when we can barely perceive the problems. We must be careful not to abandon prematurely all the various courses of development that we have been following—perhaps the greatest disaster would be to try to change too much too quickly.

A massive and complex (highly inefficient and wasteful) system has grown up. From much of it has come enormous benefit to many of our people. As the process of overall economic growth slows down we can start to create new small growth points to take the place of the old as they go into decline and die. We can concentrate much of our attention on new growth centres because it may well not be possible to transform the old. In this way, and in due time, much of the old will disappear to be replaced by a technology which, if we learn as we go, will be humane, small-scale, congenial, economical and harmonious with its environment. The best of what has been created during the industrial era will be retained and the worst will slip without regrets into history.

Schumacher subtitled his book *Small is Beautiful*,—'A study of economics as if people mattered'. The new technology—whether big or small—will only be beautiful if it is for people, who matter most.

THE GROTESQUE LITANY GOES ON.

III. Design, technology and production for social needs

An initiative by the Lucas aerospace workers

Mike Cooley, Senior Design Engineer, and TASS chairman, U.K. sites of Lucas Aerospace.

THERE are many contradictions which highlight the problems of our so-called technologically advanced society. Four of these contradictions are particularly relevant to what I shall have to say.

Firstly, there is the appalling gap which now exists between that which technology could provide for society and that which it actually does provide. We have a level of technological sophistication such that we can design and produce Concorde, yet in the same society we cannot provide enough simple heating systems to protect old-age pensioners from hypothermia. In the winter of 1975–6, 980 died of the cold in the London area alone. We have senior automotive engineers who sit in front of computerized visual display units 'working interactively to optimize the configuration' of car bodies such that they are 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 miles per hour at the turn of the century when the vehicles were horsedrawn. In London at certain times of the day it is about 8·5 miles an hour. We have sophisticated communication systems such that we can send messages round the world in nano seconds, yet it now takes longer to send a letter from Washington to New York than it did in the days of the stage coach. Hence we find 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 wastage our society makes of its most precious asset—that is the skill, ingenuity, energy, creativity and enthusiasm of its ordinary people. We now have in

Britain 1·6 million people out of work. There are thousands of engineers suffering the degradation of the dole queue 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 semi-slums in this country. In the London area we have about 20 per cent of the schools without an indoor toilet, when the people who could be making these things are rotting away in the dole queue.

The third contradiction is the myth that computerization, automation and the use of robotic equipment will automatically free human beings from soul-destroying, back-breaking tasks and leave them free to engage in more creative work. The perception of my members and that of millions of workers in the industrial nations is that in most instances the reverse is actually the case.

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 some latter day Yahoo, to misquote Swift. 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 non-recycleable containers 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 maximization of profits. It is therefore not surprising that some of our most able and sensitive sixth formers will now not study science and technology because they correctly perceive it to be such a dehumanized activity in our society.

All these four contradictions—and indeed many others—have impacted themselves upon us in Lucas Aerospace over the past five years. We do work on equipment for Concorde, we have experienced structural unemployment and we know 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 the 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 rationalization 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 Reorganization Corporation to facilitate this rationalization programme. No account at all was taken of the social cost: Arnold Weinstock subsequently sacked 60,000 highly skilled workers. This may have made GEC look efficient but the taxpayer had to pick up the tab firstly for the payment of social services and secondly the nation state as a whole suffered the loss of the productive capacity of these talented workers.

We in Lucas Aerospace were fortunate in the sense that this happened about one year before our company embarked on its rationalization programme. We were therefore able to build up a combined committee which would prevent the company setting one site against the other in the manner Weinstock had done. This body—the combined committee—is unique in the British trade union movement in that it links together the highest level technologists and the semi-skilled workers on the shop floor. There is therefore a creative cross-fertilization between the analytical power of the scientist and the technologist on the one hand and, perhaps what is much 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 manner in which other groups of workers were attempting to resist it. We had in Lucas already been engaged in partial sit-ins, in preventing the transfer of work from one site to another and a host of other industrial tactics which had been developed over the past five years. But we realized that the morale of a workforce very quickly declines if they 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.

The Lucas proposals

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

We prepared 180 letters ... described in great detail the nature of the workforce, its skills, its age, its training, the machine tools, equipment and laboratories that were available to us and the types of scientific staff, together with the design capabilities which they had. We wrote to 180 leading authorities, institutions, universities, organizations and trade unions, all of which in the past had one way or another suggested that there was a need for the humanization of technology and the use of technology in a socially responsible fashion. What happened really was a revelation to us: all of these people who had made great speeches up and down the country, in some instances written voluminous books about these matters, were smitten into silence by the specificity of our request. We had asked them very directly what could a workforce with these facilities be making that would be in the interest of the community at large—and they were silent with the exception of four individuals, Dr. Elliott at the Open University, Professor Thring at Queen Mary College, and Richard Fletcher and Clive Latimer at the North East London Polytechnic.

