half of the table, but those who ask them tend to assume that objective answers can be given. There is little recognition of the way in which promoters of projects must usually answer the question differently from the lay public. Yet even to present the lay public as a single entity may be over-simple, for consumers, employees of the project and local residents whose amenity is disturbed will have quite different points of view.

A more significant way in which discussion is curtailed, however, is that questions in the bottom half of the table may never be asked at all. It is assumed that decisions about nuclear energy can be rationally made merely by weighing benefits against risks and costs. Thus many arguments that may be more important to some people are ignored or disguised, and debate on cost-benefit issues becomes distorted by the strong feelings that people have on questions that never surface. Thus concern about the risks of nuclear power becomes shrill and hysterical because those who voice them are worried about a lot of other issues as well. Equally, the claims of the promoters are distorted by a range of hidden motives.

Thus in fuel-rich Britain, the case for nuclear power has been based, since 1980, on elaborately documented claims about the cheapness of nuclear electricity. Yet the differences in cost are marginal, and leaked reports from cabinet committees suggest that the factor which weighed most heavily in favour of the present nuclear programme was a wish to reduce the political leverage which the coal miners' union can exert.[24] That may be a very proper cause for concern, but only if it is debated openly. Subjecting it to a cover-up can only confirm fears that the further development of nuclear electricity is part of a process by which political power is being centralized and consolidated.

If we are to have a democratic control over technological development, we need public inquiry and technology assessment procedures that are able to strip off the various disguises which allow fundamental conflicts of basic values and political interests to hide behind utilitarian arguments about benefits and costs. But many technology assessments and most major British inquiries have served mainly to cloak issues with technical detail that is often barely relevant. Commenting on one such inquiry, a writer in the science journal *Nature* observed that: 'Technical decisions as complex as these have a political content, and that content must be isolated and recognized for what it is.'[25] This had not been done.

It is easy to see why such issues are so rarely fully debated. To engage in a genuinely open dialogue is inevitably to share power over the final decision. If this is a decision about granaries or latrines in an African village, and the only people who have to share this power are a couple of professionals and the villagers, the problem is not insuperable. However, if it is the technocrats who manage a nation's energy supplies and the industrial lobbies and government bodies which support them that must share power with the public, then the stakes are much higher and open dialogue much less likely.

This is important not only in the context of democracy, but also in the interests of innovation. Totalitarian structures, I have argued, restrict innovation to linear paths. Dialogue at many levels, from practical modifications of equipment to formal inquiries, may stimulate innovation in new directions and make it more responsive to people's needs and wants. In western societies, trade unions and consumer groups can play a crucial role, by insisting on high safety standards in equipment and on the performance of welfare functions. In the famous instance of the British firm Lucas Aerospace, trade unionists took on an additional role in putting forward a list of one hundred and fifty socially useful products the firm could be manufacturing instead of working chiefly on armaments.

The organization of work is another important area for dialogue, especially as more computerization is introduced. In one office which had allowed staff some flexibility in fixing their working hours for a number of years, the introduction of word processors meant a return to more rigid work patterns. One employee commented: 'all the . . . machines are switched on and off at the same time, and they want . . . a record of all the work we do, so they can monitor how many orders each person is dealing with'.[26] However, computerization could make more flexible work possible. More people could work from home. There could be modification of the sexual division of labour: job-sharing could allow for family shifts, whereby father leaves work early on one day to meet the children from school and make their tea while mother is at work, but next day the roles are reversed.

Another aspect of technology which cannot be left only to the experts is the allocation of funds and other resources. At the Massachusetts General Hospital in 1980, surgeons were planning ahead for six heart transplant operations in a year. However, it was found that this would absorb such resources that there would be fifty fewer heart operations of more conventional kinds. The transplant programme was then turned down by the hospital trustees, who are mostly lay people. They did not question the doctors' technical judgement, but in this instance were able to press a need-oriented view in place of the virtuosity-oriented imperatives of the experts.[27] This brings out one of the many reasons why dialogue is so important: without it, experts are often carried away by enthusiasm for the technical potential of their work, and lose touch with those aspects of human need they are supposed to serve.

Architects more than most technologists tend to be responsive to arguments such as these, perhaps because the house, more than most other products of technology, must reflect both cultural values and the needs of people. But while architects have sometimes been at the forefront of efforts to devise methods by which people can participate in house design – and in city planning also – there is a tendency among a populist fringe to say that an architect must provide only what lay people want. Where this is taken to its limits, it is arguably as irresponsible as dictating from some technocratic eminence what people must have. Where the professional panders to the public, he gives up on the obligation to maintain a dialogue just as much as when he dictates to them.

Such dialogue is vital at several different levels. It is vital as a dialectic between conflicting sets of values. It is important as a means of balancing narrow specialist views against broader insights. It is highly significant in stimulating innovation through interaction, and leading sometimes to the modification of equipment, or sometimes to new adjustments between organization and technique. In all these ways, if dialogue – or interaction – can be encouraged, future innovation may become more relevant to our problems and needs rather than to experts' ideals of the technically sweet.

9

Cultural Revolution

Democracy and information

Two principal issues have emerged from previous chapters, one intellectual and the other political. The intellectual issue concerns the way value systems inform world views, and how they support beliefs about resources, the arms race, the Third World and technology itself. The political issue concerns the totalitarian nature of many of the institutions which control technology; it is associated with the difficulty encountered at almost every level, of opening any real dialogue between experts and users, technocrats and parliamentarians, planners and people. On the government level, the growth of bureaucracy 'has tended to shunt parliament away from the centre of political life. The executive apparatus functions increasingly without adequate political control.'[1] That has led to a widespread sense of political impotence, and some loss of faith in elected government, and so to the growth of protest movements concerned with the environment, the arms race and nuclear energy.

In both Europe and America, the feeling that totalitarian institutions were taking over was forcibly expressed in the unrest of the late 1960s (especially 1968) and the early 1970s, and in response to this there have been many modest reforms. In several countries, legislators have improved their ability to scrutinize bureaucratic action and technology policy (in Britain, since 1979, through strengthened Parliamentary select committees). There have also been moves to reduce the secrecy that surrounds many decisions; citizens' rights of access to some categories of official information have been recognized in law, first in the Scandinavian countries, then by the American Freedom of Information Act (1967), and later in West Germany (1973) and France (1978). In addition, there have been deliberate efforts to open up