Seven

DRAWING UP THE CORPORATE PLAN AT LUCAS AEROSPACE

At no stage in human history has the potential for solving our economic problems been so great. Human ingenuity, expressed through appropriate science and technology, could do much to free our world from squalor and disease and fulfil our basic needs of food, warmth and shelter. Yet at the same time there is a growing disquiet, even alarm, among wide sectors of the community about the future of 'industrial society'.

THE CONTRADICTIONS

There are many contradictions which highlight the problems of our supposedly technologically advanced society. Four of these contradictions in particular influenced the events at Lucas Aerospace.

Firstly, there is the appalling gap which now exists between what technology could provide for society, and what it actually does provide. We have levels of technological sophistication such that we can guide a missile system to another continent with an accuracy of a few metres, yet the blind and disabled stagger around our cities in very much the same way as they did in medieval times. We have vast nuclear power industries, huge conventional power-generating systems, complex distribution networks and piped natural gas, yet pensioners die of hypothermia because they cannot get a simple effective heater. In the winter of 1984, some 1000 died of the cold in the London area alone. We have senior automotive engineers who sit in front of computerised visual display units 'working interactively to optimise the configuration' of car bodies to make them aerodynamically stable at 120 miles an hour when the average speed of traffic through New York is 6.2 miles an hour. It was in fact 11 mph at the turn of the century when the vehicles were horse-drawn. In London at certain times of the day it is about 8.5

miles an hour. We have such sophisticated communications systems that we can send messages round the world in fractions of a second, yet it now takes longer to send a letter from Washington to New York than it did in the days of the stage coach.

We find on the one hand the linear drive forward of complex esoteric technology in the interests of the multinational corporations, and, on the other hand, the growing deprivation of communities and the mass of people as a whole.

The second contradiction is the tragic waste our society makes of its most precious asset: the skill, ingenuity, energy, creativity and enthusiasm of its ordinary people. We now have in Britain, even according to the doctored official figures, some 3.3 million people out of work. The real, if unofficial, figure must be close to 4.5 million if we take into account those who haven't registered, those who would work part time, and the thousands of women who would welcome the opportunity of a job if it could be provided on a basis of flexible time.

There are thousands of engineers suffering the degradation of unemployment when we urgently need cheap, effective and safe transport systems for our cities. There are thousands of electricians robbed by society of the right to work when we urgently need economic urban heating systems. We have, I believe, 180,000 building workers out of a job when by the government's own statistics it is admitted that about 7 million people live in slums in this country. In the London area about 20 per cent of the schools lack an adequate indoor toilet and the people who could be making these are rotting away in the dole queue.

The third contradiction is the myth that computerisation, automation and the use of robotic devices will automatically free human beings from soul-destroying, backbreaking tasks and leave them free to engage in more creative work. The experience of my trade-union colleagues and that of millions of workers in the industrial nations is that in most instances the reverse is the case.

At an individual level, the totality that is a human being is ruthlessly torn apart and its component parts set one against the other. The individual as producer is required to perform grotesque alienated tasks to make throwaway products to exploit the indi-

vidual as consumer. We are at a stage where our incorporate science and technology, with their concepts of efficiency and optimisation, converge with the requirements and value systems of the vast multinational corporations.

Fourthly, there is the growing hostility of society at large to science and technology as at present practised. If you go to gatherings where there are artists, journalists and writers and you admit to being a technologist, they treat you as scum. They really seem to believe that you specified that rust should be sprayed on car bodies before the paint is applied, that all commodities should be enclosed in containers that can't be recycled, and that every large-scale plant you design is produced specifically to pollute the air and the rivers. There seems to be no understanding of the manner in which scientists and technologists are used as mere messenger boys of the multinational corporations whose sole concern is the maximisation of profits. It is therefore not surprising that some of our most able and sensitive sixth-formers will not now study science and technology because they perceive it to be such a dehumanised activity in our society.

Propelled by the frantic linear drive forward, of this form of science and technology, we witness the exponential change in the organic composition of capital and the resultant growth of massive structural unemployment. So stark is the situation becoming that predictions of 20 million jobless in the EEC countries by 1990 no longer seem absurd.

LUCAS WORKERS RESPOND

All these four contradictions impacted themselves upon the work force in Lucas Aerospace during the 1970s. We were working on equipment for Concorde, we had experienced structural unemployment and we knew, day by day, of the growing hostility of the public to science and technology.

Lucas Aerospace was formed in the late 1960s when parts of Lucas Industries took over sections of GEC, AEI and a number of other small companies. It was clear that the company would engage in a rationalisation programme along the lines already established by Arnold Weinstock in GEC. This, it will be recalled, was the

time of Harold Wilson's 'white heat of technological change'. The taxpayer's money was being used through the Industrial Reorganisation Corporation to facilitate this rationalisation programme. No account at all was taken of the social cost and Arnold Weinstock subsequently sacked 60,000 industrial workers with a wide range of skills.

We in Lucas Aerospace were fortunate in that this happened about one year before the company embarked on its rationalisation programme. We were therefore able to build up a Combine Committee which would prevent the company setting one site against the other in the manner Weinstock had done. This body, the Combine Committee (which is still active in 1987), is unique in the British trade-union movement in that it links together the highest-level technologists and the semiskilled workers on the shop floor. There is therefore a creative cross-fertilisation between the analytical power of the scientist and, what is perhaps more important, the direct class sense and understanding of those on the shop floor.

As structural unemployment began to affect us, we looked around at the way other groups of workers were attempting to resist it. In Lucas we had already been engaged in sit-ins, in preventing the transfer of work from one site to another and in a host of other industrial tactics which had been developed over the past five years, but we realised that the morale of a work force very quickly declines if the workers can see that society, for whatever reason, does not want the products that they make. We therefore evolved the idea of a campaign for the right to work on socially useful products.

It seemed absurd to us that we had all this skill and knowledge and facilities at the same time as society urgently needed equipment and services which we could provide, and yet the market economy seemed incapable of linking the two. What happened next provides an important lesson for those who wish to analyse how society can be changed.

AN IMPORTANT LESSON

We prepared a letter which described in great detail the nature of the work force, its age, its skills, its qualifications and the machine tools, equipment and laboratories that were available to us, together with the types of scientific staff and the design capabilities which they possessed. The letter went to 180 leading authorities, institutions, universities, trade unions and other organisations, all of which had in the past, one way or another, suggested that there was a need for the humanisation of technology and the use of technology in a socially responsible way. What happened was a revelation to us. All these people who had made great speeches up and down the country, and in some cases written books about these matters, were smitten into silence by the specificity of our request. We had asked them, quite simply, 'What could a work force with these facilities be making that would be in the interests of the community at large?' and they were silent – with the exception of four individuals, Dr David Elliott at the Open University, Professor Meredith Thring at Queen Mary College, Richard Fletcher and Clive Latimer, both at the North East London Polytechnic.

We then did what we should have done in the first place. We asked our own members what they thought they should be making.

I have never doubted the ability of ordinary people to cope with these problems, but not doubting is one thing, having concrete evidence is something quite different. That concrete evidence began to pour in to us within three or four weeks. In a short time we had 150 ideas of products which we could make and build with the existing machine tools and skills we had in Lucas Aerospace. We elicited this information through our shop stewards' committees via a questionnaire.

This questionnaire was very different from those which the soap-powder companies produce, where the respondent is treated as some kind of passive cretin. In our case, the questionnaire was dialectically designed. By that I mean that in filling it in, the respondents were caused to think about their skill and ability, the environment in which they worked and the facilities available to them. We also composed it so that they would think of themselves

in their dual role in society, that is, both as consumers and as producers. We were, therefore, deliberately transcending the absurd division which our society imposes upon us, which seems to suggest that there are two nations, one that works in factories and offices, and an entirely different nation that lives in houses and communities. We pointed out that what we do during the day at work should also be meaningful in relation to the communities in which we live. We also designed the questionnaire to cause the respondents to think of products for their use value and not merely for their exchange value.

When we had collected all these proposals, we refined them into six major product ranges. These are now embodied in six volumes, each of approximately 200 pages. They contain specific technical details, economic calculations and even engineering drawings. We sought a mix of products which included, on the one hand, those which could be designed and built in the very short term, and, on the other, those which would require long-term development; those which could be used in metropolitan Britain mixed with those which would be suitable for use in the Third World – products that could be sold in a mutually nonexploitative fashion. Finally, we sought a mix of products which would be profitable by the present criteria of the market economy and ones which would not necessarily be profitable but would be highly socially useful.

THE PRODUCTS AND IDEAS

Before we even started the Corporate Plan, our members at the Wolverhampton plant visited a centre for children with spina bifida and were horrified to see that the only way the children could propel themselves about was by crawling on the floor, so they designed a vehicle which subsequently became known as hobcart. It was highly successful, and the Spina Bifida Association of Australia wanted to order 2000. Lucas would not agree to manufacture it because, they said, it was incompatible with their product range.

At that time the Corporate Plan was not developed and so we were unable to press for the manufacture of hobcart. However, the design and development of this product were significant in another

sense. Mike Parry Evans, its designer, said that it was one of the most enriching experiences of his life when he delivered the hobcart to a child and saw the pleasure on the child's face. It meant more to him, he said, than all the design activity he had been involved in up till then. For the first time in his career he saw the person who was going to benefit from the product he had designed, and he was intimately in contact with a social human problem. He needed to make a clay mould of the child's back so that the seat would support it properly. He was working in a multi-disciplinary team together with a medical doctor, a physiotherapist and a health visitor. This illustrates very graphically that aerospace technologists are not only interested in complex esoteric technical problems. It can be far more enriching for them if they are allowed to relate their technology to really human and social problems.

A LIFE-SUPPORT SYSTEM

Some of our members at another plant realised that about 30 per cent of the people who die of heart attacks die before they reach the intensive-care unit in the hospital. They designed a light, simple, portable life-support system which can be taken in an ambulance or at the side of a stretcher to keep the patient 'ticking over' until he or she can be linked to the main life-support system in the hospital.

They also learned that many patients died during critical operations because of the problems of maintaining the blood at a constant optimum temperature and flow. This, it seemed to them, was a simple technical problem once they were able to get behind the feudal mysticism of the medical profession. They designed for this a simple heat exchanger and pumping system and they built it in prototype. I understand that when the assistant chief designer at one of our plants had to have a critical operation, they were able to convince the local hospital to use it, and it was highly successful.

ENERGY-CONSERVING PRODUCTS

In the field of alternative energy sources we came up with a very imaginative range of proposals. It seemed to us absurd that it takes more energy to keep New York cool during the summer than it does to heat it during the winter. Systems which could store this

energy when it was not required and use it at a time when it was required would make a lot of sense.

One of the proposals for storing energy was to produce gaseous hydrogen fuel cells. These would require considerable funding from the government, but would produce a means of conserving energy which would be ecologically desirable and socially responsible.

There are further designs for a range of solar-collecting equipment which could be used in low-energy houses. We worked on this in conjunction with Clive Latimer and his colleagues at the North East London Polytechnic, and components for a low-energy house were produced. This house was designed so that it could be built by its owner. Some of the students working on the communications design degree course at that polytechnic have written an assembly-instruction manual based on directions given by the skilled people who designed the low-energy housing. This manual would allow people, working side by side with skilled building workers, to go through a learning process and at the same time produce very ecologically desirable forms of housing. If this concept were linked to imaginative government community funding, it would be possible, in areas of high unemployment where there are acute housing problems, to provide funds for employing those in that area to build houses for themselves.

In order to demonstrate the potential of this in practice, Clive Latimer has constructed a low-energy house in Suffolk and lives in it. The technical press were invited to view it in 1984 and were extremely enthusiastic about its potential. The London Innovation Network, one of the Greater London Enterprise Board's technology networks, is now developing the project further and a scale model was demonstrated at the Energy Exhibition in London in the autumn of 1985.

We made a number of contacts with county councils as we were keen to see these products used in communities by ordinary people. We were unhappy about the present tendency in alternative technology for products to be provided which are little more than playthings for the middle class in their architect-built houses, so we made links via the Open University with the Milton Keynes

corporation and in conjunction with the OU we designed and built some prototype heat pumps for installation in the corporation's houses. These pumps use natural gas and have a coefficient of performance (COP) of 2.8 when it is 0°C outside the building.

Obviously, heat pumps have been around for many years, but they are usually electrically driven. Given the energy losses in the transfer from fossil fuel to electrical power and the transmission losses in the lines, only a little over 30 per cent of the original fossil-fuel value is ultimately available in the house or building as electrical energy to drive the pump. The real advantage of the natural-gas heat pump over electrically driven ones is that you start with some 70 per cent of the original fossil-fuel value and still get a COP of 2.8.

