

Design of a Cellular Manufacturing System:

A Critique Based on Catholic Social Thought

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1. Introduction

I expect many people reading this paper would say that they could not imagine two subjects further apart from each other than theology and technology. That, however, is a rather unusual reaction if one takes into consideration the full sweep of human history, including well into the industrial revolution. Even as late as 1835, Andrew Ure, a practising engineer who had been training engineering students for 25 years, could write a very practical book on the state of manufacturing which he called: *The Philosophy of Manufactures, or, An Exposition of the Scientific, Moral and Commercial Economy of the Factory System of Great Britain*. Thus, by turning our minds to the interrelation between theology and technology, we are not doing something new; rather, we are taking up again an older tradition of thought about technology that has become more obscured in our own century (for more or less good reasons).

There are all sorts of facets one could take up in an engagement between theology and technology. In this paper, I want to focus on factory organization and thereby on factory work. Since one of the major concerns in manufacturing today is the "human factor" and the Christian church has always emphasised the importance and value of human work, these issues are likely to be illuminated by a discussion that draws on both areas of thought. Important changes are occurring in the workplace which create an opportunity for the Church to provide some kind of critique of the change. Providing a critique is a useful way of offering a different point of view to those involved in a situation as a challenge to them to examine their own thought and so learn and develop. In every work system, there are strengths and weaknesses; what can we say about the strengths and weaknesses of these new forms of work organization? One of the most important of these

new forms is that of cellular manufacturing. Here, then, we present an evaluative framework drawn from the Christian tradition and relevant to the subject of CM, followed by the description of an actual implementation of a CM program. Finally, we pull the framework and case together to draw out what the tradition can offer technologists in the redesign of the workplace.

2. Basic Assumptions for a Catholic approach.

One has to be careful in offering a "Catholic" approach to analysing an manufacturing organization, since it is likely that no two Catholics will do it the same way! I would argue, however, that each one would include something similar to what we discuss here, so that the differences would be at a more superficial level. Figure 1 summarises the main concepts to be considered. The two fundamental concepts are those of the common good and the human person. The way these ideas are formulated within the Catholic tradition provides one way to express a balance between the needs of the community or firm and those of the individual, a problem which any organisation theory has to address. In another way, we could see these two assumptions relating to the well-known organisational problems associated with the need for both integration and differentiation in the firm.

Figure 1 suggests a model for a Catholic approach to business which integrates these two basic ideas with intermediate levels of analysis: principles for the structure of an organization (participation, subsidiarity and solidarity) and models of human behaviour (the virtues). Using this diagram, we can present an integrated view of a good business organization from a Catholic perspective.

2.1 The Common Good

The idea of the common good is much older than Christianity, but has been taken into Christian philosophy and developed in a distinctive way within the Christian tradition.

The first thing to note is that the Christian understanding of the common good is not equivalent to the utilitarian idea of the "greatest good of the greatest number". The latter conception of the common good would allow us to accept situations where basic human rights are being played off against each other, so long as the majority benefit, since it is based on a calculation of what is the best distribution of resources without regard to rights or, what some philosophers would call, "incommensurable goods". For instance, it might be helpful to society overall if a small number of people were sold into slavery to some others, but our sense of the contravention of a deeper good (the dignity of each person, not just of human beings in general) prevents us from

Figure 1: A Framework for Analysing the Workplace from a Catholic Perspective

doing this. To trade off the freedom of one person against another's in such a way is seen to be comparing and evaluating two aspects of the common good that are equally basic

and incommensurable. We certainly need to consider the most efficient means by which good can be brought about; it is not enough to have good intentions. The point is that the common good *encompasses* a notion of choice and allocation of resources but cannot be reduced to this. In practice, this means that there are some choices which could be made on the grounds of efficiency but cannot be permissible if we take a wider view of the common good. We need to distinguish between the *basic values* that constitute the framework of the common good, values which are incommensurable, and *particular projects* and techniques for promoting the common good among which choices need to be made.

With this in mind we could take the common good to be: "the sum total of those conditions of social living whereby people are enabled more fully and more readily to achieve their own perfection". This definition thus excludes any self destructive group or one with pathological or unreasonable aims from claiming to work towards the common good. It indicates that there can only be a common good where there is an aim in view, an overall goal, for which we agree to collaborate in reasonable ways. The definition leads us to ask what the "conditions" referred to could be. I suggest that in relation to the organization of work in manufacturing, there are three fundamental conditions: participation, subsidiarity and solidarity. These provide the basis for more detailed expositions of the conditions for the common good than we can enter into here. What they do give us is the basis for a critique of the nature of organization and communal good in the manufacturing firm, and, since this is how I want to apply the concept of the common good in this paper, this brief account can suffice us here.

In the discussion, it will appear that there is a close interlinking between these principles and our understanding of the human person; our concept of the common good then implies some features of our concept of the human person. Both concepts need to be seen in the light of each other.

2.1.1 Participation

For the common good to be realised, genuine participation of the persons in the group is an important component; it has a normative value. How that participation is expressed is a subsequent important question, needing to be addressed at the level of strategies and choices (Naughton, forthcoming). What needs to be established here is that participation is an integral part of the common good and therefore of the organizational structure of the firm. At a generic level, we can say that participation entails more than belonging to a group; it encompasses further that cooperation amongst members of the group that allows each one to *act*, responsibly and purposively and to find a degree of fulfilment in her or his contribution. Where participation is practised, what goes on in the group does not involve some of its members becoming purely the instruments of other members in achieving the goals of the group. This undermines their dignity as persons and is therefore not an authentic form of cooperation. In the promotion of the common good, then, participation forms an essential part of its formation and ongoing development.

