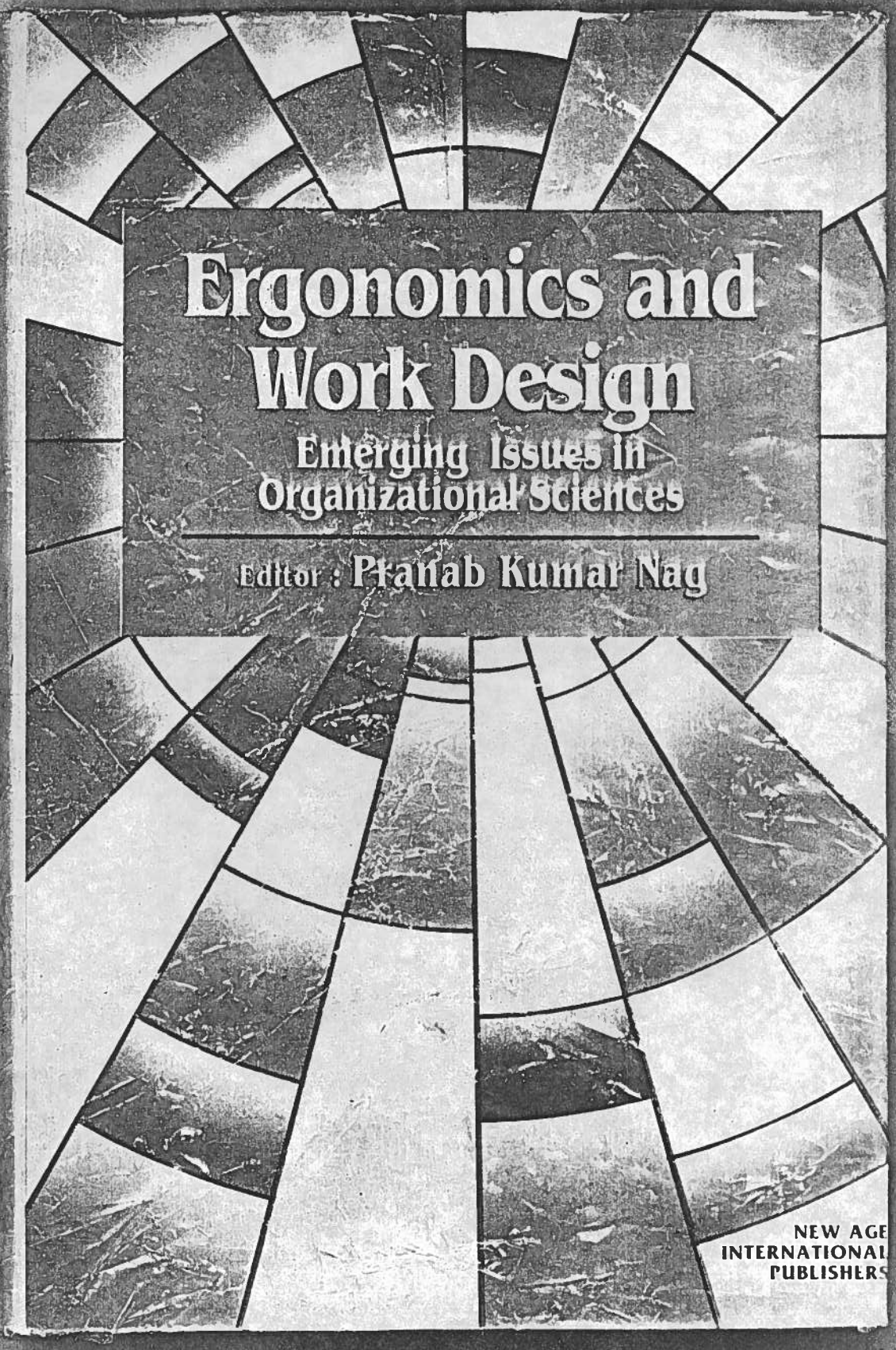
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Work Design
Emerging Issues in
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Emerging Issues in Organizational Sciences

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Dedicated to
Fellow Workers Striving for a Better World of Work
Through Design of Jobs Fitting to Man

THE NEW FACTORY IN INDUSTRIALLY DEVELOPING COUNTRIES
Transfer or New Design

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Contents

INTRODUCTION: DILAPIDATED OPERATING MODE

The significant difficulties encountered by technology transfers to industrially developing countries (IDCs) now constitute a major ergonomics question. The negative effects noted are located in both the field of health and that of the economy. Health is affected in various ways (Wisner 1976b, 1977):

* The high rate of work accidents.
* The sharp rise in work illnesses.
* The appearance of considerable ailments linked to the disorders of industrial and urban development.