A NEW HYBRID POWER PACK

The problem of finding an ecologically desirable power unit for cars is one which needs to be solved as a matter of urgency.

Lucas Electrical, which is a separate company from Lucas Aerospace, proposed a solution based on a battery-driven car. However, with a vehicle of this kind it is necessary to recharge it approximately every forty miles of stop-start driving and every 100 miles on flat terrain. Furthermore, it is necessary to carry a significant weight of batteries. At a chassis weight of around 1300 kilos an additional 1000 kilos of batteries would have to be carried. Because the batteries need charging at regular intervals, vehicles of this kind are unsuitable for random journeys, and a large number of roadside charging facilities would be needed.

One possibility would be to provide these in existing garages, but having a large number of vehicles waiting to be charged overnight would create considerable difficulties. Interchangeable batteries could be made available, but it would clearly be a significant task regularly to change 1000 kilos of batteries (about a ton). Moreover, storage space for batteries would in the London area cost around £6 to £10 per square foot per annum. Drivers would have to pay for the additional reserve batteries *and* for the space to store them.

The aerospace workers' approach was quite different. They pointed out that the average vehicle has an engine twice and maybe

three times larger than necessary, simply to give it take-off torque. Once the vehicle is moving along, a much smaller engine could satisfactorily power it. They also pointed out that the performance characteristics of an electric motor are the opposite of those of a petrol engine. That is to say, the electric motor has a high starting torque whereas a petrol engine has a better torque at high revs. By linking these two together, a new unity can be formed. A small component combustion engine, running constantly at its optimum revs and at its optimum temperature, drives a generator which in turn charges a very small stack of batteries. These act merely as a temporary energy store and supply power to an electric motor which drives the transmission system, or, in a revised version, will drive hub motors directly on the wheels.

A number of variations on this theme were proposed. One is for intercity driving. Once the vehicle has gained speed, the combustion engine could drive the wheels directly through the mechanical transmission system, whereas when the vehicle enters the suburban area, with the consequent stop-start driving, it could run in the hybrid mode.

The Lucas workers envisaged that in coming years the internal combustion engine would be banned from city centres. With the hybrid power pack it would be possible to drive to the perimeter of the prohibited zone and then, within the zone, drive slowly, solely on stored energy. The system would be recharged when operating in the hybrid mode elsewhere.

In general use, however, the internal combustion engine would be running continuously at its constant optimum rate. All the energy that is wasted as one starts from cold, accelerates and decelerates, changes gear or idles at traffic lights, would go into the system as useful energy. This, it is suggested, would improve fuel consumption by about 50 per cent. Since the engine is running constantly and at its optimum temperature, it follows that combustion of the gases will be much more complete, thereby reducing the emission of toxic fumes by about 80 per cent, since the unburned gases are not going out into the atmosphere, and it would improve specific fuel consumption by 50 per cent. The initial calculations on this have subsequently been supported by work done in Germany.

The engine would run at constant revs so the resonance frequencies of the various components in the system could be different from that of the engine and noise levels reduced. With a background noise of 65 decibels, the power pack would be inaudible ten metres away. A prototype unit of this kind was built and tested under the direction of Professor Thring at Queen Mary College, London. Similar hybrids are now being developed in Germany and Japan.

No individual component of the system is in itself revolutionary. What is new is the creative manner in which the various elements have been put together. The only reason why such a power pack had not been designed and developed before, it seems to us, is that they would have to last for fifteen years or so, to accord with our views of long-life products to conserve energy and materials and to justify the installation cost, and maintenance services would have to be developed to repair and maintain them. This is completely contrary to the whole ethos of automotive design, which has as its basis the notion of a nonrepairable throwaway product with all the terrible waste of energy and materials which that implies.

While the Lucas workers are proposing this kind of power pack, their colleagues at another large car manufacturer's are having to design and develop an engine which would be thrown away after 20,000 miles or two years, whichever comes first. The idea is that the engine would simply be bolted on the input side of the gearbox so that it could simply be unbolted and replaced with another at the end of its life cycle. The owner would even be denied the pleasure of putting water and oil in. It is a criminally irresponsible type of technology, yet the whole political and economic infrastructure of society is based on the assumptions of this technology, namely that the rate of obsolescence of products will increase, and that the rates of production and consumption will grow. I am convinced that Western society cannot carry on in this wasteful and arrogant way much longer.

ALL-PURPOSE POWER GENERATION

Drawing on our aerodynamics know-how, we proposed a range of wind generators. In some instances these would have a unique

rotor control in which the liquid used as the medium for transmitting the heat is also used to effect the braking, and is heated in the process.

We proposed a range of products which would be useful in Third World countries. We feel, incidentally, that we should be very humble about suggesting that our kind of technology would be appropriate in these countries. Probably one of the most important things the Third World countries could learn from us, looking at the incredible mess we have made of technology in our society, is what not to do. It is also very arrogant to believe that the only form of technology is that which we have in the West. I can see no reason why there should not be technologies compatible with the cultural and social structures of these other countries.

At the moment, our trade with these countries is essentially neocolonialist. We seek to introduce forms of technology which will make them dependent on us. When the gin-and-tonic brigade go out to sell a power pack, for example, they always seek to sell a dedicated power pack for each application; that is, one power pack for generating electricity, another power pack for pumping water and so on.

The Lucas workers' approach is quite different. They designed a universal power pack which is quite capable of providing a wide range of services. It has a basic prime mover which could run on many different fuels, including naturally available materials and methane gas.

By using a specially designed, variable speed gearbox it is possible greatly to vary the output speed. The unit is capable of providing the speed and power necessary to drive a generator which could supply electricity at night. When running at one of the lower speeds, it could drive a compressor to provide compressed air for pneumatic tools. It could drive a hydraulic pump to provide power for lifting equipment, and at very low speeds it could drive a water pump and be used for irrigation. The unit could thus be used in a number of ways for almost twenty-four hours a day.

In considering the design, the various bearing surfaces have been made much larger than normal and the components deliberately

designed to last for about twenty years with almost no maintenance. The instruction manual would enable the users to carry out the maintenance themselves and learn by doing it.

ROAD/RAIL VEHICLE

In the mid-1950s Lucas Aerospace (Rotax) spent over £1 million developing an actuating mechanism whereby a set of pneumatic tyres could be brought down into position so that a railway coach could run on the roads. In its railway mode, a metal rim still ran on a metal track, which in practice resulted in all the shocks going up through the superstructure. Inevitably, this meant a large rigid superstructure of the type we have inherited from Victorian rolling-stock design.

But again, there is another approach, which was followed up by the Lucas workers and Richard Fletcher and his colleagues at the North East London Polytechnic. By using a small guide wheel with servomechanical feedback, the vehicle can be steered along the track with the pneumatic tyres running on the rails.

With the guide mechanism retracted, the vehicle can be used conventionally on the road. This provides the basis of a flexible lightweight vehicle which is capable of going up a rail incline of one in six.

Normal railway stock, because of the low friction between the metal rim and the metal track, is capable of going up an incline of about one in 80. This means that when a new railway line is being laid, for example, in the developing countries, it is necessary literally to flatten the mountains and fill up the valleys, or build tunnels and viaducts. Typically, this costs £1 million per track mile. With the hybrid vehicle, it is possible to follow the natural terrain and lay down new railway lines for £20,000 per track mile. The vehicle can of course be run on disused tracks to service remote areas.

A prototype of the road/rail vehicle has been built at the North East London Polytechnic and tested out on the East Kent railway line with great success. In parts of Britain, there is a growing interest in a vehicle of this kind since it could provide the basis for a truly integrated transport system with vehicles running through

our cities like coaches and then moving straight on to the railway network.[1]

KIDNEY MACHINES

The Lucas workers do not merely design and build *new* products. There are one or two existing products in Lucas Aerospace which they would like to see produced at a much greater rate. One of those is the home dialysis or kidney machine. In the mid-seventies, the company attempted to sell off its kidney-machine division to an international company operating from Switzerland. We were able to prevent them doing so at that time by both threats of action and the involvement of some MPs. When we checked on the requirements for kidney machines in Britain we were horrified to learn that 3000 people die each year because they cannot get a machine. In the Birmingham area, if you are under fifteen or over forty-five you are allowed, as a medical practitioner put it so nicely, 'to go into decline'. The doctors sit like judge and juries with the governors of hospitals deciding who will be saved. One doctor told us how distressed he was by this situation and admitted that sometimes he did not tell the families of the patients that this was happening as it would be too upsetting for them.

We were disgusted when we saw, in an ITV programme, an interview with a teacher who was over forty-five and being allowed to 'go into decline'. She said she was going to commit suicide at some stage so that her grandchildren would not see her going through the progressive stages of debility. Ernie Scarbrow, the secretary of the Combine Committee, said: 'It is outrageous that our members in Lucas Aerospace are being made redundant when the state has to find them £40 a week to do nothing except suffer the degradation of the dole queue. In fact the £40 a week amounts to about £70 a week when the cost of administration is taken into account. Our workers should be given this money and allowed to produce socially useful products such as the kidney machine. Indeed, if the social contract had any meaning and if there were such a thing as a social wage, surely this is the kind of thing which it should imply, namely having forgone wage increases in order that we could expand medical services, we should then have the

opportunity of producing medical equipment the community requires.'

TELECHIRIC DEVICES

One of the most important political and technological proposals in the Corporate Plan is for the design of 'telechiric' (hands at a distance) devices. With these systems, the human being would be in control, real-time, all the time, and the system would merely mimic human activity, but not objectivise it. Thus the producer would dominate production, and the skill and ingenuity of the worker would be central to the activity and would continue to grow and develop. This would link human intelligence with advanced technology, and help to reverse the historical tendency to objectify human knowledge and thereby confront the worker with an alien and opposite force, as described earlier.

The methods by which the Lucas workers arrived at the concept of this product range are in themselves revealing. It was suggested to them that it would be highly socially responsible if a means could be found of protecting maintenance workers on North Sea oil pipelines. These maintenance workers experience a very high accident rate because of the depths at which they have to work.

Since they had been conditioned by traditional design methods, they immediately thought of a robotic device which would eliminate the human being completely. However, as they began to consider the programming problems of getting a system which would recognise which way a hexagon nut was about (let alone if it had a barnacle on it!) and select the correct spanner and apply the correct torque, they recognised what a difficult task this would be. Yet it is the kind of task that skilled workers can perform even 'without thinking about it'. They simply have to look at the diameter of a nut and bolt, and will know through years of experience what torque they can apply to it without wringing it off and yet at the same time tightening it sufficiently so that it won't become loose again. Without any 'scientific knowledge', such as the torsional rigidity of the bolt or the shear strength of its material, they will get it right repeatedly.

That is to say, workers don't express this knowledge in writing

or speech. They demonstrate their knowledge and intelligence in what they do. The common sense and tacit knowledge described in Chapter 4 would be pivotal for systems of this kind.

Comparing the levels of intelligence of robotic equipment of that kind with total human information-processing capability, we have seen that the order of things is the machine 10^3 to 10^4 and the human being 10^{14}. This 10^{14} brings with it, however, consciousness, will, imagination, ideology, political aspirations; and these are precisely the attributes which employers regard as disruptive.

PEOPLE ARE TROUBLE – MACHINES OBEY

One doesn't have to engage in sociological research to work this out. The multinationals and the employers are so arrogant that they have constantly put it in writing in case we might fail to understand. A decade ago the *Engineer* had a headline which said, 'People are trouble, but machines obey.'[2] It is, therefore, no accident that systems today are designed around the trival 10^3 whereas the 10^{14} is deliberately suppressed. It is a political act which reflects the power relationships at the point of production.

The Lucas workers feel that there are hazardous, dangerous jobs which should be automated out of existence. What they were questioning was the politics of elevating these design methods to universal principles.

SILENCING THE WORKER

It has been pointed out that technological change viewed thus has more to do with the exercise of control over the workforce than it has to do with increasing productivity.[3] Andrew Ure, in his *Philosophy of Manufactures* puts it even more clearly when he says that

> the industrialists aim to take any process which requires peculiar dexterity and steadiness of hand, from the cunning workman, and put it in charge of a mechanism so self-regulating, that a child may superintend it. The grand object therefore, of the manufacturer is, through the union of capital and science, to reduce the task of his workpeople to the exercise of vigilance and dexterity appropriate to a child.