2.1.2 Subsidiarity

The principle of subsidiarity is another key aspect of the common good, closely related to participation. It consists in arranging the structure of authority in a group such that the higher levels only take on what cannot be successfully managed by the smaller groups in their charge. The relationship envisaged is one where the smaller groups work on with what they are doing unless they find this impossible and have to call on the help of other or higher authorities. In practice, this implies an iterative process of decision-making between higher and lower levels; the principle of subsidiarity emphasises the active participation of the smaller groups in the ongoing preservation and promotion of the common good of the organization.

2.1.3 Solidarity

Action based on the principle of solidarity unites participation and subsidiarity within the group for the sake of the common good. For Wojtyla (1979), solidarity is the constant readiness to accept and to realise one's share in the community because of one's membership of it. In this, he means that in going beyond one's own wants and needs, in looking to those of others, one develops oneself. By analogy with friendship, where each friend sees his or her own fulfilment as interlinked with the fulfilment of the other, an attitude of solidarity involves developing a "third viewpoint" (Finnis, 1980) that is neither focussed on oneself nor on the group, but on the good of both. Sometimes, there may be reason for doing more than one's share for the sake of the good of the group, and so also, paradoxically, for one's own sake. Reflecting on this, Wojtyla (1979) sees implied in the idea of solidarity the principle of opposition, as its mirror image reflected in a situation where one is being asked to cooperate in a system that is unjust and dehumanising. Whereas solidarity is an authentic attitude where the common good is being fostered, opposition is similarly authentic where it is not, since opposition is aimed at restoring the conditions which promote the good of all. Opposition is essentially a constructive attitude, inviting dialogue; both solidarity and opposition have as their focus the common good. Their opposites he calls 'conformism' and 'non-involvement'. The first implies uniformity rather than unity and thus a participation which is more akin to servility than a genuine cooperation between human persons equal in dignity. Non-involvement implies a surrender to the existing system, perhaps through despair or cynicism, by opting out of doing anything either to oppose it where opposition is needed or to build it up in participative solidarity where it has strengths.

2.2 The Human Person and Humanization of Work

Many people try to consider how work could be made more fulfilling for human beings, but few ask the logically prior question: what does it mean to *be a human being*? It is difficult to over-emphasise the importance of this question, and unless it is faced squarely and an answer attempted, the secondary question as to how the work situation can be made more human is doomed to be dealt with ineffectively..

The concept of the person developed in the early Christian Church through reflection on the nature of God. It took centuries for this idea to germinate and take hold in the minds

of thinkers, but gradually, we find that the recognition of the personhood of God linked with the belief in humankind as bearing the "image and likeness of God" gave the impetus to understanding the human being as a personal being too. From this a number of consequences flow. Firstly, every person is due the highest respect because of the image she or he bears. This respect is based on being a human person, and is thus applicable to all human beings, any kind of handicap notwithstanding. Secondly, in its very essence, personhood involves relationship; persons "find" and understand themselves in relationship, since God, of whom the person forms an image, exists as three persons in constant self-giving to each other.

2.2.1 Human Work in the Catholic Tradition

What understanding of human work can we build on the theory of the human person outlined above? Firstly, one can say that work is a "fundamental dimension of (our) life on earth" (John Paul II, 1981). For the Christian, this rests fundamentally on the recognition that we are made in the image of God, who also "worked" in creating the world. We are "called" to work, and in a sense define ourselves in it. The concept of work as a calling implies the presence of the "other" as intrinsic to work and creates the possibility for understanding work as a service (Bellah et al, 1988). We could call this account a "personalist" approach to work, since it implies the central importance of relationships within work. In line with what we said above about acting and needing to "make a difference", work must be an activity in which the person is seen and felt to be the "subject", that is the active "agent" accomplishing a task through working on "objects". Throughout, then, the primacy of the person is preserved. While the objective value of the work done is important, the key aspect of work is the effect on the worker in bringing about an ever deeper expression of her or his being. In John Paul II's words, "the (primary) purpose of any kind of work that man does is always man himself", so that "man does not serve work, but work serves man" (John Paul II, 1981). In this, we should find technology as an "ally", where it is viewed as "a set of instruments which man uses in . . . work". It helps to make work more effective and productive; it forms part of the heritage that we receive from those who invented, built, planned and continue to improve them. However, another dynamic can inspire technological advance, where the human person is reduced to dependency on the technology and is deprived of the opportunity to act as a person. Instead, she or he is forced to become the thing which is "acted in", something passive and diminishing of the human person's real possibilities. This kind of technological advance would not be faithful to the understanding of the common good and the human person discussed here

2.2.2 Virtue

The idea of virtue, like the common good, goes back well beyond the foundation of Christianity. Aristotle thinks of virtue as the "fullness of ability". It involves working efficiently and effectively towards a good end. There are thus two components to behaving virtuously: end and means. If one has good intentions, but is ineffective in carrying them out or uses means which do not respect basic human rights, one is not

virtuous. At the same time, just being efficient is not a sign of virtue in itself; one can be efficient at producing pornography. Thus, the end is important too.

Recently, the idea of virtue has become more popular in the business literature, and thus it represents an area in which Catholic thought and business theory can mutually enrich each other. Traditional Catholic teaching saw four main "secular" virtues: justice, moderation, prudence and courage; these were applicable to any kind of life. Recently, thinkers in the Catholic tradition have applied these virtues to the business sphere; for instance, there has been discussion of the entrepreneurial virtues as applications of the virtue of courage; those with large resources at their disposal have been exhorted to exercise the virtue of magnificence.