We then did what we should have done in the first instance: 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 it is one thing, having concrete evidence is something different. That concrete evidence began to pour into 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. I should explain that 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 respondent was caused to think about his or her skill and ability, the environment in which he or she worked and the facilities which they had available to them. We also deliberately composed it so that they would think of themselves in their dual role in society, that is both as producers and as consumers. We were therefore quite deliberately transcended the absurd division which our society imposes on 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 be meaningful in relation to the communities in which we live. We also deliberately designed the questionnaire to cause the respondents to think of products not merely for their exchange value but for their use value.

When we collected all these proposals we refined them into six major product ranges which are now embodied in six volumes, each of approximately 200 pages. They contain specific technical details, economic calculations and even engineering drawings. We quite deliberately sought a mix of products which on the one hand included those which could be designed and built in the very short term and 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 incidentally which could be sold in a mutually non-exploitative fashion. Finally we sought a mix of products which would be profitable by the present criteria of the market economy and those which would not necessarily be profitable but would be highly socially useful.

Products for the community

I shall explain briefly some of the products we are proposing.

In the medical field Lucas already makes pacemakers and kidney machines. About three years ago 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 both by 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 3,000 people die each year because they cannot get a kidney machine. If you are under twenty-five and over fifty-five it is almost impossible in many areas to get one. The doctors involved sit like judge and juries with the governors of hospitals deciding who will be allowed, as they so nicely put it, 'to go into decline'. One doctor said to 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 because they would otherwise be distressed. We regard it as outrageous that the skilled workers who design and make this equipment face the prospect of the dole queue where they will be paid about £40 a week (which when administered by the bureaucrats is approximately £70 a week),

when with a little commonsense if they were paid £70 a week to stay in industry they could at least be producing artefacts which will be required by society. Indeed, if the social contract meant anything and if there were such a thing as a social wage, surely this is precisely the sort of thing which it should imply, namely having foregone-wage increases in order that we could expand the services to the community at large we should have the opportunity of producing medical equipment which they require.

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 they could propel themselves about was literally 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 2,000 of these. Lucas would not agree to manufacture these because they said it was incompatible with their product range and at that time the corporate plan was not developed and we were not able to press for this. But 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 actually took the Hobcart down 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 to then. For the first time in his career he actually saw the person who was going to use the product that he had designed. It was enriching also in another sense because he was intimately in contact with a social human problem. He literally had to make a clay mould of the child's back so that the seat would support it properly. It was also fulfilling in that for the first time he was working in the multi-disciplinary team together with a medical type doctor, a physiotherapist and a health visitor. I mention this because it illustrates very graphically that it is untrue to suggest that aerospace technologists are 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.

Some of our members at another plant realized that about 30 per cent of the people who die of heart attacks die between the point at which the attack occurs and the stage at which they are located in the intensive care unit in the hospital. So 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 they are linked to the main life support system in the hospital. They also learned that many patients die under critical operations because of the problem of maintaining the blood at a constant optimum temperature and flow. This, it seemed to them, was a simple technical problem if one were able to get behind the feudal mysticism of the medical profession. So they designed a fairly simple heat exchanger and pumping system and they built this 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.

In the field of alternative energy sources we have come 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. If therefore there were systems which could conserve this energy at a time when it is not required and use it at a time when it is, this would make a lot of sense. One of the proposals for storing energy in this way was to produce gaseous hydrogen fuel cells. These would require considerable funding from the government but would produce means of conserving energy which would be ecologically desirable and socially responsible. We also designed a range of solar collecting equipment which could be used in low energy houses and we worked in conjunction with Clive Latimer and his colleagues at the North East London Polytechnic in producing components for a low energy house. I should add that this house was specifically designed so that it could be constructed on a self-build basis. In fact some of the students working on the Communications Design Degree course at that polytechnic are now writing an instruction manual which would enable people without any particular skills to go through a learning process and at the same time to produce very ecologically desirable forms of housing. One can now see that 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 to employ those in that area to build their own housing.

We have made a number of contacts with county councils as we are very keen to see that these products are used in communities at large. We are unhappy about the present tendency of alternative technology for products to be provided which are little more than

playthings for the middle class in their architect-built houses. Hence we have already made links via the Open University with the Milton Keynes Corporation and have designed and are currently building in conjunction with the OU prototype heat pumps which will use natural gas and will increase the actual coefficient of performance (COP) to 2·8.