The extent to which capital and science have succeeded in achieving this was dramatically illustrated in the July 1979 issue of the *American Machinist*. It reported that an engineering firm had found that the ideal operators for its numerically controlled machining centre were mentally handicapped.

One of the workers held up as ideal for this type of work had the intelligence level of a twelve-year-old. The employer pointed out in gloating terms, 'He loads every table exactly the way he has been taught, watches the Moog operate and then unloads. It's the kind of tedious work that some nonhandicapped individual might have difficulty in coping with.'

This would have been laudable had the objective been to provide work for the mentally handicapped, but what happens in installations of this kind is that some of the most highly skilled, satisfying and creative work on the shop floor, such as turning and milling, is so deskilled by these new technologies that it is rendered suitable for twelve-year-olds.

This historical process of deskilling[4] is an important means through which the employer extends his control over his employees. But in a wider sense, it destroys the social and cultural values which surround the exercise of those skills, and the means by which they are acquired. Indeed, we seem to have seriously underestimated the educational, cultural and other significance of skill and craftsmanship.[5]

Thus the significance of raising these issues through the very specific proposals surrounding the telechiric devices. The Lucas workers are indeed developing profound political ideas; so also are those who, in the wider sense, are proposing human-centred systems even in the field of high-level intellectual activity like design.

SOCIAL INNOVATION

We believe it is arrogant for aerospace technologists to think that they should be defining what communities should have. The Lucas workers were deeply conscious that if the debate were limited to industrial workers of this kind, it would represent a new form of elitism. We therefore made strenuous efforts to involve wide

sections of the community at large in discussions around these issues in order to interact with them and learn from them. We sought, through the local trade unions, political parties and other organisations in each area, to get people to define what they needed, and to begin to create a climate of public opinion where we could force the government and the company to act.

To this end, the Lucas workers cooperated with Richard Fletcher at the North East London Polytechnic to convert a coach into one of their hybrid road/rail vehicles. As a way of consciousness-raising the vehicle was used as a technological agitprop with a photographic exhibition, slides and videotapes describing the concepts underlying the Corporate Plan and showing some of the prototypes in action. Local trade-union branches, trades councils and community groups sponsored visits of the vehicle to different cities and these culminated in large public meetings where discussions took place between technological and industrial workers and members of the public.

Part of the exhibition in the vehicle was a display of photographs composed by Dennis Marshall, a skilled worker at Lucas Aerospace. It vividly demonstrates the way that the ideas embodied in the Corporate Plan have released not only the technical creativity, but also the artistic creativity among the employees. Dennis Marshall has produced beautiful and vivid depictions with his camera of pollution, decay of inner cities, neglect of railway systems, and nuclear hazards. When I used these as illustrations to one of my talks at the Royal College of Art, the people there were amazed that an industrial worker could have produced such impressive work. I suggested that we would all benefit if they came to work at Lucas and made way for Dennis Marshall at the RCA.

TRADE-UNION RESPONSE

At national level, the trade-union movement has given very little support and encouragement to the Corporate Plan, although there have been some positive developments. The TUC has, for example, produced a half-hour television programme dealing with the Plan and this has appeared on BBC2 as part of its trade-union training programme for shop stewards.

The Transport and General Workers' Union came out with a statement indicating that its shop stewards throughout the country should press for corporate plans of this kind. In 1986, the T&GWU produced a major policy statement on the conversion of the arms industry to socially useful production, as a phased reduction in arms expenditure. This is now the official policy of that union.

At an international level, the interest has been enormous. In Sweden, for example, they have produced six half-hour radio programmes dealing exclusively with the Corporate Plan, and have made cassettes which are now being discussed in factories throughout Sweden. They have also produced a one-hour television programme and a paperback book in Swedish dealing with the Corporate Plan. Similar developments are taking place elsewhere. In Australia, there have been television and radio programmes, including the *Science Show*, dealing with the Lucas Plan ideas. The Metalworkers' Union has produced a number of reports on the possibility of using resources such as railway workshops for the development of new forms of transport. The Australian government has also established a Commission for the Future, and I was the speaker at one of the conferences that launched it.

In the past, our society has been very good at technical invention but very slow at social innovation. We have made great strides technologically, but our social organisations are virtually the same as several hundred years ago. One of the Swedish television interviewers said, 'When one looks at Britain in the past, it has been great at scientific and technological invention and frequently has not really developed or exploited that. The Lucas Workers' Corporate Plan shows a great social invention, but it probably is also the case that they will not develop or extend that in Britain. If this were true it would be very sad indeed.'

THE TECHNOLOGICAL ASPECT OF THE PLAN

Although the social and political implications of the Lucas Aerospace workers' campaign have received considerable attention, the technology contained within the Corporate Plan has largely been ignored, even though the workers themselves, in their Plan, placed

considerable emphasis on the forms taken by the technology, the products and the manner of producing them. This is particularly true of criticisms of the Plan.[6]

This reluctance to deal with the technology of the Plan is on the one hand due to the remarkable incompetence of those on the Left in the field of science and technology, and on the other to an indifference to it, because it is perceived, as described earlier, to be 'neutral'.

The Lucas workers had sought to find, and debated in considerable detail, forms of technology that would give full vent to the creativity of the hands and minds of the workers, and that could be carried out through nonhierarchical forms of industrial organisation. For the fact is that for those at the point of production, the considerations of the technology, the design methodologies, and the nature of the labour process which arises from them, are of equal importance to the political considerations precisely because these workers do not separate one from the other. Indeed, one of the most positive features the Lucas workers saw arising from their Corporate Plan was the discussions which eventually took place with shop stewards and representatives of workers at all levels in industry, from scientists to semiskilled workers, in a range of companies from Vickers, Parsons, Rolls-Royce, Chrysler and Dunlop to Thorn EMI. These discussions centred not just around the political aspects, but gave rise to a profound questioning of the nature of the technology itself and the design methodologies used.

In the course of designing and building prototypes they discovered that, as one worker expressed it, 'Management is not a skill or a craft or a profession but a command relationship; a sort of bad habit inherited from the army and the church.'

They did not mean by this that forward planning, project management and the coordinating and synchronising aspects of a project are unimportant. They were suggesting, rather, that these conceptual and planning aspects of work should be integral to the labour process, thereby ensuring that those who do work also plan and manage it.

Historically, when the great master builders designed, planned, managed and built their own structures, there was, of course, a

hierarchy, but it was based on a legitimacy of leadership in that those who were managing knew what they were talking about and were capable of exercising the skills themselves.

The objection expressed above is to that form of management that seeks to remove the internal conceptual part of work and place it in the hands of those who represent capital, capital which has now become external to the productive process. There are hordes of accountants, financial planners, monitors and other nonproductive workers who are simply there to act as police people for external capital. This is part of that wider process in which finance capital increasingly dominates industrial capital, a moribund stage in which the production of capital becomes more important than production itself.

None of this is to imply that there are not important project-planning, financial-control and other skills. What the Lucas workers were suggesting is that facilities should be provided for industrial workers to acquire these skills rather than to have them used against them in a crude set of power relationships. They have also shown, if only in embryo, that the design methodology used in a 'socialist technology' would have to be radically different from that which applies in our current technology.

At present, in the technologically advanced nations, highly qualified designers and technologists spend months drawing, stressing and analysing a prototype before telling the workers on the shop floor what should be done. These design stages involve rarefied, complex mathematical procedures which are necessary only because, for commercial reasons, materials have to be exploited to the full. Both the materials and the systems of the products are designed just to perform a precisely defined function for a very short length of time before the product is rendered redundant (planned obsolescence). The rarefied mathematical procedures are outside the experience of the mass of industrial workers and are used as a means of silencing their common sense.

DRAMATIC EXAMPLE

There is a tendency for computer specialists to imply that they have the solutions to all our problems without necessarily having much

real design experience behind them. Dramatic examples of what can result from this are already coming from the United States. At one aircraft company they engaged a team of four mathematicians, all of Ph.D. level, to define, in a programme, a method of drawing the afterburner of a large jet engine. This was an extremely complex shape, which they attempted to define by using Coons' patch surface definitions. They spent some two years dealing with this problem and could not find a satisfactory solution.

When, however, they went to the experimental workshop of the aircraft factory, they found that a skilled sheet-metal worker, together with a draughtsman, had actually succeeded in drawing and making one of these. One of the mathematicians observed, 'They may have succeeded in making it but they didn't understand how they did it.' This seems to me to be a rather remarkable concept of reality. It dramatically illustrates the manner in which the three-dimensional skill of draughtsmen and skilled workers can be thoughtlessly eliminated in this drive to replace people by equipment. All their knowledge of the physical world about them, acquired through years of making things and seeing them break and rupture, is regarded as insignificant, irrelevant or even dangerous.

With the prototypes developed for the products proposed in the Corporate Plan, the methodology of production was quite the reverse of the above. Workers on the shop floor had every opportunity of giving full vent to their skills and creativity since the prototypes were designed more by tacit knowledge than by analysis.

It is a sad reflection of the specific form technology takes in this society that this wealth of knowledge is deliberately eliminated. Clearly, any talk of industrial democracy with this kind of technology is simply a deception.

AN ELEMENT IN DESIGN

It will undoubtedly be argued by the authoritarians, both of the Right and of the Left, that the Lucas workers' approach to technology is romantic, unrigorous and unscientific. Such a view ignores the fact that a desire to meet real social needs is a vitally

important stimulus to good quality and creative design, and is a qualitative element of design which cannot be treated in a mathematical way as the quantitative elements can.

Nor are the Lucas workers alone in taking this view of science and technology. In a recent paper, one of the country's leading technologists and academics, Howard Rosenbrock, had this to say:

> My own conclusion is that engineering is an art rather than a science and by saying this I imply a higher, not a lower status. Scientific knowledge and mathematical analysis enter into engineering in an indispensible way and their role will continually increase. But engineering also contains elements of experience and judgement and regards all social considerations and the most effective ways of using human labour. These partly embody knowledge which has not yet been reduced to exact and mathematical form. They also embody value judgements which are not amenable to the scientific method.[7]

HUMAN-CENTRED SYSTEMS

Howard Rosenbrock, a highly creative scientist, has developed advanced interactive graphic systems which actually place the designer and human intelligence at the centre of the design process.

In the field of computer-aided design, he cautions against the computer becoming an automated design manual, leaving only minor choices to the design engineer. The automated design manual approach, he says, 'seems to me to represent a loss of nerve, a loss of belief in human abilities and further unthinking application of the doctrine of the Division of Labour.' The designer is reduced to making a series of routine choices between fixed alternatives, in which case 'his skill as a designer is not used, and decays'.[8]

Rosenbrock's interactive graphic systems are described in his book together with their basic mathematical techniques.

He has developed graphic displays from which the designer can assess stability, speed of response, sensitivity to disturbance and other properties of the system.[9] This he and his colleagues did by using the inverse Nyquist array. Having demonstrated through his

computer-aided design system that alternative approaches can be applied to problems of this kind, Rosenbrock then raises the much wider question as to whether we are not cutting off options in other fields of intellectual work in rather the same way as we have done at an earlier historical stage in the field of manual work. He has termed this the Lushai Hills effect.

Other computer scientists, J. Weizenbaum among them, are now seriously questioning where their work is taking society, and what its impact on human beings and their self image is likely to be.[10]

What is often lacking in honest expressions of concern of this kind is an economic and political analysis of the forces in society which control and distort science and technology to fulfil specific class roles.

Thus the discussions at Lucas and elsewhere should really be viewed in the context of the overall questioning of the way science and technology are developing under advanced capitalist society. It is linked with the wider challenges workers are attempting to make against the way technology is being organised: the Green Bans Movement in Australia, the attempts by Fiat workers in Italy to transcend the narrow economism which characterised trade-union activity for so long, and the courageous struggle by the women at Algots Nord in Sweden.[11] The Green Bans Movement was started by the building labourers in Australia in the seventies. It was an attempt to link their industrial strength and strike power to community groups and conservationists, in order to prevent developers from destroying buildings of architectural, cultural or social significance. The bans also applied to areas of land held to be important to the local community and regarded as part of a heritage which should be protected for future generations. The Fiat workers proposed alternative products. The women workers at Algots Nord, when faced with the closure of their clothes factory, took it over and went out and asked the community, and occupational groups like nurses and electricians, what kind of clothes or working garments *they* would like to have, and worked with them to design new product ranges.