In terms of the scheme in diagram 1, the idea of virtue presents us with a way of describing the types of behaviour and of interaction that are appropriate to a workplace that is promoting common good. The principles of participation, subsidiarity and solidarity provide guidelines for the structure of the organization. Hence, the scheme proposed is aimed to address both the structure and process issues of running a manufacturing company from a human and religious perspective.

2.2.3 Sociotechnical Design Principles

The basic assumptions behind a Catholic critique have been discussed. The next stage in a full exposition would be to show what particular theories and forms of analysis are appropriate for application to the particular case under study. In order to keep this paper to a manageable length, I include one set of ideas to use in the analysis, called "sociotechnical design principles". The basic assumption behind sociotechnical theory is that there exist in the firm interacting social and technical systems which operate in an external environment. Mumford (1987) also identifies a "clear ethical principle" at the base of sociotechnical design "to increase the ability of the individual to participate in decision taking and in this way to enable him or her to exercise a degree of control over the immediate work environment". Sociotechnical design thus appears to fit with the concept of the human person adopted here.

Looking back over sociotechnical experiments in the literature and from his own experience, Cherns (1976) identifies a number of practical principles which have been found helpful in sociotechnical design; he followed this up ten years later by "revisiting" his first discussion of the subject (Cherns, 1987). Table 2.2.3 summarises the principles as given in the 1987 edition. Cherns sees the key to sociotechnical design as *compatibility*, where the production system is designed in the way in which it is envisaged it will run. For instance, if the system is to be run participatively, it should be designed participatively as well. In discussing the last principle, *incompletion*, he returns to compatibility where he observes: "implementation must begin with the start of design; the principle of compatibility foreshadows this". Corbett et al (1986), however, claim that the principle of *variance control* is the "dominant" principle; it has certainly figured more highly in sociotechnical experiments than some of the others. Variance control involves dealing with unexpected occurrences, such as breakdowns, changes in material quality or

fluctuating demand. The idea is derived from cybernetic models and relies on the concepts of deviation, negative feedback and control. By using the cybernetic analogy, the methods of control in the firm can be analysed as one of the following: (i) *exportation*, where jobs are divisionalised: those doing the jobs and those monitoring and correcting them are different people or devices; (ii) *incorporation*, where performance information goes straight back to the planning stage of the process (rather than to the operators themselves). This is the strategy of total automation, but is always vulnerable to time delays between detection and rectification; (iii) *modification*, by controlling the variance at its source. The sociotechnical approach deals with variances through modification, seeing this as the most efficient as well as the most human approach.

In analysing the short case study which we are about to present, we will only be able to use the principle of compatibility as part of the critique; another paper would be needed in which to use them fully. However, they are introduced here because we can make use of one of the principles. I hope this will give an example of how these design principles can be used in the spirit of the basic assumptions, to help in analysing what went on and how to evaluate it within a Catholic framework.

Table 2.2.3: Sociotechnical Principles (drawn from the text of Cherns, 1987)

3. The case: The Jetfield site of Aerodynamics PLC (AD PLC)

In the light of our sketched framework, the situation we will evaluate is the change to cellular manufacturing at a site of an aerospace company in Britain which we will call Jetfield. We briefly lay out why they had to change and what they did, before attempting an evaluation.

3.1 The Problem: The Jetfield Site in Crisis

A life and death crisis loomed for the Jetfield site of AD plc. At the end of 1988, sales forecasts showed that the market for their product, civil aircraft, was about to take a nosedive. At the same time, benchmarking data showed them to be seriously trailing their competitors on most important indicators. On top of this, AD had too many sites and

perhaps too many airfields, so that Jetfield had to prove to the main board that it was worth keeping open. It was not a situation that could go on for long. . .

3.1.1 Background to the AD Jetfield Site

Aerodynamics plc (AD) is the largest manufacturing company in Britain. Formed in 1977 through the nationalisation of a number of independent aircraft manufacturers, it was one of the first companies to be privatised by the Thatcher government in 1981. AD Jetfield has a history of new aircraft development since the war; the Comet, Trident and AD 125 executive jet were all designed on this site. Most recently, Jetfield's main product has been the AD 146, a jet aircraft with passenger, VIP transport, freight and military airlifting applications, selling at over £10 million (\$15 million) per aircraft. Its main competitors are the Fokker 100 and DC-9. AD claim the 146 has a competitive edge in its reliability and quietness of operation, allowing more night flying. Of particular note are its four engines, giving greater safety in the event of an engine failure. Alongside the 146, Jetfield also has other activities on site: the wings for the Airbus pass through the same assembly halls; the main marketing and commercial offices for the division are based here. London Business Aviation, a subsidiary of AD, run the small airport on the site.