The economic success of the technology transfer is threatened by several major technical causes (Wisner 1981, 1984a):

* The low operating rate of machines and, due to this, the insufficient production volume.
* The mediocre quality of the products which means they cannot be exported or even used in the country itself.
* The rapid deterioration of equipment leading to dilapidated operation.

It is obvious that these sinister triads are not encountered everywhere: Brazil is now the world's 10th industrial power and is a formidable rival in matters of engineering and the sale of arms to the Middle East. India is also one of the world's major industrial powers and produces small nuclear power stations since it is also a great intellectual country, including in the technological field. South-East Asia produces one third of the shoes sold in France. But it is noticeable that these are newly industrialized countries (NICs). There is a limited number of NICs and the favourable characteristics which have just been mentioned are far from being spread over these countries in a homogenous way, as shown in Abrahao's (1986) study of Brazilian distilleries. In effect, in each country, for example in France (Negroni 1986) there are industrially developing regions (IDRs) which raise questions similar to those of IDCs.

The negative effects on health and the economy most often originate from the so-called *dilapidated operating mode*. In this situation, in particular it is the automated action and control systems which are altered or put out of action. The machines are used under circumstances that are very different from those envisaged by the manufacturer; machine maintenance is neglected and staff are often insufficient in number, qualification and experience.

Sahbi (1984) showed the serious deterioration of the timbering and walling system in the Gafsa phosphate mines in Tunisia. Thousands of obsolete hydraulic pit props were littered around the maintenance workshop. The main causes of this situation are:

* The equipment was not suitable for phosphate mines since it was designed for coal mines.
* The lack of communication between departments and inside departments.
* The absolute predominance of concerns relative to the production volume compared to the cost of deterioration of the equipment.
* Very poor development of the maintenance and repair activity.

Sahbi also noted the value and the insufficiency of the strategies used by workers to ensure production in the dilapidated operating mode.

Since 1984, research has been done in various companies to find the origin of the dilapidated operating mode (Kerbal 1987, in Algeria), the strategies used by workers to compensate for mediocre operation or non-use of automated action or control systems (Sagar 1989, in Tunisia), the importance of the skills developed as such by the operators, the fact that managers were frequently unaware of this (Aw 1989, in Senegal), and the increased workload which is not very well accepted (Khoulali 1987, in Algeria). The dilapidated operating mode often led to an acceptable production volume but that the operator cannot replace automated action and measuring systems in order to ensure a good, stable level of quality. It is obvious that this situation of dilapidated operation also exists in

industrialized countries, but the extension of dilapidated operation is a lot lower in these countries due to the strict social and economic constraints and the easier means of prevention (Keyser 1987).

THE ORIGIN OF THE DILAPIDATED MODE

In fact, there are many ways in which a complex system can operate in a dilapidated mode (Aw 1989). There are also many origins. Two main explanations, which are very debatable, are usually put forward to explain the dilapidated operation of systems imported into IDCs: *the mediocrity of staff* and *the dishonesty of transactions*. First of all, we shall mention the multiple geographical type difficulties linked to the transfer.

Transfer Problems Linked to Geography

More particularly, we shall consider four geographical factors: the poor quality of transport, installation in an underprivileged region, the effects of a hot climate and the instability of electricity supplies.

Poor Quality Transport The studies carried out already are very explicit about a lot of important points. As such, Abrahao (1986) shows that a distillery installed in the industrial region of Ribeiro Preto (State of Sao Paulo in Brazil) near the factory which makes the distilling equipment for a lot of the distilleries in Brazil, can almost immediately obtain the spare parts necessary to cover any breakdown. But, on the other hand, a distillery located far from the factory, in the State of Goias, linked by poor quality roads, would have to wait several days for spare parts necessary to repair a breakdown or incorrect operation and this would be at a high price in view of the deterioration of trucks on the road.