All these forces can be linked together in a challenge to the

system as a whole, and as a forerunner to a transformation of society which will take it away from its present exploitative, hierarchical form to a new type of society, which, the founder of cybernetics, Norbert Wiener, once said:

> differs from those propounded by many fascist successful businessmen and politicians. People of this type prefer an organisation where all information emanates from the top and where there is no feedback. The subordinates are degraded to become effectors of an alleged higher organism. It is easier to set in motion a galley or factory in which human beings are used to a minor part of their full capacity only, rather than create a world in which these human beings may fully develop. Those striving for power believe that a mechanised concept of human beings constitutes a simple way of realising their aspirations to power. It maintains that this easy way to power not only destroys all ethical values in human beings, but also our very slight aspirations for the continued existence of mankind.

The new technologies highlight the fact that we are at a unique historical turning point.

Eight

THE LUCAS PLAN – TEN YEARS ON

On the front page of the now famous Lucas Workers' Plan for Socially Useful Production there is the statement that 'there cannot be islands of social responsibility in a sea of depravity'. Lucas workers themselves never believed that it would be possible to establish in Lucas Aerospace alone the right to produce socially useful products. Only some of their baton wavers seemed to believe that, or those who sought to decry their activities by suggesting they were utopian.

What the Lucas workers did was to embark on an exemplary project which would inflame the imagination of others. To do so, they realised that it was necessary to demonstrate in a very practical and direct way the creative power of 'ordinary people'. Further, their manner of doing it had to confirm for 'ordinary people' that they too had the capacity to change their situation, that they are not the objects of history but rather the subjects, capable of building their own futures.

The Lucas workers could see about them the grotesque absurdities of modern industrial society. They were aware of the growing powerlessness and frustration of masses of people as decisions were concentrated in the hands of vast multinational corporations whose size and activities dwarfed that of nation states. It was a courageous attempt to repossess that precious ground of decision-making which planners, managers and coordinators were removing from them. They highlighted and built on the major contradictions in industrial society.

The audit of their own skills and abilities, and the surveys in different factories and workshops analysing and assessing the production equipment, product ranges and skills, represented an enormous extension of consciousness, since we are all of us conditioned to view the world from the one lathe we operate or the one

desk from which we function. Never are we encouraged or allowed to take a panoramic view of our industry and see how that fits into a wider pattern of society.

Prototypes of the products included in the plan were built and displayed on a wide scale. Lucas workers then went to the Labour government and pointed out that its manifesto had said that it stood for 'an irreversible shift of power in the interest of working people'. The government, and in particular the Department of Industry, was clearly bewildered by the notion that one might think of products for their use value rather than their exchange value. In addition, most trade-union bureaucracies bitterly resented a rank-and-file activism which they perceived as a challenge to their leadership. The idea that leadership might be catalytic, enabling and supportive was beyond them.

The whole exercise demonstrated in a very direct way to the Lucas workers the nature of power relationships. For example, when they proposed the manufacture of heat pumps using natural gas in internal combustion engines, the company turned the proposal down, saying that it would not be profitable and was incompatible with their product range. Burnley workers subsequently revealed that the company had had a report prepared for them by American consultants showing that the market for the heat pump would have been some £1000 million in the private and industrial sectors in the EEC countries by the late 1980s. Lucas would be willing to forgo a market of that kind to demonstrate that it, and it alone, would decide what was made, how it was made, and in whose interests it was made. Lucas workers then quickly recognised that they were dealing not just with an economic system but with a political system concerned with the retention of power.

When the company moved on to the offensive and victimised some of the leading stewards, amid worldwide protest, there was inadequate support from union leaderships. The Lucas Plan was turned down by the Labour government and rejected by trade unions, with the exception of the T&GWU and some peripheral support from ASTMS. Lucas workers then felt that the key strategic position was to diffuse the ideas as widely as possible through the Labour and trade-union movement. They formed a

Trade Union combine committee and produced a number of very well worthwhile reports. Increasingly they also entered into discussions with those who were contesting elections in local government.

THE GREATER LONDON ENTERPRISE BOARD

In its manifesto for the 1981 election, the Labour Party in London committed itself to restructuring industry along the lines of the Lucas Workers' Plan if it came to power.

Once elected, Labour sought enthusiastically to meet that commitment. They set up an Industry and Employment Branch at County Hall, and an early part of its work was to establish the Greater London Enterprise Board. The GLC provided the board with some £30 million a year and in its first two and a half years of operation it established, restructured or assisted 208 companies and created directly some 4000 jobs, with many more jobs created indirectly. Based on its direct investment in industries, it was able to create jobs at some £4700 per job, whereas if somebody is unemployed in Britain and has a couple of dependants, it costs the taxpayer £7000 a year.

It was only to be expected that a project as innovative as this – one for which there were no real precedents – would encounter many difficulties. Apart from the problems arising from its innovative nature, there was also a conflict between long and short-term investment policies. Frequently, the design, research and development of new products requires ten or even fifteen years. However, such products then become part of the nation's productive activity, and help to create real wealth. There is growing concern, even in City circles, that the City is concerned only with those investments which will show a quick return in the short term.

GLEB's achievements, limited though they are, have to be seen in the hostile context in which GLEB found itself at both a national and local level. Certainly, it was seeking to swim against the economic tide. It came into existence and is attempting to operate at a historical stage when finance capital is dominating industrial capital, and when there is a dramatic decline of the British manufacturing base. In the Greater London area, the trend, stimulated

and supported by the Thatcher government, has been to transform London into the finance centre of the world, with precious little support for its manufacturing base.

To all these difficulties must be added the government's determination to abolish the Greater London Council. Of particular significance were the months of uncertainty in 1985 surrounding the GLC's future and then its final abolition in March 1986. This did much to damage GLEB and its projects. And the decision of the government in March 1986 to refuse to release the remaining £8 million which the GLC had provided for GLEB will inevitably mean that for the foreseeable future its capacity to act will be greatly constrained and the future of many of its projects precarious.

However, what is clear is that many of its exemplary projects indicate alternatives for the future – its policies on cooperative enterprises, its framework for enterprise planning and equal opportunities, and the relationship of these to the overall London industrial strategy and enterprise planning.[1] GLEB's technology policy, in particular, has attracted both national and international attention and, indeed, emulation. That policy was based on an imaginative framework which was agreed with the GLC in early 1983.[2] This framework provided for the establishment of new and high-tech companies and it also provided for human-centred means of production. Perhaps its most innovative aspect was the proposal to set up a range of technology networks throughout London.[3] These would draw on the ideas of the Lucas Workers' Plan and also on the experiences of the science shops in Holland, the innovation centres in West Germany and the more desirable aspects of science and technology parks.

GLEB'S TECHNOLOGY NETWORKS

A pivotal aspect of the policy was that of linking two of London's great resources – the skill and ingenuity of the people of London and the facilities of London's higher educational infrastructure in seven polytechnics, three universities and many teaching hospitals and colleges.

Two basic forms of network were proposed and established:

geographically based networks and product-based networks. A north and east network and a south and east network provide facilities and support for the communities in their respective areas. In January 1987, four of the west London boroughs, together with GLEB, put forward a proposal for the establishment of a west London network, calling on each of the west London boroughs to provide some funding, and on GLEB to provide some of the technical expertise required in setting up and running it.

These geographical networks have proved more difficult to establish than the product-based networks. Firstly, what constitutes a community? Secondly, when meetings of the 'community' were called to define the types of products and services they wished to have from the networks, these meetings were invariably attended by the habitual meeting-goers who tend to turn up at all such gatherings, whether they are about the bomb, unemployment or whatever, and who tend to say the same things at each meeting. To get through to real people proved to be much more difficult. Further, many of the 'community activists' came from that tradition which is obsessed with the contradictions of distribution at the expense of a serious analysis of the contradictions of production. They often tend to be 'takers' rather than 'makers' and were sometimes more concerned about the control of resources than the creation of new ones.

However, the needs of those who are dying of hypothermia, or unable to get a kidney machine, or immobilised because they lack the resources to overcome a comparatively simple disability, are so clear, so obvious and so well defined that an organisation professing to deal with the requirements of the community cannot easily avoid providing these services. A structure gradually evolved that enabled the networks to respond creatively to community and other needs.

The product-based networks in general found it easier to establish themselves. They had the cohesion of a clearer framework. Three such networks were established: the New Technology Network, the Energy Network and the Transport Network. Each network is a combination of people, skills and physical facilities. The main physical facility is a workshop located close to a univer-

sity or polytechnic but never actually on the campus. A university campus can be very alienating for the unemployed, for those whose experience of the world is real and experiential, for women's groups, ethnic minorities and the disabled. (They are probably also somewhat alienating for the students, but they don't have much choice at this stage.) So the buildings were located so that academics and the community could meet on neutral ground and the facilities and skills in the polytechnics could be utilised in a supportive fashion. In this way, academics who wish to support the communities in which they are based have a framework in which they can do this without being reduced to industrial fodder for the multinational companies. Furthermore, it is possible to provide exciting student projects rather than artificially contrived ones which frequently are highly demotivating for the students.

Each technology network is constituted as a company limited by guarantee with which GLEB has an annual funding agreement against set objectives and projects. The management committee of a network will typically involve representatives of local councils, trade unions, special interest groups and local academic institutions.

Even for high-tech projects, the policy is to provide a practical environment based on design by doing. Each of the networks has around six or eight technicians, engineers and support staff who appreciate the tacit knowledge of ordinary people and can relate to it. Each network building typically has four times as much workshop space as office space so that it is action-oriented, since there is a real danger that anything relating to local government can quickly degenerate into report-writing, and there are those who believe that a report constitutes a final product rather than being a guide to some real action which will follow. The issue still is to change the world and not just analyse it.

Each of the networks has tended to develop its own contacts and product ranges.

THE PROJECTS

The North and East Network has now been transformed into the London Innovation Network, and still serves the same geographi-

cal area while providing an innovation service for London as a whole. One of its most exciting features has been to see disabled people working with engineers and technologists on the design of new equipment for themselves. Some of the equipment is therapeutic and is related to new programmes of therapy supported by the local authorities. Some provides systems of mobility for the disabled and the elderly.

The energy network has produced an imaginative series of products and services. These range from energy audit systems (which analyse the energy requirements and costs of a building and suggest more effective ways of providing the heating necessary) to proposals for building conversions. Council tenants, short of funds, have been put in contact with building societies and banks who will provide forward funding so that buildings can be converted in an energy-conscious fashion and the tenants can then pay for this over a two-year period, at the end of which they will have a permanent gain as a result of reduced energy costs. Integrating dehumidifiers with energy-conscious systems reduces not only the heating costs but also the problems associated with condensation.

At the other end of the spectrum, expert systems are being developed, using very advanced computing techniques, in conjunction with some of the teaching hospitals. These systems provide the technology through which advanced expert knowledge can be diffused back into general practice and the community, thereby democratising decision-making between the general practitioner and the medical consultant. The data base is structured in a way that provides the medical practitioner and the patient with different treatment options, thereby encouraging a dialogue between them.

Such a form of expert system avoids the problems associated with many of those in the United States, in which the knowledge is only visible to a small elite of medical consultants. The medical profession downstream is deskilled. The London system means that people need not go into large, alienating, factorylike hospitals to be treated for each major illness, but may in future be treated in their local community by their own GP.

In the transport field, new forms of power-assisted bicycle have

been developed. These are ecologically desirable forms of transport and will give people exercise more naturally than sitting on absurd exercise bicycles in their front room, going nowhere. The power-assisted bicycles would enable older people, who have given up cycling, to resume, since the power will assist them on inclines. But this would require an infrastructure of cycleways in cities, and the GLC was embarking on this before its abolition.

Other products include 'hush kits' to reduce the noise levels from vehicles in the inner-city areas, and these might provide the basis for future legislation.

Still in the field of transport, one outcome of the work on developing the Lucas workers' road/rail vehicle has been a new kind of composite tyre which will retain the desirable characteristics of a pneumatic tyre, but cannot be punctured.[4]

Polytechnics have supported the development of cell-immobilisation techniques. These make possible the production and storage of real ale, and have other applications, possibly in the field of yoghurt production.

Many of the networks are now beginning to provide new products as a way of opening up new markets, and they can suggest new products to existing GLEB and other London companies which will experience difficulties with their product ranges during coming years. Desirable products with a future will also become available, for example, to black businesses, which too often are constrained to ghetto trading, and to cooperatives, so that they are not left with the dregs of the market economy. As a result of all these activities, a product bank has now been built up containing some 1500 products at various stages of development, from the idea or concept to prototypes and items in production.