On top of AD's general problems, Jetfield experienced particular threats to its future. The site consisted of 800 acres only 20 minutes by train from central London. At the time, property values around London were still very high. People on the site felt that they were in danger of closure due to the value of the land on which they were operating. They realised that they would have to reach and exceed the cost reduction targets if they were to survive, and for that they would have to introduce a major programme of change. To do this, they had to convince the main board that they were capable of it. They decided on a two stage attack. Firstly, they concentrated their efforts on removing inventory from the business. There was a lot of scope here; they found that, at around £400 million, they had one of the largest inventory holdings in Europe! By the end of 1989, they had managed to recover £239 million from the liquidation of stocks. With these results, they managed to convince the main board to let them institute their real programme of change

3.2 The Solution: Cellular Manufacturing

To decide what to do, they looked around at what others were doing. They called in consultants; they visited other factories, they went on a tour of the East Coast of the US, taking the works convenor and the union representatives with them. It was from this tour that they developed their interest in CM. Data from recent surveys of cellular manufacturing in the UK and US corroborate these findings. They show that there has been considerable interest shown in CM, especially of late, and that the results they report are promising. The fact that most of the cells need people links in with the central importance outlined in both surveys of the "people" issues.

As a result of their researches, the managers at AD decided that their way of bringing in the changes they saw as needed would be to implement cellular manufacturing. This was the key to their change programme.

3.3 The Strategy

With the help of their consultants, managers at Jetfield went through a strategy formulation process. The targets they set covered numbers of employees, turnover per employee, added value per square metre and total used space, inventory value and inventory turns per annum. They also described their approach as "cash-sensitive restructuring"; by reducing inventory, they would generate cash that could be used for training and other restructuring activities, as they had already shown. Later on, the development manager was able to say of the change that: "our people (were) our most important asset" and that the strategy was devised around them.

From the earliest stages, they decided to split the site up into three businesses. This, they claimed, was because they did different types of work; they had different management priorities, and, above all, they had different types of customer. As a result of their deliberations, they set themselves an overall target or "mission statement", given by the operations development manager:

"to have the highest sales per employee of any Commercial Aircraft site (ie, of any of the other relevant sites within AD)".

The head of operations put it a different way: "to become a leading world class supplier of 19-120 seater aircraft, with equivalent standard in the aerostructures and support businesses and to establish appropriate, profitable levels of activity". Their goal was to be a "World class" manufacturing company (see Schonberger, 1987).

Along with the organisational change to CM, there was to be the introduction of two major programmes, "Total Quality" and "Just-in-Time", with other subsidiary changes in workflow and layout and the reassessment of "make or buy" decisions. Of these, it is clear from their documentation that the most important from the management's point of view was the JIT programme and the consequent reduction in inventory, simplification of factory control, decrease in flowtime of the product through the site and lower space requirements. The TQM programme was also closely related to the cellular manufacturing plan; the MCM, described its aim as "to push authority and accountability for problem-solving as low as possible". Devised and proven in the US by the Quality Improvement Company, in its scheme everyone was to monitor and improve their work, after having had Total Quality training.

3.4 Cellular Manufacturing as viewed at Jetfield

By this early stage, the overall scope of the cellularisation project had already been decided on, summed up in one of the slides used during the presentation to the workforce. Cells were to be set up in the component manufacturing and assembly areas, with a Manufacturing Centre Manager (MCM) running several cells in an area. The cell was defined as "a multi-skilled, multi-process production unit with a defined physical boundary", which is "small enough to be managed by one person who is responsible for inputs, outputs and all internal activities". Working for the MCM and serving the cells,

there was to be a support team, covering production control, quality and production engineering support .

All these changes were designed to achieve low inventory, high quality and faster response, with simple performance measures controlling the new system. Many changes in jobs were envisaged: moving to a new part of the site, changing shift patterns, retraining or working in new teams, but the company claimed that "everyone who wants a job will have one". The way in which the change was to be handled was also discussed, with the promise to further inform and involve people as the changes progressed. Management had already decided to set up a pilot cell in the doors subassembly area because, as the support manager later put it, "nobody really knew what the full implications of cellular manufacturing would be and there was a site strategic plan for it". The strategy proposed that all the programmes should be prepared for implementation in the following six months, which included time for detailed negotiation and the setting up of the pilot cell.

3.5 Implementation

The existing culture favoured functional boundaries: middle managers had a stake in it; apprentices were trained within it; unions organised around it. The whole social system was kept together by mutual consent to this set of relationships. Managers felt they had to emphasise the need for change in this context. The documentation for the change programmes they produced at the time is full of phrases like "breaking down the old barriers", "destroying the old cultural web" or "getting rid of outdated traditions". They saw communicating the idea of CM as critical, "the way we communicated our ideas would make-or-break our chances of changing the company culture to embrace the ideas of flexibility and teamwork", said one manager. Communication became one of the central foci of the implementation.

Team briefings were established; the Jetfield Development Centre was set up, housing 60 people initially, whose job was to ensure that the change programme succeeded. A "control room" was set up full of charts and housing a model of the reorganised factory; it was used as a meeting room, but most of the day it was free for people to visit. An expanded series of visits to other sites was set up, involving a broader cross-section of the workforce. One of the most important aspects of the communications exercise was to establish that the problems they were addressing were real and that all this breaking down and disruption of the existing system, with its concomitant threat of loss of status and even of jobs, would actually help both the company and the workers. They were not helped in this by a history of too many "flash in the pan" initiatives that had made people cynical.

3.6 The Pilot Cell

In order to progress, there had to be some agreement with the unions. This proved impossible; coupled with the fact that they were trying to negotiate over 25 change issues at once, neither management nor unions could precisely define what a lot of these new

concepts meant and how they would be applied (they had no experience of them). In particular, they did not know how to measure changes nor how much they were worth to the company. Negotiations foundered. The cellular manufacturing project was in a critical condition. What allowed it to continue was an idea from the union: they proposed a four and a half month experiment, with no commitment on either side.