Drawing on our aerodynamics knowhow, we have proposed a range of wind generators. In some instances these would have a unique rotor control in which the liquid which is used as the media for transmitting the heat is actually used to achieve the breaking and is thereby heated in the process itself. We have 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; if one looks at the incredible mess we have made of technology in our society probably one of the most important things the Third World countries could learn from us is what not to do rather than what to do! It is also a very arrogant assumption 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 which are compatible with the cultural and social structures of these other countries. At the moment our trade with these countries is essentially neo-colonialist. We seek to introduce forms of technology which will make them dependent upon 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. We have proposed a unique power pack which could operate on a range of indigenous fuels and methane and which, by means of a variable speed gearbox, would be capable of alternatively pumping water, compressing air, providing high pressure hydraulics and generating electricity. This would, therefore, be a sort of universal power pack which could provide a small village or community with a range of services. This is quite contrary to the present design methodology which seeks to do actually the reverse.

Time and space does not permit a detailed account of the rest of the 150 products. Three further ones, however, are worth describing.

We are proposing a hybrid power pack which could be used in

cars, coaches, lorries or trains. There is now a growth in the use of battery driven vehicles. This is clearly ecologically desirable but has the great disadvantage that in a stop-start situation they have to be charged every forty miles and on a flat terrain about every hundred miles. We are proposing a power pack in which we have a small internal combustion engine running at its constant optimum revs: this will mean that all the energy which is lost as one accelerates, decelerates, idles at traffic lights, starts cold and so on, is put in as useful energy through a generator which charges a stack of batteries which then operates an electric motor. Our initial calculations (which have subsequently been supported by work done in Germany), suggest that this would improve specific fuel consumption by 50 per cent; it would reduce toxic emissions, since the unburned gases are not going out into the atmosphere, by about 80 per cent. Further, since the whole system would be running at constant revs one could calculate all the resonance of the system and effectively silence it: our calculations suggest that a power pack of this kind would be inaudible against a background noise of about 60 or 70 decibels at 10 metres.

It may be asked, of course, why such a power pack had not been designed and developed before. The simple answer, it seems to us, is that such a power pack would have to last for about ten or fifteen years and this is absolutely contrary to the whole ethos of automotive design which has as its basis the notion of a throw-away product with all the terrible waste of energy and materials which that implies. We are convinced that Western society cannot carry on in this wasteful and arrogant fashion much longer.

This work has caused us to question very fundamentally the underlying assumptions of industries such as the automotive industry. We have had long discussions with our colleagues at Chryslers and British Leyland. In fact the workers at Chryslers now see that the choice facing them two or three years ago was not to continue producing rubbishy cars or to face the dole queue. There were a whole series of other options open to them if the political and social infrastructure were there to allow them to do so. We have been working with Richard Fletcher and his colleagues at the North East London Polytechnic on a unique road-rail vehicle which is capable of driving through a city as a coach and then running on the national railway network. It could provide the basis for a truly integrated, cheap, effective public transport system in this

country. It uses pneumatic tyres and is therefore capable of going up an incline of 1 : 6—normal railway rolling stock can only go up an incline of 1 : 80. This meant in the past that when a new railway line was laid down it was necessary literally to flatten the mountains and fill up the valleys or put tunnels through them. This costs about £1 million per track mile—this was the approximate cost of the railway in Tanzania which the Chinese put down. With our system a track can be put down at about £20,000 per track mile since it follows the natural contours of the countryside. This vehicle would therefore not only be of enormous use in metropolitan Britain but would also be of great interest in developing countries and even in areas such as Scotland and some of the less densely populated areas in Europe.

The last range of equipment I would like to mention is what we call telechiric devices. This literally means hands or control at a distance. If we examine the present development of technology we will see that machines and systems are designed in such a fashion as to objectivize human skill and thereby diminish or totally replace the human being. This means in practice that industries are becoming capital intensive rather than labour intensive. These are also invariably energy intensive. This is now giving rise to massive structural unemployment in all of the technologically advanced nations. There have been about five million people permanent unemployed in the United States over the past ten years; in Britain we have now got 1·6 million. Even in West Germany, that most optimistic of the technologically advanced nations, they now have one million people out of work and 700,000 on short time working. In 1974 they increased the number of process computers by 50·3 per cent and in 1975 by 33·8. They will have sixty times as many microprocessors by 1984 and they reckon that in 1982 60 per cent of all measuring and control equipment will include these microprocessors. It is clear that this is going to give rise to a massive dislocation of the workforce and these concerns are now being expressed by the West German trade union movement, in particular by Ulrich Briefs of the DGB (German TUC). Gradually they too are learning that the more we invest in industry in its present form, the more people we put out of work. When we were considering the design of robotic equipment to maintain North Sea oil pipelines, the more we thought about this the more it became clear the terrible waste we are making of the great human intelligence which is

available to us. If you try to design a robot to recognize which way a hexagon nut is about, much less to select the correct spanner to use on it and then to apply the correct torque, it is an incredible programming job and you realize how intelligent people are in the sense that they can do this without really 'even thinking about it'. In fact comparisons we have made show that the most complicated robotic equipment with pattern recognition intelligence has intelligence units of 10^3, whereas human beings have synaptic connections of 10^{14}. There is therefore no comparison even at a theoretical level between the intelligence of human beings and the intelligence of these artificial devices. Yet with the linear drive forward of science and technology we deliberately design equipment to eliminate all that vast human knowledge.