The product bank is exciting, especially the way it has been developed. Special-interest groups concerned about energy conservation have been able to develop product ranges. The disabled have shown great creativity not only in thinking up alternative products for themselves, but in designing and, in many cases, making them. The networks have also caused cultural shifts. Frequently, ideas are regarded in our universities and polytechnics as important only at the conceptual level, and it is sometimes held

to be second-rate or even slightly obscene to be involved in production. Both the academics and their students have enjoyed access to a socially responsible framework in which to diffuse scientific and technical ideas through society.

The teaching hospitals frequently develop individual pieces of equipment for research or patient-specific treatment. It is often possible to elevate these to product ranges to make specialist treatment more widely available and at the same time provide work for those who make the new products.

All the products are geared to opening up new social markets, and this, linked with popular planning, could provide a structure in which we would have much of the dynamism of the market without its indifference to environmental impacts and the real needs of human beings.

NEW FORMS OF TECHNOLOGY – THE ESPRIT PROJECT

There has, in recent years, been a growing tendency to assume that there is only one form of technology – that which we may now think of as 'American technology'. This view constitutes a kind of Taylorism at the macro level, a belief in the notion of the 'one best way'. A richer and more sensitive way to view technology would be to perceive it as a cultural product, and since culture has produced different languages, different music and different literature, why should it not produce different forms of technology, forms which reflect the cultural, historical, economic and ideological aspirations of the society which will use them? Should there not be a form of European technology reflecting European aspirations (if more in the rhetoric than the reality) of motivation, self-activism, dignity of the individual, concern for quality etc., and reflecting also the reality of the European manufacturing base which is composed predominantly of medium-sized and small-scale units?

To explore the potential of this human-centred approach to advanced technology and to demonstrate its feasibility in the real world, ten partners from three European countries have come together within ESPRIT project 1217. The partners in the £3.8 million EEC ESPRIT project are from Denmark, Germany and the UK. Extending the Lucas proposals for telechiric devices, it

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will set up a demonstration centre in London in 1988 and display, for the first time ever, a human-centred computer-integrated manufacturing (CIM) system. It will shift the ground from theoretical discussions to a practical demonstration of the potential for the integration of advanced computing systems with human skill and ingenuity.

The CIM system will provide a complete manufacturing capability right through the spectrum from computer-aided design (CAD). This area of work will be undertaken by the Danish partners, drawing on systems-design work developed at UMIST. They will use a novel capability in which the designer can really sketch and those on the shop floor can converse with the designers and express their ideas through sketches, thereby creating a dialogue between the shop floor and the design office to the enhancement of both areas.

From the design area, the work will flow through its production scheduling and sequencing via a computer-aided production (CAP) system which will be developed by the German partners. They are exploring exciting possibilities of rendering visible, via the computers, the production sequencing, and are considering linking this to innovative organisational forms which include 'islands of production'. The actual machine tools and the production cells will be based on computer-aided manufacturing (CAM) systems which will be designed and developed in the United Kingdom. The CAM system will build on the skill of craft workers and enhance that skill so that they in fact become production cell managers.

This human-centred concept will, we hope, dramatically shift the paradigms of systems design. The complexity of such systems at the design level will be a challenge to the ingenuity of a new multidisciplinary design team which will draw, not merely on technical and scientific expertise, but also on expertise in the fields of social science, psychology and political science. It is also likely to have an important impact on industrial relations. The last ten years have been characterised by trade unions simply reacting to the forms of technology imposed on them by the large corporations. The human-centred CIM system could mean that trade unions

need no longer be caught in Wapping-like situations but could demand alternative forms of systems that meet the requirements of their members and, in the long term, demand technologies that enhance human skill rather than marginalising it.

HUMAN-CENTRED CONCEPT

The human-centred concept is based on the premise that a computer-integrated manufacturing system will be more efficient, more economical, more robust and more flexible if designed to be run by a human than a comparable unmanned system. The operator, who is really a cell manager, will run the cell with the aid of powerful software tools. His or her job will include the following tasks:

Creation of the machine programs, from 'part data' originated elsewhere, by using high-level software tools. The colour-graphics systems available today are an example of these tools.

Optimisation of these programs, using the operator's skills and experience to minimise the cutting time.

Machine scheduling of the cell's job list to make the most savings possible; for example, by running similar jobs sequentially with the same tool set-up.

Programming the work handler to load and unload all the parts that can be gripped by standard grippers, using powerful software tools with a simulation facility.

Doing all the jobs needed to run the cell, for example, load parts that cannot be handled by the robot work handler, change tools and de-burr parts.

The human-centred system will be more efficient than conventional fully automated systems because the operator can use his skills and experience, with the aid of powerful software tools, to optimise the machining programs and the job scheduling in the cell. It will be more flexible because any job that the machines can cope with can be machined in batch sizes of one upwards. It will be more robust because there is much less dedicated automation and

electromechanical complexity, so that when a failure occurs the cell may be instantly reconfigured to allow for greater human intervention, and the fault will take less time to fix because there are fewer dedicated subsystems. It will be more economical because it is designed to be more efficient, more flexible, have a higher uptime, lower running costs, cost less to buy and take less time to commission.

ESPRIT PROJECT 1217 (1199) HUMAN-CENTRED CIM SYSTEMS

A manufacturing cell comprising integrated CAM, CAD and CAP modules will be developed and installed at a user site. In the first phase the CAM cell will consist of two lathes and a work handler; a prismatic machine will be added in the second phase. The CAD system will integrate a drawing board with a CAD work station and the CAP system will be designed especially for shop-floor operation.

The CAD section will be handled in Denmark, the CAP in Germany and the CAM in Britain, with the Greater London Enterprise Board acting as prime contractor. In addition to these three areas, the University of Bremen will examine the educational requirements for such enhanced systems.

ROLE OF THE OPERATOR IN A HUMAN-CENTRED CIM CELL

The operator's role includes some or all of the following tasks, depending on the cell configuration:[5]

Produce and optimise part programs and work-handler load/unload programs with extensive use of simulation tools.

Use tool-wear data to determine when tool tips should be changed.

Reduce machine set-up times, e.g., schedule similar jobs sequentially.

Optimise machine utilisation, e.g., make sure there is no more than one machine awaiting attention at a time.

Quickly switch to high-priority jobs.

Allocate work to machines in the cell.

Feedback problems with production of the part to the designer.

Prove-out new part programs and load/unload programs.

Decide when to have tea breaks while still keeping the cell running.

Manual recovery from problems, e.g., tool breakage.

Any nonautomated activity, e.g., tool changing, loading/unloading awkward parts that the work handler cannot grasp.

Inspect the parts produced and carry out any consequent corrections to the machining process.

Devise and carry out de-burring strategies and systems and advise on appropriate equipment.

INTERACTION OF CAD, CAP AND CAM ELEMENTS

The CAM cell operator has considerable responsibilities above those that have been traditionally accepted.

The management of this change in the balance of power between the office and shop floor will be critical to the success of the concept.

CAD design is definitely not a shop-floor operation, but, despite the advent of modern technological aids, designers do not have the capability for developing competent part programs.

Communications protocols between CAP, CAD and CAM systems and the elements within these systems are largely human-independent, and current standards initiatives such as MAP and IGES are thus likely to be compatible.

The following are examples of interactions between the three elements:

CAD to CAM: the part geometry, material and blank geometry will be down-loaded, together with questions like 'Is this design OK for machining?'

CAM to CAD: request changes to the design to suit the machine and operating questions such as 'May I use a different material?'

CAP to CAM: job schedules with priorities, urgent jobs, warnings of changes to schedule, estimated-time requests for new designs.

CAM to CAP: real-time information on status of machine and accomplishments, estimates of times for new jobs, completion estimates for urgent work.

BENEFITS OF HUMAN-CENTRED SYSTEMS

The economic benefits will stem mainly from the increased efficiency achieved by incorporating the skills and experience of the operator into the running of the cell.

Human-centred systems will provide more stimulating and challenging work, resulting in a higher degree of motivation. They will require greater intelligence, involvement and commitment from the operator.

The human-centred concept is well suited to European industry, where workers have a high degree of skill and now have many years' experience with computer control of machines.

LIST OF CRITERIA

A prime objective of the three-year ESPRIT project that we have embarked on is to establish criteria for the design of human-centred systems; this list is only a summary of the present state of the art.

Technology can evolve in a direction that includes the skill and initiative of workers, who make it more productive and evolve new skills appropriate to the new kinds of technology.

The shop-floor workers have knowledge of the production process and especially deviations from the normal, so detailed specifications of the machining processes should be made on the shop floor.

At this stage design will only be undertaken in the office, but the

design information received at the shop floor could be returned, with suggestions for improvement relating to production, to the office.

All manufacturing data should wherever possible be manipulated in a high-level form appropriate to the users' interactions and not at the machine-level program; appropriate software tools must be developed to aid this.

CAD technology can be adapted to encompass tacit knowledge built up from experience and to some extent tied to the use of the drawing board by developing a system concept combining the use of the CAD system and the drawing board.

The human-centred operator-interface software packages would incorporate flexibility to encourage the development of alternative ways of working.

CAP systems would provide well-structured information about the current and expected state of the manufacturing process to any employee.

Real-time monitoring will be tailored to the planning and control functions to eliminate any time lags in the CAP system.

The operator's ability to deal with any unforeseen circumstances and cure malfunctions should be enhanced by structuring the information-processing systems for human operation.

Defined and compatible linkages are required between the technological concepts and the skill and experience of the workers. This will be accomplished by off-line training and on-line reinforcement.

A practical exploration of the potential of human-centred manufacturing systems is long overdue. The frantic linear drive forward towards a workerless factory may well prove to be a solution lacking systems robustness and flexibility and even then applicable only to very narrow segments of industry which are in no way typical of the mass of European industry. Human-centred CIMs

may also provide one important element in a wider strategy to cope with structural unemployment and deskilling and begin to address trade-union concerns for the quality of working life and the humanisation of work.[6]

SOCIALLY USEFUL PRODUCTION

I have referred frequently to the desirability of socially useful production as an alternative to growing structural unemployment. What then is socially useful production? And what criteria would we look for in a socially useful product?

Interestingly enough, the Lucas workers never set out to define socially useful production in an academic way, but rather counterposed it as an alternative to forms which they regarded as obviously not socially useful, for example, large-scale systems of mass destruction. Wittgenstein once said something to the effect that words define themselves by their use, and that has tended to be the case with socially useful production.

Given that the Lucas workers identified 150 products and services which they could provide, and subsequently the Technology Networks developed hundreds of socially useful products, we can begin to construct a tentative list of those attributes, characteristics and criteria which constitute socially useful production. It is not suggested that all these will be present in any particular socially useful product or production programme, but rather that some of these are key elements within it.

1. The process by which the product is identified and designed is itself an important part of the total process.
2. The means by which it is produced, used and repaired should be nonalienating.
3. The nature of the product should be such as to render it as visible and understandable as is possible and compatible with its performance requirements.
4. The product should be designed in such a way as to make it repairable.
5. The process of manufacture, use and repair should be such as to conserve energy and materials.

6. The manufacturing process, the manner in which the product is used and the form of its repair and final disposal should be ecologically desirable and sustainable.
7. Products should be considered for their long-term characteristics rather than short-term ones.
8. The nature of the products and their means of production should be such as to help and liberate human beings rather than constrain, control and physically or mentally damage them.
9. The production should assist cooperation between people as producers and consumers, and between nation states, rather than induce primitive competition.
10. Simple, safe, robust design should be regarded as a virtue rather than complex 'brittle' systems.
11. The product and processes should be such that they can be controlled by human beings rather than the reverse.
12. The product and processes should be regarded as important more in respect of their use value than their exchange value.
13. The products should be such as to assist minorities, disadvantaged groups and those materially and otherwise deprived.
14. Products for the Third World which provide for mutually nonexploitative relationships with the developed countries are to be advocated.
15. Products and processes should be regarded as part of culture, and as such meet the cultural, historical and other requirements of those who will build and use them.
16. In the manufacture of products, and in their use and repair, one should be concerned not merely with production, but with the reproduction of knowledge and competence.

This list is by no means exhaustive, and is being developed day by day by the Technology Networks and groups worldwide who are now putting the concept of socially useful production into practice. The examples above demonstrate the capacity of quite ordinary people to question the direction in which technology is going, and demonstrate in a practical way some of the alternatives, and the processes by which we develop those alternatives. As we set

out to do so, there is a danger that our sense of what is necessary will be silenced by technocratic, scientific jargon. We should not permit this, nor should we be intimidated by the determinism of science and technology into believing that the future is already fixed.