The experimental pilot cell was started in Oct 1989. Conditions for the pilot cell were not ideal from the point of view of management; they had to ask for volunteers; the unions nominated the cell leader. After the initial training and floor layout, production began. For those on the shopfloor, technical tasks were as they had been, except that they could call on members of the support team if there was a need. Trust and honesty were required in this new situation, since, if a fitter were to make a mistake and a part needed to be scrapped, then the support engineer would need to know about it to pass an order back to detail manufacture.

More significantly, what had changed for them was their integration with those in the office. Symbolically, the office doors to the manager and the support team leader remained open, so that those out on the shop could come straight in. As planned, supplies were controlled by the cell leader in conjunction with the MCM, who later claimed that this was the most important change to his job, allowing him to accept much more accountability for what went on than when material control was located elsewhere. Under the pilot cell regime, the aircraft doors were delivered in specially designed boxes to hold the kits, so that it was easy for Aero dispatchers to see if all the pieces were in the kit. Production meetings were held each morning for a few minutes, with the whole of the team involved, although it took sometime to implement the performance measures which later allowed the meetings to be more effective.

Dealing with the cell's "customers", the final assembly lines at Jetfield and Steelbridge, proved much more difficult, since neither were set up in a way that allowed them to have enough control over their process to be able to predict reasonably accurately when they would need doors and to call them off before they were needed. This was partly exacerbated by the fact that the doors could be mounted onto the rest of the structure at any time during the four week structural assembly stage at the beginning of the final assembly process, since they were not on the critical path.

Some small incidents giving some indication of the emerging social system within the cell were recorded by the operations development manager. One member of the team used to sit in his car until the 8.00am bell and then get into the cell a few minutes late. This rather irritated the cell team members, but after some counselling of the cell team, instead of management intervening, the others in the group encouraged him to come in and talk to the rest of them if he arrived early and he responded to this. Similarly, someone who proved to be a slow worker and who some of the others initially wanted moved out of the cell, finally became a focus for their help, and his work improved considerably. Teabreaks provide some interesting insights. Even though managers encouraged the cell members to take their teabreaks when they needed them, rather than at fixed times, they never felt able to do so. They felt too closely the influence of the rest

of the site. Although the pilot cell was a "vehicle for change", as one manager called it, it was introducing incremental, not revolutionary change. One can see both change and continuity in these small examples.

3.7 Support and the Pilot Cell

The support team for the pilot cell was located alongside the shop, with the four members of the team in the one office. It was only when production began that the operators really began to feel the benefits. Now they had particular people to whom they could go. They knew these people, working with them day by day. Further, instead of requesting help from these experts as they had had to do in the past, these same experts now had a responsibility towards the shopfloor workers to deal with their problems; it was now the the MCM and the shopfloor employees, rather than managers in functional departments, who had authority over these support personnel. They knew that, like themselves, these people had to be committed to the work on the shopfloor and that their careers and self-respect in their jobs depended on the success of production as theirs did. Similarly, the support personnel knew who and what they were "supporting". Two way communication was developing, with learning going in both directions. In the past, the shopfloor connection with support would have been through a "faceless paperwork system", as they called it, with delays in responding to their queries blamed on its processing. The immediate contact between shopfloor and support makes that situation almost impossible.

3.8 After the Jetfield Pilot Cell

What was gained from the pilot cell? Taking different perspectives, different aspects come to light. First of all, for both management and unions, it gave important indications of the savings to be made, which allowed some basis for negotiation of the sharing of the gains. Secondly, different people highlighted particular lessons that they gained from the experience. These were largely to do with successes or problems in communication, the degree to which they were able in practice to work out and live up to the different way of working that their plans and ideas beforehand had seemed to envisage, and the way the cell structure meshed with other plans.

A midterm review presentation was put together around Christmas 1989, at which the benefits achieved so far and those projected for the future were discussed. From this, the company put together a package for negotiation. By the time the negotiations began, towards the end of the first quarter of 1990, the experiment had finished and the benefits were better quantified. Inventory levels had been reduced from £3 million (the equivalent of 80 finished doors) to £900,000 (24 doors equivalent) with the aim to reduce it 50% again within the year. Suggestions were up four times, as alluded to earlier. Transactions (such as product orders, shop orders or GRN's, goods received notices) associated with the particular part of the production process going on in the cell were reduced by 60%. Engineering changes took an average of 5 days to sort out instead of 10, needing only one paperwork system and half the people needed previously.

3.10 Ongoing Change

Once the pilot cell had been so successful, the management at Jetfield were able to develop a much wider programme of cellularisation, covering the whole site. The principles on which such a development could take place had been established in the pilot cell. Training and reorganisation were very much expanded in scale, but the same approach was followed. The pilot cell had done its job as a vehicle for change.

4. Evaluating the Change at AD Jetfield from a Critical Catholic Perspective

Having laid out a framework for evaluation and the details of the case study on the introduction of cellular manufacturing, we turn now attempt an evaluation of the change from Catholic perspective. We focus on the level of the assumptions of the programme and how these relate to the assumptions behind the Catholic approach adopted here, since the practice of the cell manufacture was still in its infancy when the case was written. Assumptions, however, condition the way the practice develops and hence it is useful to analyse them in their own right. We also include an evaluation of the way the change was handled, for the implementation of the change can set the tone for the way the new system is perceived on the site and how it develops.