So we are proposing these telechiric devices which reverse the historical tendency to diminish or objectivize human skill. Basically they are a range of equipment which will mimic in real time the motions of a human being. This would mean that in the case of mining, the skill of the miner would still be used but the miner could go through the mining process remotely in a safe environment whilst the telechiric device actually did the mining for him. Thus we human beings would continue to be involved in that precious learning process which comes about through actually working on the physical world about us and it would also mean that we would be countering structural unemployment. We would, in a word, be very creatively linking a relatively labour-intensive form of work with a reasonably advanced and responsible technology. We would not therefore be proposing a return to the so-called 'good old days' in which some romantics seem to believe that the populace spent its time dancing round maypoles in unspoiled meadows. We are deeply conscious of the squalor, the disease, the filth which existed in the past and the contribution science and technology has made in overcoming these. What we believe is necessary is to draw on that which is best from our past and link it with that which is best in our science and technology.

Harnessing technology to human needs

The Lucas workers corporate plan has the distinct advantage that it is a very concrete proposal put forward by a group of well organized industrial workers who have demonstrated in the past, by the products they have designed and built, that they are no

daydreamers. It is proving to be a unique vehicle with which to test the boundaries of the system both in a technological, political and economic sense.

We have of course approached the government and we have had every sympathy short of actual help! We have been enormously impressed at the ability of the various ministries to pass the buck; indeed we have experienced at first hand the white heat of bureaucracy. Although the company has centrally rejected the corporate plan and is now refusing to meet the combined committee to discuss it, no Minister has been prepared to insist that the company should meet us to do so. In fact junior ministers, like Les Huckfield, continuously write to us saying 'In my considered view those best suited to deal with this question are the company and the trade unions involved'. It is absolutely clear that the company will not and has not met us to discuss the plan. However, support from the trade union movement is growing—large shop stewards committees at Chryslers, Vickers, Rolls Royce and elsewhere are are now discussing corporate plans of this kind. One of our colleagues from Burnley, Terry Moran, has made a tour of trades councils in Scotland discussing these matters. The combined committee is now itself organizing a series of meetings in the towns in which Lucas Aerospace has sites. We believe it is arrogant for aerospace technologists to think that they should be defining what communities should have. We are seeking through the local trade unions, political parties and other organizations in each area to help us to define what they need and to begin to create a climate of public opinion where we can force the government and the company to act. At the national level the TUC has produced a half an hour television programme on BBC-2 dealing with our corporate plan: this is part of its TU training programme for shop stewards. The Transport & General Workers Union has just come out with a statement indicating that its shop stewards throughout the country should press for corporate plans of this kind. At an international level the interest has been truly 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 made a one-hour television programme and a paperback book has been produced dealing with the corporate plan. Similar developments are taking place in Australia and elsewhere and the

interest centres not merely on the fact that a group of workers for the first time are demanding the right to work on socially useful products, but that they are proposing a whole series of new methods of production, where workers by hand and brain can really contribute to the design and development of products and where they can work in a non-alienated fashion in a labour process which enhances human beings rather than diminishes them.

Our society in the past has been very good at technical invention but very slow at social innovation. We have made incredible strides technologically but our social organizations are virtually those which existed several hundred years ago. One of the Swedish television interviews 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 *great social invention* but it probably is also the case that they will not develop or extend that in Britain' (my italics). If this were true it would be very sad indeed.

The concluding point I would make is this. Science and technology are not given. It is not like the sun or the moon or the stars. It is man made and if it does not do what we want then we have a right to change it. It is interesting to look at some of the adverts for tranquillizers: one I have here shows a woman dominated by what technology has done to her—high-rise flats, she is suffering from high-rise blues and it says very subtly, 'she cannot change her environment but you can change her mood with Serenid D'—which incidentally is a tranquillizer. We in Lucas Aerospace are trying to say that it is not pills and tranquillizers we need but a very clear political and ideological view of what we want technology to do for us and the courage and determination to fight for its implementation. We hope that in that fight we will be supported by widespread sections of the community because we will not be able to create an island of responsibility in Lucas Aerospace in a sea of national depravity.