LUCAS PLAN SIGNIFICANT

The Corporate Plan is significant in that it was a very concrete proposal put forward by a group of well-organised industrial workers who had shown in the past, by the products they had designed and built, that they were no daydreamers. It demonstrated clearly to a whole host of scientific and technical workers, through the medium of their own jobs, what the limits of the system are. Many of them actually used to believe that the only reason society didn't have nice, socially useful products was that nobody had thought of them. The fact that these products are being built and are still being rejected, both by the government and the company, demonstrates in very dramatic terms the kind of priorities dominant in this society.

Nine

SOME SOCIAL AND TECHNOLOGICAL PROJECTIONS

COMMUNITIES

There is, correctly, much discussion about the need to revitalise communities and establish local job-creation schemes. One possibility worth considering is that of community-owned enterprises on non-hierarchical lines, closely integrated with local needs for equipment and services. However a serious aspect of this 'community rejuvenation' is the drift towards what I shall call industrial feudalism. Our economy is now dominated by the massive multinational corporations and financial institutions. The role of even nation states is quite subordinate to these, since they set the economic, and increasingly the political, framework within which the governments of the individual nation states are allowed to legislate. These vast corporations spearhead the so-called technological revolution, and distort its development to meet their needs for profit maximisation. The underlying assumption is that of a rapacious economic system fired by ever increasing consumption and production. Apart from the waste of energy and materials their throwaway products bring in their wake (not to mention widespread pollution), they are becoming increasingly capital-intensive rather than labour-intensive. Throughout the technologically advanced nations, they are displacing millions of workers and are permanently destroying jobs and skills while extending their control over the cultural as well as the economic and social lives of the mass of the people.

In addition to this, the ecological crisis is likely to assume even greater political significance and it is important that it should not be seen as a middle-class preserve. After all, it is always the stream in which a worker does his bit of rough fishing that will be polluted, seldom if ever will it be the salmon stream in Scotland. It is usually

the working-class community that will have a motorway running through it, not the stockbroker belt in Surrey. It is usually the working-class playground that will have filth belched out upon it from local factories, hardly ever the middle-class golf course. Workers do not stand to gain from the misuse of science and technology. They make no profit from the pollution of the rivers, the seas and the air. It is in their class interests to resist these things and it is vital that they should be involved.

Public hostility to the naked power of this 'democratic oppression' is growing, and ranges from the reluctance of young people to work for the big multinationals, to the more dramatic actions against businessmen in West Germany and Italy. These are as yet isolated indicators of what may become a very significant movement, when large sections of the labour and trade-union movement finally realise that we are dealing with structural unemployment rather than the cyclical forms we experienced in the past.

THE NEW FEUDALISM

The vast multinationals are increasingly conscious that there is going to be a backlash from society at large due to the way they are distorting its development. Some of my acquaintances, who are well-placed technocrats in these vast companies, tell me that they are about to engage in what they call 'programmes of enlightened self-interest', and are planning to move into the community and job-creation field.

The idea is that the big firms will supply some funds, and second their executives (with all the elitism that implies) to set up small-scale community enterprises. In this way they hope to be able to placate the public, on the one hand, and thereby, on the other, be left free to get on with the serious business of maximising their profits at the commanding heights of the economy.

Computerisation and automation will mean that smaller numbers will be required to run the large corporations. These will be a separate elite from the rest of the community and highly organised on the 'business union' basis as in the United States. They will be true 'Corporation Men', satisfied economically with company cars,

company houses and company medicare schemes (not insignificant, with the systematic attempt to break up the National Health Service). There will be funds for the schooling of the Corporation Man's children, special superannuation schemes and of course expense accounts for overseas travel, entertaining and other corporation 'responsibilities'.

A large sector of those who remain unemployed will be left to fiddle around with 'community work'. These activities will be deliberately chosen because they yield no economic power. It will be a sort of therapeutic, do-it-yourself social service. The industrial feudal lords will sit in the multinational headquarters while the peasants scratch out a living in the deprived communities in which they reside. In practice, this will mean that they will spend their time repairing, cleaning up, modifying and recycling the rubbish which the large corporations are imposing on them. While it is conceivable that some of these jobs will be craft-based and thus provide an outlet for some initiative and self-activism, the significant reality will be that they have no economic power and no industrial muscle. So a considerable proportion of the population seems destined to have no 'real job' – no paid employment. Caring activities, leisure activities, unpaid social work and community work are not recognised as real jobs. The social multiplier effects of unemployment will be alienation, drug taking, suicides, interpersonal violence and general degradation, all of which are evident in abundance in our inner-city areas.

We will all be assured, of course, that this kind of work will be nonalienating and will enhance our self-reliance. Both of these are highly desirable in themselves, but that will not be the objective of the sort of community activity now envisaged and being supported by the government. The implications of such a development are far more profound than it would at first appear.

There is growing evidence that in sectors of the government as well as in the boardrooms of the massive multinational corporations, there is the intention of actively encouraging the growth of this dual economy. Some of the corporations have already released leading executives to become involved in job-creation schemes. As one of them jokingly put it, 'The government can only pay about

£8000 for them to do this work, so we'll make up the other £30,000 for them.'

Their concern seems to be to diffuse the growing resistance among the unemployed and the critical sectors of the community to the manner in which the corporations and the government are displacing large groups of workers on the one hand and dominating the manner in which technology is developing on the other.

In the process they are, of course, maximising their profits and in practice are able to circumvent or negate any enlightened programmes of industrial reorganisation which nation-state governments might attempt to implement. Such enlightenment, I must add, is not particularly evident anywhere in this country under this government or indeed the last one. It is not, therefore, too far-fetched to suggest that the government and the large employers will conspire to force the unemployed and the deprived communities to provide their own social services.

Culturally, the members of these communities may live in a world they no longer understand or can cope with. At a political level, with such a concentration of economic power and technical know-how within the elite, it is unlikely that the present concepts of equality and democracy would long survive, and the development of a highly centralised, authoritarian corporate state would thereby be facilitated. Further, the small elite in the highly capitalised 'scientific and productive' sector of the economy would be involved in the design and development of forms of repressive technology which could be used against the remainder without the hindrance of any countervailing force in the traditional form of a class-conscious, organised working class within the productive processes.

A FOOT IN BOTH CAMPS

It is against this scenario that the Lucas workers have raised the demand that everybody should have the right to a job, and on socially useful work. If there is to be a dual economy with high-level and low-level sectors, then the work in the advanced sector should be available to, and shared out among, the whole labour force. No one who wants to take part should be written off as

incompetent or incapable, and an appropriate educational and training infrastructure should be made available to all. Socially useful production should raise the level of interest, involvement and job satisfaction of workers and help to release the immense creativity of the work force which is at present deliberately stifled through Taylorism and scientific management. Work sharing would entail a dramatic reduction of work hours in the 'productive sector' leaving workers time to engage in the alternative 'uneconomic service sector'.

This is not as far-fetched as it may sound. Probably the majority of the population is already engaged in some form of do-it-yourself or voluntary activity not carried on for profit, whether it be community action, hospital visiting, house repairing or home brewing, and there is great scope for cooperative organisation in any such activities where group working is desirable.

All this implies a significant shift in the way in which trade unions would function. Firstly, it would require them to attach far greater importance to workplace organisation than is now the case. The present grudging acceptance of developments like those at Lucas Aerospace would have to be replaced by active support. Secondly, if we are to have a dual economy, the unions must be prepared to function in both sectors, to organise the unemployed and the partially employed and to expand the cooperative sector where traditionally 100 per cent trade unionism has been readily accepted. To succeed in doing this, a dramatic re-examination of trade-union structures will be necessary, and the highly centralised authoritarian bureaucratic forms of some of them will have to be altered. More importantly, they could provide a bridge through both education and collective bargaining whereby workers could as of right have a foot in both camps if we are going to accept that there will be two. In other words, they would be helping to link together the dual role of human beings, namely that of producers and consumers.

ON WORKERS' CONTROL

If we look about us in Britain at the moment, we can see there is a serious crisis. There is a crisis of structural unemployment, our

National Health Service is being dismantled and even the air we breathe is being polluted by this system. Yet, in spite of this crisis, the influence of the Left is significantly small in Britain.

When you say that to left-wing people, they have a tendency, in all seriousness, to take the view of Brecht who, on one famous occasion, said, with brilliant irony, 'The government has decided the people are wrong, therefore the people must be disbanded.' Some people say if *only* we had the French working class or if *only* we had the Italian working class we would surge forward. But we have the British working class with all its weaknesses and all its strengths – and its strengths are many. It is an experienced and courageous working class.

Part of the trouble is that we don't listen to the working class nearly enough. When you talk to workers about a socialist society, they tend to ask whether there is any country where that sort of society exists, and that's a pretty difficult question. I wouldn't like to say that the sort of society I want is the one I see in the Soviet Union, for example. It is in many respects the contrary of what I wish to see.

They ask 'What kind of leaders? How would the country be run?' It is clear from the whole way they question these things that they have no intention of replacing one elite with another. They don't want tsars, whether they be government tsars, trade-union tsars or any other kind. They want a society in which they can really participate and use their creativity to the full.

Now in many ways, that concept is in contradiction with the notion of leadership that exists in many parties and factions in the United Kingdom. There is the notion going around that leadership is declaring yourself to be a vanguard. Having said that, you then pursue a sort of Jesuitical logic and say that if we are the vanguard it necessarily follows that we represent the highest level of consciousness of the working class. We are also the most dynamic in the working class and anybody who disagrees with us must be an enemy. This dogma induces political leaders to perceive their role as solely that of telling others what to do, since by virtue of being part of this elite vanguard, they know by definition precisely how ordinary people should behave in all circumstances and at all times.

The problem about this is that even if we could find leadership – and I certainly don't see it in Britain at the moment – such a leadership would deny the working class a most precious experience. This is the self-activism and development which raise the level of consciousness and competence to that high level which is a prerequisite of social advance, that is, a really democratic society. Insofar as workers' control is one of the components which would do that, it is, in my view, important.

WORKERS HAVE VISION

I mention that particularly because of the significant developments in Lucas Aerospace. As a result of trying to draw an image of what the future of that company might be like, and an image of the society in which it would operate, it has been possible to be practically engaged in a whole series of activities which have exposed our members, far more clearly than ever before, to the objective role of the government and many of the ministers within it. We have seen both the pathetic, slavish grovelling of some government ministers to this big multinational company in which they work, and the objective role of the trade-union leaders who, behind our backs, had secret meetings with the company to prepare the carve-up of our jobs. These are the same people who, when confronted eight years ago with our request to assist us in deciding what products we could be making, and how we should be making them, were absolutely silent. Yet they are the people who will tell us that they know best and will always lead us. We don't like that kind of hierarchy at all, whether it be in the trade-union movement or in political parties.

In the course of that struggle, we have, as well, been able to demonstrate in practice the non-neutrality of science and technology. We have been able to do it in objective circumstances through activity, in a way we could never have done just by reading about it, or by getting lectures from very profound leaders. 'I know because I do,' as one of the Lucas workers said, 'not, I do because I know.'

Any organisation that provides a framework in which workers can be involved in that kind of activity is, in my view, an important and significant development towards creating the level of con-

sciousness we need to safeguard and guarantee democracy in the future.

STAY AT THE BASE

When the superstructure has been changed in other countries, there has been a tendency to run industry precisely as before. It was Lenin who said how important Taylorism could be to the running of the Soviet Union. Now you may recall that Taylor said that a worker should not make improvements upon the instructions given to him, and this reminds me of some political leaders who claim that the mass has been subverted when it does not pursue the direct party line.

What we are talking about is a level of consciousness which comes through struggle. We maintain that those who become separated from the base of the action and go into the superstructure very quickly begin to challenge the base. There is a contradiction between superstructure and base. In my view, any full-time trade-union leader, taken away from the point of production – he can be as benevolent and dynamic and energetic and political as he wants – that person, over five years or so, will change. I have seen that change happen among my colleagues. If we are talking therefore about workers' control, we have got to ensure that we develop mechanisms where people are continuously exposed to the contradiction at the point of production itself.

When Jack Mundy suggested that trade-union leaders should return to the point of production after three years and work there for six years before they have the possibility of becoming a full-time official again, he was torn apart both by the Right and the Left in Australia. Both these groups saw real workers' control, where there was rotation of function and involvement of people at the point where the decisions would be made, as a challenge to their power structures. It is worth recalling that during the Cultural Revolution in China (which, in spite of some horrific excesses, raised profound questions of the contradictions between base and superstructure) the workers at the Shanghai machine-tool factory said on one occasion that in their opinion, the most dynamic members of a party or class should never go into the superstructure, but should

stay at the base, fermenting and toppling the superstructure if necessary. That to me is the dimension of real industrial democracy and workers' control.