4. 1 Assumptions behind the cellular manufacturing programmes

At Jetfield, the driving force or main aim behind the programme was to survive. If we can speak of this as an assumption, as the goal that was assumed throughout, then we must say that this was the leading, central assumption. The sense of needing to survive came across in their emphasis to reduce the coverage of land, because otherwise they feared being sold off; they knew that there were many sites within AD and some could be closed. A similar impression is given by the comment of one manager that they needed to talk about external competitors as "the enemy" to emphasise that they were in a "war" situation in which they could be destroyed. This assumption lead to their focusing their change strategy on inventory reduction and JIT material control - the "key" to the whole strategy as one manager put it - rather than on more visionary aims. Even their "mission statement" was limited in its scope, setting their target in relation to other AD sites within Commercial aircraft rather than in relation to worldwide competition.

At Jetfield, we can see then that the assumptions to do with the human person and work within the cellular manufacturing programme were conditioned by this basic stance towards survival. Obviously, it is good from the point of view of the employees that the site remains in being. At the same time, however, this shows the fundamental problem which any attempts at taking the human person and the common good seriously in the workplace faces. In a capitalist economy such as our own, the final goal of the economy is to maximise wealth, which is a good thing as far as it goes. The problem is that every other good, such as the good of each person or the common good of the community, is subordinated to this economic goal. In a Catholic approach, things would need to work the other way around; economic gain is important but it is not the goal of society and work; it is a means for the promotion of good in the society. These are two fundamentally opposed points of view, which cannot be accommodated to each other without doing violence to one or other of them. In practice, the humanising assumptions usually take

second place to the capitalistic ones, as we have seen here; even where self-conscious attempts are made to produce humanised workplace arrangements there are great problems in actually making it work given the environment within which such systems must operate (see Pasmore et al, 1982). Whether it would be possible to run modern societies along the lines of different assumptions is something we cannot address here, although it is extremely important for the possibility of further development in the direction of the humanised workplace. For the time being, we have to accept that our attempts at humanization are set within a way of ordering society and economic life which is, at its deepest level, non-humanistic, even if, as the development of human-centred technologies and other alternative approaches have shown, there is still considerable scope within its confines for fostering a more human workplace.

4.2 The Common Good and the CM Programme

If we look at the "set of conditions" for the development of a genuine common good under the headings of participation, subsidiarity and solidarity, a general assessment might be that the change and its aims were "good in parts". Participation was clearly evident in the new jobs that the cell members had. Crucially, they were involved in their own control; the cell leader was trained to be a "facilitator" rather than a controller. Each morning, the production meeting involved them all, and they all shared in gathering the data for the performance measures on which the morning's meeting was based. Symbolically, participation was encouraged between the cell members and the support staff through the "open door" policy. In laying out the cell, the members had been able to suggest improvements, which were incorporated before the cell was set up. One cell member described the experience of all this as "fantastic".

Evidence for an expanded sense of the need for subsidiarity as compared to the more centralised decision-making structures of the past emerges both in the implementation process and once the cell started running. From one perspective, the fact that the management let the unions take the initiative in negotiations and accepted their offer of an experiment indicated that, while they were setting the overall parameters, they were not unwilling to put themselves in the position of responding to the lead set by a smaller group within the organisation. In the running of the cell, a form of subsidiarity operates; the cell can make decisions and run itself to a degree, made possible by the direct access to resources that it has. Measuring itself against its own performance measures, controlling its own material supply, having authority to call on members of a support team when needed: these all allow genuine control to be exercised by the cell. The implementation of Total Quality and Just-in-Time programmes underpins this devolved responsibility, without loss of relationship with higher levels of management. Managers liked to talk of the cell as a small business with customers and suppliers because they felt it captured the new sense of localised control within the cell. The danger, however, with this analogy is that it makes the relationships with higher management seem an intrusion into the cell. If managers had been able to think of authority within the cell in terms of subsidiarity rather than customer chains, a clearer conception of how authority was working within the firm would have been possible.

The discussion of the differences between the inter-cell relationships and those of the small firm with its external environment indicates that it may be useful to consider solidarity within the cell and between cells. Within the cell, the possibility for participation in acting responsibly is part of the "constant readiness to accept and to realise one's share in the community because of one's membership of it" which we took as a working definition of solidarity. The examples of the way in which the group tried to integrate the late and slow workers, which in the past they would have regarded as the job of management discipline, seem to indicate a greater awareness of the need that the cell members have to help each other for the good of them all. So far, the evaluation seems to be good. Between cells, however, relationships were not quite so easy. The pilot cell had considerable difficulty in dealing with its "customer", the final assembly line; because of the designation of the latter as "customer", it was difficult for it to apply any pressure for clearer schedules. Since the model of the relationship between the supplier and the customer is that the supplier "serves" the customer, it is difficult to see how pressurising the customer to be more organised and predictable can be seen as legitimate. The lack of development of the idea of subsidiarity arises here too; if the cell had felt more able to draw in the assistance of higher management in dealing with this problem, there would have been the potential for a better relationship to develop between the cell and the final assembly line. There is clearly a problem here, which the management programme had not really addressed, that is, what to do about disagreement and even conflict between cells or MCM's. The egalitarian structure coupled with the dominance of the customer-supplier model makes this problem very difficult to handle. It would appear that one of at least two courses could develop from this. Firstly, there could be a regression to more centralised management, that is, the way in which these problems were dealt with before. Or there could be the development of the idea of subsidiarity which would allow the initiative for dealing with these problems to remain with the shopfloor, while shopfloor personnel could call on higher management to assist them in a "subsidiary" way. So far, they are able to call on support teams for technical support; it would be a new development if higher management could also become responsive to their needs in an analogous way. This would certainly facilitate a broader degree of solidarity between cells, which at the the time of the study could not develop as far as it might have done. Too much concentration on the model of the small firm for the cells has meant that the possibilities for deeper cooperation, based on their shared employment contract and shared final aim for their production, have not been grasped.