COMPROMISE

It may be that industrial democracy and workers' control, as it is spoken about, could represent a compromise with the system which oppresses us. There seems to be in some circles the idea that if only we could get more and more people into positions of authority, we might wake up one morning to find that we have five seats on the board against the employers' four seats and we could then disband it altogether.

I don't believe for one moment that any ruling class, of the right or the left, acquiesces in its own destruction. I take the view that there is a need ultimately for a party and for an organisation of the working class which can face up to that power. Although that would require a level of consciousness among the working class which we don't have in Britain at the moment, our experience in Lucas Aerospace is that we are developing the levels of consciousness which will make that sort of thing possible.

I think, therefore, that insofar as workers' control can begin to move towards a dual power situation in industry, where the workers begin to flex their own muscles and be conscious of their own great intellects, it is of some importance. These are the people who design and build everything we see about us and without whom we could not survive. After all, you can't live in a pound note, you can't eat a pound note, neither can you drive around in one. All that we see about us comes as a result of the power, the ingenuity and the creativity of working people. If through workers' control they have the opportunity of sensing that power, of using it in practice and thereby understanding how parasitic and how irrelevant are those who control society, then workers' control will have been important. Insofar as it represents one challenge to the naked power of the multinationals in this country, it is, I believe, of great significance.

NUCLEAR POWER – THE POLITICAL DANGERS

It is not my intention to attempt to deal with the issues of nuclear hazards or the wider ecological issues. I will confine myself to what I regard as the enormous political consequences of this type of technology. These political issues can and should represent a major rallying point for the trade-union movement. Nuclear technology will be an avenue to attack basic democratic and trade-union rights, which our movement has established after generations of struggle and sacrifice.

For 300 years, our predecessors fought against the employers, governments and the law to establish the right to strike. Only a slave cannot strike! Nuclear technology will prove to be one of the most effective strikebreakers in history. It will be recalled that when previous governments, both Conservative and Labour, sought to deny some of these rights through industrial-relations policy, there was an upsurge against it. With this type of technology, the same sort of thing will be done by more surreptitious means. We will therefore be able to find a community of interest between those concerned about the ecological impacts and hazards of nuclear power, and those concerned about its impact on democratic rights. So far, progressive forces have failed to make these links, and one witnesses on all sides narrow, single-issue activity, lacking a cohesive organisational and political framework.

These concerns and the manner of addressing them do not fall into conventional left or right political pigeonholes. We find Margaret Thatcher's approval of the French socialist government's nuclear programme, and the adherence of the Soviet Union to its nuclear policies in spite of the Chernobyl accident. This compares strangely with the situation in the United States, where the building of nuclear reactors stopped after the Three Mile Island events. All these countries of course continue to develop nuclear power for their military programmes.

The nature of this technology will shape the society in which we live, and even if we could succeed in so redesigning the nature of that industry as to render it 'safe' in an environmental sense, it is unlikely that we will be able to render it 'safe' from a democracy

point of view. Tony Benn, an advocate of industrial democracy, was the minister for energy and felt compelled to use troops to end a dispute in the nuclear industry on the grounds that the strike constituted a major public hazard. It is now significant that arising from the public concern about nuclear power which has been heightened dramatically by the Chernobyl accident, Tony Benn and some other Labour leaders have been honest enough to alter their position on the nuclear-power issue and have now pressed for a searching and public debate on the phasing out of nuclear power plants in Britain.

Once it has been established through the nuclear industry that it is industrial policy to prevent strikes in circumstances of this kind, the argument could then extend to many ICI plants, or indeed to almost any large plant, as we know from the recent events in the north of Italy. This kind of industry could do to us what anti-trade-union legislation has failed to do to us in the past, that is, deny us a most basic right – the right to strike.

BRITISH *BERUFSVERBOT*

Trade unions have always tried to prevent employers victimising workers because of their political views. With nuclear technology, it will be said that to guard against terrorists, the government must increasingly insist on knowing the political affiliations, the intimate personal habits and even the bank balances of those who work in those industries. It will be a massive intrusion into the personal privacies of those who are expected to do this work, and workers will be denied the right to work in such industries on the basis of the political views that they hold. We will no longer be able to sneer at West Germany, with its repressive legislation. We will have our own, much more subtle, English forms of *Berufsverbot*.

Even the communities which live around the stations will be subjected to scrutiny, in case they might harbour potential terrorists.

For those who work in the industry, there can be no industrial democracy. Since the industry and its operation represent enormous industrial hazards, all actions of the workers in it are determined well in advance. All command systems emanate centrally, and must be obeyed at all levels. It is run on almost military

lines. Even the clothing that the workers wear is specified in many of the areas.

One of the latest arguments is to say that we must have this technology because it will create new jobs for us. We suddenly find lots of strange allies of the working class; those converted overnight to concern about our right to work. We heard little from these people when Arnold Weinstock was destroying 60,000 jobs in GEC. We heard little from them when companies like Leyland were destroying thousands of jobs as well. In particular, we in Lucas Aerospace heard nothing from them when our company brutally reduced its work force from 18,000 to 12,000. If for a moment we accept that these people are genuinely concerned about jobs for the whole population, we would have to say immediately that their proposal that we need nuclear power to do this will represent the most expensive job-creation scheme in history. Probably in more senses than one.

If we regard this expense, not in terms of hazards or potential loss of life, but simply in first-order economic terms, it will cost something like £600,000 to create one permanent job at Sellafield. Yet one could create jobs in energy conservation, say in the East End of London, insulating houses at approximately £4000 per job.

LEARN TO USE THE ENERGY WE HAVE!

I wish to state, as a trade unionist and a technologist, that I am not opposed to technological change. I am certainly not like some romantics who seem to believe that before the Industrial Revolution, the populace spent its time dancing round maypoles in unspoiled meadows. I am deeply conscious of the enormous contribution science and technology have made towards eliminating squalor, disease and filth. What I am totally opposed to is the irresponsible use of technology, and I regard it as irresponsible to introduce a form of technology such as nuclear power, until we have examined very carefully what real alternatives exist – until we have put as much research money into alternative forms as we presently put into nuclear power. Further, we must test and assess the long-term implications of some of the nuclear technologies at present being proposed.

Nuclear power, as we now know it, will not create the type of jobs we should be demanding in the trade-union movement. They will be hazardous jobs, hazardous for the workers and for the community. There will be enormous political implications in the social infrastructure which will be set up around these industries. It *will* destroy our right to strike.

Those who work at the rank-and-file level in the trade-union movement have an enormous task to get these issues raised in that movement, and gradually to get opposition built up to it.

ORDINARY PEOPLE

I am frequently asked if I believe that ordinary people are really able to cope with the complexities of advanced technology and modern industrial society.

I have never met an ordinary person. All the people I meet are extraordinary. They are fitters, turners, housewives, nurses, airline pilots, doctors, draughtsmen, designers, teachers. They all bring vast bands of intelligence, experience and knowledge to the daily tasks that they perform.

Lucas Aerospace has ordinary maintenance fitters who go to London airport if a generator system is causing a problem. The whole aircraft might perhaps be grounded because of it. One of these fitters can listen to the generator, make a series of apparently simple tests – some of the older fitters will touch it in the way a doctor will touch a patient – and, if it is running, will be able to tell you from the vibrations whether a bearing is worn and which one.

The fitters will subsequently make decisions about the reliability of that piece of equipment, and on that decision, the lives of 400 people may directly depend. The decision may be far more profound in many ways than that which a medical practitioner might make, yet if you asked those 'ordinary people' to describe how they reached that decision, they could not do so in the usually accepted academic sense. That is to say, they would not be capable of drawing a decision-making tree leading to their final conclusion. Yet that conclusion will be right, because they have spent a lifetime accumulating the skill and knowledge and ability which helps them to arrive at it.

When a great politician goes on a world tour, he or she will be dependent, among other things, on the skill and ability of the people who have maintained the aircraft, those who designed and built it, the pilots who fly it and the traffic controllers who regulate its flight paths. However, all these will be completely unheard-of, ordinary people.

Likewise, when we travel on a high-speed train, we are dependent on the skill and ability of those who have maintained and built it, the people who maintain the tracks and the people who operate the signalling systems.

In everything we do, whether we are in hospital, travelling along a motorway or in the underground, we depend on the skill, ability, understanding and intelligence of so-called ordinary people. Every building we see about us has been constructed by people like that. Every car that runs along the roads has been built by them. Yet, in spite of all the knowledge these people demonstrate in practice, they are effectively excluded from the major decisions which affect the way their lives are run and the industries in which they work are organised. They are induced to believe that they are incapable of making the major decisions about the way society should develop.

This in spite of the fact that everything we see about us has been designed and built by those people. They are deliberately conditioned to feel no association between the technology, or the products they have produced, and their own intelligence.

INTELLIGENCE OR LINGUISTIC ABILITY?

When building workers erect a building, they do not scratch their name on it as an artist or a sculptor might do. They do not associate themselves with the building, yet it has been produced by them. The whole educational and political system works to reinforce these assumptions. We have more regard for those who write and talk about things than those who actually do them. We confuse linguistic ability with intelligence.

Workers express their intelligence by the things they make and do, and the manner in which they organise themselves in producing these things. They have developed and utilised very high-level and complex communication systems among themselves.

When, for example, they are erecting a power station and are lining up a turbine and generator set, the workers will go through highly complex decision-making routines, and communicate these decisions to each other with crisp, simple sentences. An instruction manual on how this is done could be a vast technical work. If you hear two 'intellectual workers' talking about these procedures, they frequently have to go into great detail and describe these matters in a language of great complexity.

It seems to me, therefore, that if we are effectively to question the way science and technology are developing, and do it in such a manner that we involve masses of people in the process, avoiding the dangers of elitism (which are as dangerous from the Left as from the Right), we shall have to organise our affairs so as to release the tacit knowledge of these workers.

Further, we shall have to organise our decision-making routines and our social organisations in such a way that the knowledge, intelligence and experience of these people is not bludgeoned into silence by academic rambling and technological jargon and a deliberately confusing overcomplexity.

This is not to say that profound questions can be treated in a simplistic fashion, but they should be dealt with in a manner which makes them accessible to so-called ordinary people. These questions are of profound and fundamental importance to the whole issue of democracy itself. If we hold it to be desirable that our societies are composed of alert, vigilant, self-active, self-reliant, cooperative and concerned citizens, we have to provide political structures which cater for this.

It is my experience, having spent some twenty-five years in the engineering and manufacturing industries, that 'ordinary people' are well capable of understanding and coping with these problems when they are directly put to them. If academics have difficulty in communicating with workers, then it is *their* fault, not the fault of the workers involved. As an African rebel leader once said, 'Let your words be so direct and clear and simple that the ideas they represent flow through ordinary people's consciousness as naturally and as easily as the wind and the rain flow through the woods.'

COULD WE USE SCIENCE DIFFERENTLY?

I have suggested earlier that science and technology are not neutral, but reflect the economic base which gave rise to them. If this is correct, then the use/abuse model will be inadequate to explain the contradictions we see in technologically advanced society. We shall have to probe deeper.

Technological change has certainly been used, not merely to increase productivity, but to extend control over those who work within those processes. Further, D. F. Noble has brilliantly demonstrated that engineers, in the application of science and technology, have been serving and advancing the cause of corporate capitalism.[1]

I have questioned whether the means of production so developed would be appropriate in a society where human beings could develop their potential to the full, even when the ownership of the means of production is 'in the hands of the people'.

Science as practised in the technologically 'advanced' nations, and I would include here the so-called socialist countries, shares with Taylorism the methodological assumptions of predictability, repeatability and quantifiability.

If one accepts these to be tenets of the scientific method, it then follows that to be scientific implies eliminating human judgement, the subjective and uncertainty; yet skill, in the intellectual and also in the manual sense, can be closely related to the ability to handle uncertainty. Skilled work, we may say, is work of risk and uncertainty, whereas unskilled work is work of certainty. The contrast between a skilled turner using a universal lathe and an unskilled worker on a numerically controlled machine will illustrate the point, as will the contrast between a conventional designer and one using a design-manual type of computer-aided design system. Further, the exercise of skill is an important learning and developing process. If we regard it as desirable to enhance human skill and ability, we have to design systems which are responsive to human judgements, and which respond to the persons using them rather than acting upon them. The telechiric devices described earlier begin to address this problem. Other ideas are being

explored which in embryo start to point the way to a human-enhancing, liberatory form of technology. Two examples only will be given here to illustrate the possibilities – one in the field of manual work, the other in the field of intellectual work.

FIRST EXAMPLE

Over the past 200 years, turning has been one of the highly skilled jobs to be found in most engineering workshops. Toolroom turning is one of the most highly skilled jobs of all. The historical tendency, certainly since the war, has been to deskill this function by using numerically controlled machines. This is done by part-programming, a process by which the desired numerically controlled tool motions, are converted to finished tapes. Conventional (symbolic) part-programming languages require that a part-programmer, having decided how a part is to be machined, describes the desired tool motions by a series of symbolic commands. These commands are used to define geometric entities, that is, points, lines and surfaces which may be given symbolic names.

In practice, the part-programming languages require the operator to synthesise the desired tool motion from a restricted available vocabulary of symbolic commands. However, all this is doing is attempting to build into the machine the intelligence that would have been exercised by a skilled worker in going through the labour process.

It is possible, by using computerised equipment in a symbiotic way, to link it to the skills of a human being and define the tool motions without symbolic description. Such a method is called analogic part-programming.[2] In this type of part-programming, tool-motion information is conveyed in analog form by turning a crank or moving a joystick, or some other hand/eye coordination task, using readout with precision adequate for the machining process. Using a dynamic visual display of the entire working area of the machine tool including the workpiece, the fixturing, the cutting tool and its position, the skilled craftsman can directly input the desired tool motions to 'machine' the workpiece in the display.

Such a system, which may be described as part-programming by

doing, would represent a sharp contrast to the main historical tendency towards symbolic part-programming. It would require no knowledge of conventional part-programming languages, because the necessity to describe symbolically the desired tool motions would be eliminated. This is achieved by providing a system whereby the information regarding a cut is conveyed in a manner closely resembling the conceptual process of the skilled machinist. Thus it would be necessary to maintain and enhance the skill and ability of a range of craft workers who would work in parallel with the system.

Significant research has been carried out in this field,[3] yet, in spite of its obvious advantages, it has not been received with any enthusiasm by large corporations, or indeed funding bodies. This would appear to be an entirely political judgement rather than a technological one.

SECOND EXAMPLE

In the field of intellectual work, Rosenbrock has questioned the underlying assumptions of the manner in which we are developing computer-aided design systems. He charges that the present techniques fail to exploit the opportunity which interactive computing can offer. The computer and the human mind have quite different but complementary abilities. The computer excels in analysis and numerical computation. The human mind excels in pattern recognition, the assessment of complicated situations and the intuitive leap to new solutions. If these different abilities can be combined, they amount to something much more powerful and effective than anything we have had before.

Rosenbrock objects to the automated manual type of system, since it represents, as he says, 'a loss of nerve, a loss of belief in human abilities, and a further unthinking application of the doctrine of the "Division of Labour".'[4]

As in the case of turning, described above, Rosenbrock sees two paths open in design. The first is to accept the skill and knowledge of the designer, and to attempt to give designers improved techniques and improved facilities for exercising their knowledge and skill. Such a system would demand a truly interactive use of

computers in a way that allows the very different capabilities of the computer and the human mind to be used to the full.

The alternative to this, he suggests, is 'to subdivide and codify the design process, incorporating the knowledge of the existing designers so that it is reduced to a sequence of simple choices'.[5] This, he points out, would lead to a deskilling, so that the job could be done by a person with less training and less experience.

Rosenbrock has demonstrated the first human-enhancing alternative by developing a CAD system with graphic output to develop displays from which the designer can assess stability, speed of response, sensitivity to disturbance and other properties of the system. (See Figure 17.)

If, having looked at the displays, the user is not satisfied with the

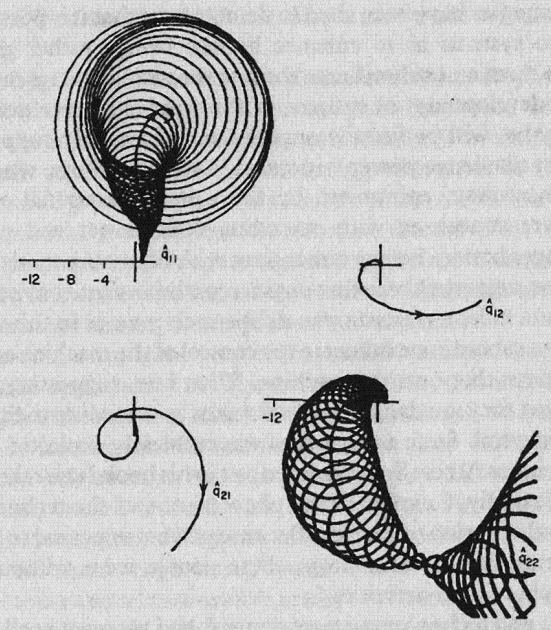

Fig. 17. Graphic display of mathematical functions.

performance of the system, the displays will suggest how it may be improved. In this respect the displays carry on the long tradition of early pencil and paper methods, but of course they bring with them much greater computing power. Thus, as with the lathe and the skilled turner, so also with the VDU and the designer: possibilities exist of a symbiotic relationship between the worker and the equipment. In both cases, tacit knowledge and experience are accepted as valid and are enhanced and developed.

In Rosenbrock's case, it was necessary to examine the underlying mathematical techniques involved in control-systems design.[6] The outcome of his work does demonstrate in embryo that there are other alternatives if we are prepared to explore them before we close off options – the 'Lushai Hills effect'.[7]

HUMAN-ENHANCING

These examples have been cited to demonstrate that it is possible so to design systems as to enhance human beings rather than to diminish them and subordinate them to the machine. It is my view that the development of systems of this kind, however desirable they may be, will be fiercely opposed and vigorously suppressed since they challenge power structures in society. Those who have power in society, epitomised by the vast multinational corporations, are concerned with extending their power and gaining control over human beings rather than with liberating them.

It is not suggested here that engineers who design conventional systems are hideous fascists who deliberately engage in this design in order to subordinate others to the control of the machine and the organisations that own the machine. What I am suggesting, however, is that they are dangerously mistaken in regarding their work as being neutral. Such a naive view was ruthlessly exploited in the Third Reich as Albert Speer pointed out in his book *Inside the Third Reich*: 'Basically, I exploited the phenomenon of the technician's often blind devotion to his task. Because of what appeared to be the moral neutrality of technology, these people were without any scruples about their activities.'

Science and technology are not neutral, and we must at all times expose their underlying assumptions. We can, at the same time,

begin to indicate how science and technology might be applied in the interests of the people as a whole, rather than to maximise profits for the few.

But it is not only the scientist and entrepreneur who must be more responsible. One of the saddest things for me has been the inability of the trade-union movement to foresee the impact that new technology would have on the unions as institutions, and particularly on their members. Even more distressing was the unwillingness even to discuss the issues in any meaningful way; and finally, when the Lucas workers sought to do something, it was deplorable to witness the manner in which the trade-union bureaucracy (with a few honourable exceptions) converged to undermine what they perceived to be an 'oppositional movement'. Furthermore, they lost a unique opportunity to show that the trade-union movement could modify and transform itself, in the terms of Wainwright and Elliott, into 'a new trade unionism in the making'.[8]

The opportunity was there to demonstrate that they were concerned about environmental issues, that they were concerned about the communities in which their members worked, and not just their members, and that in dealing with some of their own problems of growing structural unemployment they could use their skills and talents to support less fortunate sectors of the community. They lost a tactical advantage which allowed Thatcher subsequently to portray the unions as entirely selfish, inward-looking organisations lacking in compassion and concern.

However, even at the level of narrow self-interest, they failed to grasp the opportunity to organise their affairs and mobilise their strength to be one step ahead of the multinationals in defining the types of human-centred technologies that they required, rather than slavishly reacting to steps the employers had already taken. The basis existed in the Lucas Workers' Plan for avoiding, or at least preparing for, a Wapping-like situation. That possibility still exists for many engineering workers and those in a range of white-collar and administrative areas, but time is not on their side.

Trade unionists, socialists, liberals and humanitarians are now beginning to pay the price for ignoring technological development.

Some have been obsessed with the contradictions of distribution to the exclusion of an ongoing concern about the contradictions of production. Others are not interested in 'industry' except in a voyeurist fashion and many seem to believe that the world can be composed entirely of well-meaning sociologists.

A deep analysis of the form and nature of technology is required, together with a recognition that whether we like it or not it does at this stage constitute a leading edge in society in rather the same way religion did at earlier stages.

There is evidence that the Lucas Workers' Plan has contributed – at least to a meaningful discussion – on some of these issues, and in trade-union terms, it does represent quite a shift forward. The International Metalworkers' Federation, which represents over 150 unions in some seventy countries, has produced a report in seven languages which it is distributing free of charge in order that these discussions may take place among its membership.[9]

There is no doubt that at the political level, the developments in the GLC in setting up the Greater London Enterprise Board were a further expression of the ideas formulated at Lucas. The Lucas Workers' term 'socially useful production' is now in the life stream of large sections of the political movement.[10] The technology networks, for all their unevenness and considerable difficulties, represent an important step forward for that concern in the Lucas Plan, the democratisation of science and technology, and the involvement of large sections of the community in defining the types of products and services they require.[11] Although these activities were to take place at a local and even individual factory level, they were to be part of a wider scheme as set out in the London Industrial Strategy,[12] and based on the skills of the people of London as set out in the Labour Plan.[13]

These were but the job-creation and socially useful production aspects of the plan permeating the political body. In parallel, there was a paradigmatic shift in our concept of how systems might be designed in a human-centred way. An outgrowth of the earlier Rosenbrock work described above was the two-year programme to design and develop a human-centred lathe in which the qualitative, subjective elements would be handled by the operator and the

quantitative elements by the machine. Such a control system and its interface were developed at UMIST.[14]

This in turn laid part of the basis for the GLEB-sponsored ESPRIT project to design and build the world's first human-centred computer-integrated manufacturing system.[15] Discussion with colleagues in other countries since the late 1970s has gradually built up a network of engineers, scientists, philosophers, researchers and social scientists who are now working on these ideas from a theoretical level through to very practical projects. Some of them, like Peter Brödner, are discussing how we might conceptualise the factory of the future – an anthropomorphic factory – described in his vitally important book which I hope will soon be available in the English language.[16] Given the deluge of quasi-expert systems, artificial-intelligence software tools and frameworks for fifth-generation systems, it is important to have a forum where these matters can be discussed at both a theoretical and practical level, and Rajit Gill and others (including the author) have founded the journal *AI and Society – Human Centred Systems Journal*.[17] Likewise, international bodies dealing with computerisation are setting up social effects committees to analyse the multiplier effects of technology, and the International Federation of Automatic Control is a good example of this.

These all constitute important developments which I hope will converge adequately to produce visible and meaningful alternatives before an infrastructure of machine-based systems, with its attendant reconditioning through 'training', permanently closes off options for human-centred technology in rather the same way as a similar option in respect of skilled manual work was closed off around the fifteenth and sixteenth centuries.

The rate of technological change suggests to me that we have a mere fifteen or twenty years in which to do so, otherwise we will find, as an artificial-intelligence expert put it recently on British television, that humans will have found their natural place in the evolutionary hierarchy. Namely animals at the bottom, human beings in the middle and thinking machines at the top!

The future is not 'out there' in the sense that a coastline is out there before somebody goes to discover it. The future doesn't have

predetermined shapes and forms and contours. The future has yet to be built by people like you and me and we do have real choices. I hope the ideas contained in this book will have highlighted at least some of them.

The choices are essentially political and ideological rather than technological. As we design technological systems, we are in fact designing sets of social relationships, and as we question those social relationships and attempt to design systems differently, we are then beginning to challenge, in a fundamental way, power structures in society.

The alternatives are stark. Either we will have a future in which human beings are reduced to a sort of beelike behaviour, reacting to the systems and equipment specified for them, or we will have a future in which masses of people, conscious of their skills and abilities in both a political and technical sense, decide that they are going to be the architects of a new form of technological development which will enhance human creativity and mean more freedom of choice and expression rather than less. The truth is, we shall have to make the profound political decision as to whether we intend to act as architects or behave like bees.

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Michael Cooley was born in Tuam in the west of Ireland in 1934. He was educated at local Catholic schools and later studied engineering in Germany. In industry he specialised in engineering design and gained a PhD in computer-aided design.

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