4.3 The Human Person and the CM Programme

Turning to what assumptions were made in the Jetfield cellular manufacturing programme with respect to the human person, we can see that the key one is that employees in the firm can be allowed to act on their own initiative, as responsible people, even on the shopfloor. With this assumption, we see a turning away from one of the basic premisses of Taylorism, allowing the reintegration of thinking and doing in those doing manual work. This "ownership" is balanced by the introduction of performance measures. These have the dual aim of providing those in the cell with information about their own performance, so that they have some pointers showing where improvement is most needed, and of providing information to higher management so that those on the shop can

be held accountable to them for what they do. To use the terminology of Corbett et al (1986), the mode of variance control is modification. Therefore, from the point of view of the human person, this assumption is a good one from which to be starting.

Building on this, a secondary assumption is that the people within the firm needed to change. The great emphasis put on this was in part due to the importance they attributed to the people within the firm, indicated by the statement of the development manager that the "most important issue in the whole change programme was our people". However, the need for change was felt so strongly, that there seemed to be no way in which "traditions" of working within the firm could be seen as valuable. This would seem to be lacking from the point of view of humanization, if we invoke the principle of compatibility. One of the aspects of compatibility is that new work systems should relate to the old, allowing workers to transfer their skills and understandings from one work situation to the next. Since no technical changes were planned in the move to cellular manufacturing, compatibility then applies only to the ways and methods of organizing and managing work. In practice, there has been considerable overlap between the way the cells work now and the way employees worked in the past, but this has occurred inspite of rather than because of the declared aims of the cellular manufacturing project. There may well be a strong argument here that without the rhetoric of the cellular manufacturing plans encouraging change, precisely because those changes were more intangible and organisational than technical, they would not have occurred at all. Certainly there was a strong sense amongst managers of the fragility of the programme during the transition to cellular manufacturing and the fear that the project would not have enough substance and momentum to bring about a real and lasting change. The only point being made here is that the assumption of change as good and tradition as bad, without considering the value of existing practices and knowledge of the way of doing things embedded in the people within the system, does not accord with sociotechnical criteria, nor with our concept of the human person. In practice, the focus on change alone caused the employees no little anxiety, who, in response to the emphasis on change, raised questions to do with continuity: demarcation, job security and status. With hindsight, it seems to have been a mistake on the part of management not to have explicitly recognised the value of some of these traditional means of ordering the social system in the firm and thus to have tried to see how they could be harmonised with the new system. Since management saw the existing ways of doing things as "wrong", they had not put their minds to thinking about how the old could develop into the new in a way that linked them both; rather, they wanted to think of the old as destroyed by the new. An understanding of the principle of compatibility could have helped them avoid the problems this caused and would have contributed to their learning a more humanised way of introducing change. We thus see that this second assumption was not as favourable towards the humanization of the workplace as it could have been in the situation.

If we compare these assumptions that can be identified in the data with the assumptions concerning the human person, we can draw implicit connections between most of them and what we find in the data on the Jetfield case, but there remains the problem that we identified above: human issues are contingent upon economic ones in our way of life in the western economies, rather than the other way around. For instance, the operator

training scheme could well be based on assuming that "enhancement of human skill" is a good thing to do, but it could equally well be based more on the hoped-for economic benefits of a more flexible workforce. The scheme in itself is a good thing for the employees, but if its rationale were based on economic criteria, it could later become the case that training could not appear to be economically advantageous and then it might well be withdrawn. Having said this, however, in practice, the cell system as set up at Jetfield does seem compatible with sociotechnical criteria, when compared with the previous work system: there is a greater degree of choice over operating strategy, since monitoring focuses on the performance measures, leaving the cell with the responsibility and freedom to work to them; it is clear too that social communication is fostered; the work environment has been cleaned and more carefully organised, causing less frustration and stress to the employees. Having already spoken above of the reintegration of thinking and doing and of the involvement of the users in design, we see the possibility in each case for the system to develop along lines compatible with all the main assumptions of the sociotechnical approach. In this sense, we can be optimistic that the workplace could be made more human by the development of the cellular manufacturing scheme.

Looking at the more fundamental level, at our assumptions about the human person upon which the humanization of work should be based, we see that there is a partial overlap between the assumptions adopted here and those of the program. While it is good that the firm is organised so that all those within it can act responsibly, and are expected to do so, there is not quite the sense that the employees are there to work primarily for their own development, and should not be treated as an instrument in the economic gain of the whole group. This is a critical aspect of the relation between humanization and integration, or between the good of the person and the common good in a more general sense. It relates back to our discussion of the economic system in which the firm is operating, which puts limits on the extent to which the assumptions undergirding humanization can become the basis of a programme.

However, we could argue that even if the system is not solidly founded on the kinds of normative assumptions that we would want to see in the the firm, by creating a system that allows scope for these assumptions to operate, for them to have a limited legitimacy, we open the possibility for the gradual slippage of the system in a direction that is more humanised. This all depends on the way the managers and employees in the firm act day by day, on the way in which, through their patterns of behaviour, they "reravel" the social system within the firm around the cell form of organisation. In this, they are heavily influenced by the external environment, but they may, in turn, be influential on it, especially when they are in one of the leading manufacturing companies in the country. Ultimately, we are talking about a fundamental restructuring of our economic order so that people are not made the instruments of economic gain, but rather economics supports a way of life. We have very little idea of how such a system could run, but one important contribution to its development would be through the lived experience of those in firms, gradually trying to form more human ways of running a business.

On the other hand, there are some possibilities for quite a different system to develop along the lines identified by Oliver and Wilkinson (1988). The new work system does offer the opportunity for work intensification and exploitation, since the change in working practices means that it is more difficult to make direct comparisons with the work intensity before the change. What could encourage this in particular is the greater visibility of output; the introduction of the regulators combined with the JIT or minimum stock supply regimes makes it much easier to see how much work is being done. Zuboff (1988) talks of how this helps relationships, by creating the possibility for "objective" data about which decisions can be made in a way that does not disrupt personal relationships. At the same time the visibility of the regulators can create a kind of "panopticon" effect, where everything the workers do is open to scrutiny in a way that can be detrimental to health and security (every person needs some privacy at work).

The case, however, did not indicate that work intensification was occurring at Jetfield. The only comments made about the changes in material control were positive; much of the frustration in dealing with missing parts had been taken out of the job, so that cell members could concentrate on doing their jobs well. However, it is not irrelevant to this situation that demand for the 146, and aircraft in general, was stagnant at that time. Since the whole program had been introduced within that market context, the cell system had not yet been put to the test under a situation of high or growing demand. Yet, given the long term forecasts for aircraft sales over the next ten to fifteen years, it seems unlikely that AD will be in a situation of high demand for the foreseeable future. In practice, then, it would appear that Oliver and Wilkinson's theory is too deterministic, assuming, on the theoretical level, a view of industrial relations that is too manipulative, and on the empirical level, high or growing market demand. In AD Jetfield, both these assumptions are questionable and it seems unlikely given the views of those within the company today that the cell system will develop along the lines of Oliver and Wilkinson's predictions.

Overall, the case shows that there were improvements in the working practices of the firm from the Catholic perspective outlined in this paper. Inevitably, there are drawbacks too, but these are at least to some extent inherent in the economic system as it is today. The common good as defined here seems furthered and the human person more able to develop in the new working environment. That these developments could take a turn for the worse cannot be ruled out, but the case gave no indication at the time that this was about to happen. In general, keeping in mind the important criticisms that have been made, CM seems to be something to be tentatively welcomed from a Catholic viewpoint.

4.4 Conclusions

This paper has been conceived to further the dialogue between the Church and those in manufacturing industry. As such, it has had two objectives: to lay down some outlines for the development a Catholic critical approach to manufacturing organisation and to use that approach on an empirical case in order to generate a Catholic critique of use both to those in industry and the Church. On both fronts, it can only represent a beginning, partly because of the limitations of space and partly because of the need for further development of the area. However, that there is a need for a Catholic critical approach I hope has been

demonstrated, as well as the need to use it in evaluating new organizational programmes, such as cellular manufacturing. The accepted need for wider objectives for the business organization than efficiency alone, the need for excellence and virtue in business and the development of the whole field of business ethics is perhaps, literally, a God-given opportunity for those concerned about the living of their faith at work and in society. Secondly, managers and engineers are searching for help in dealing with the "human" side of the organisation; the development of an understanding of the social side of technology and business can benefit from the input of the Catholic tradition. The Church, too, needs to be aware of what developments in organization it can find as more in harmony with its faith and philosophy than others. On this point, I would suggest that cellular manufacturing, where well implemented, could represent an important advance. We would need to look in the same critical way at other changes in working practice to see whether this is the case elsewhere.

Epilogue for Jetfield

We have seen that Jetfield were very successful in implementing their change programme. If their progress had continued, there would have been the chance to discuss this evaluation with the managers on the site to see their response. Yet, despite Jetfield's success, the threat of closure which had always hung over it from the beginning finally became a reality in September 1992. Candleby benefited from the closure of Jetfield by the allocation of 500 jobs and the relocation of Jetfield production to it. Jetfield management always knew they were vulnerable to a decision of this nature by the main board, but it was a blow when it came, especially after three years of site development. The decision was not made on the weakness of the production capability of the site, but on the need to stem financial losses. The market for the 146 was certainly depressed, but the fact that AD could find a buyer for some of the business shows that at least there were some prospects for the market in the future. AD Corporate agreed to sell their Commercial Aircraft technology to Taiwan Aerospace for the derisory sum of £200 million. Unlike AD, Taiwan Aerospace have full backing from their government and therefore the possibility to take the kind of risk that the development and production of commercial aircraft at this time involves. In contrast, AD is the only aircraft manufacturer in Europe that has no government support. The involvement of government in supporting manufacturing in markets as globalised as aerospace arises from this case as a serious one, one in which Britain has taken a different course from all other West European countries.

Ironically, in the year before the closure, Jetfield had been designated as a centre of manufacturing excellence by the Department of Trade and Industry (DTI). This meant that Jetfield was hosting numbers of visits and seminars organised by the DTI for companies who were doing the sort of searching for the right manufacturing strategy that Jetfield had done in 1989. The closure of Jetfield means that a great deal that had been developed over a long period is lost. Even if the skills of those made unemployed may be re-employed elsewhere, the communal knowledge and expertise they shared with each other in the one business and which adds up to much more than the sum of the skills of the particular people in the firm cannot be regained. A number of comments were made

in this paper concerning the primacy of the economic over the human in our communal life. The closure of this site, with all its assets of learning, expertise and communal good, shows this more clearly than anything else in this paper.

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