This diversity of supply determines different distilling strategies. Some manoeuvre, which are very efficient at reducing distilling incidents, are liable to damage parts which are cheap in Ribeiro Preto and expensive in Goias. Due to this, these manoeuvre are routine in the former case and prohibited in the latter case.

Installation in an Underprivileged Region It is not always possible to choose the installation location. Sahbi (1984) studied the Gafsa phosphate mines in Tunisia, which are actually located at Metlaoui, 35 km from Gafsa, in a desert region which is polluted by the mine. Priority for water supplies, which are very rare, is given to production. Due to this, there are no gardens, swimming pools or even running water for part of the day.

Although the miners who originate from the region remain loyal to the mine - which is the only employer - the technicians, and especially the managers and their families, find this situation difficult to bear, all the more so since most of Tunisia's industry is located in coastal regions which are so attractive that they have become famous tourist areas. The average working period of a senior manager at Gafsa-Metlaoui is between one and two years. This is the same as in the paper mill studied by Sagar in Kasserine, an austere town located in the desert, but also in the middle of alfa-grass fields whose production supplies the factory.

The origin of the instability of senior managers is not due exclusively to the unpleasant character of the location, since similar conditions are

found in the paper mill studied by Kerbal near Algiers or in the phosphate treatment company whose factories are located closed to Dakar.

If anything, perhaps mention could be made of the general dissatisfaction in these four companies as regards the abnormal operation of production systems, accompanied by sudden decisions made by a general management which is often located a considerable distance from the production location. All these types of behaviour are mainly due to the lack of knowledge of the serious difficulties encountered by managers and workers when they try to operate a system that is not properly suited to the installation location. It is these difficulties which are the subject of the *anthropo-technological* analysis. A description of the real situation should lead to technical and social solutions and, in particular, should reduce the turnover of senior managers.

The Effects of Work Situation, Bad Design and a Hot Climate It is obvious that workers are also affected by the unfavourable effects of an incorrect installation. But these effects are more obvious for ergonomists and are described more often. However, an example which could be given is that of workers who load and unload crates of beer in the Bangui brewery described by Meckassoua (1986) in the Central African Republic.

For fully justifiable reasons of employment and technological simplification, the automated systems which are used in Europe for handling bottles were replaced by workers. But these men were not given the space necessary to work. This means that the production line is sometimes blocked and the work of the drawer is made more difficult. In addition, these men are tired when they arrive at the factory since they have walked around 5 km in the heat of an equatorial night. They have also slept badly due to their type of housing and the night life in a hot climate.

If the village of the workers was close to the factory and if the quality of housing was better, it would be easier to raise the quality of inspection of impurities in the bottles. In effect, this work is done by the same handling workers in order to alternate between a job that is physically hard and a sedentary job.

Unfortunately, due to fatigue and lack of sleep, they cannot maintain their concentration in a satisfactory way. They doze during the inspection phases and let impurities past.

Instability of ElectricitySupplies It is important to insist on the difficulties linked to the weakness of the country's infrastructure. Mention has already been made of the poor quality of the roads, the lack of water resources and their poor quality, the absence and poor quality of housing, and public transport. A description could be given of the effects of the saturation of ports and the irregularity of waterways. But only an essential point will be underlined here: the instability of electricity supplies.

The investments necessary for electricity production are considerable as shown by the controversy over the EDF's debt in financing French nuclear power stations. In addition, the substantial variations in the price of energy, in particular that of oil, make it difficult and sometimes prevent the necessary purchases of fuel. Due to this, in many IDCs there is insufficient electricity production which often provokes load-shedding of electrical power in companies: sudden power cuts, which can sometimes take place several times a week.

The sudden stoppage of electricity supplies can have a dramatic effect. In the port of Dakar, there is a large gantry crane whose load - which can be considerable - moves along a rail. If the electrical power is suddenly cut off when the load is being moved from the ship to the quayside and is in the last third of its travel, the inertia would crush the driver's cab through its weight. The driver knows this and confides his anxiety (Aw 1989).

Other than the serious aspect of safety, voltage cut-offs and variations clearly upset automated systems in such a way that the manoeuvre necessary to return to normal operation are not always carried out.

Here again, the ergonomist who is used to limiting himself to the design of the technical system according to the man-machine system concept, is confused since spare parts are not available, the managers are incompetent, the workers are not very efficient and there is a threat of danger for reasons which are remote from the work station or even the company. What is in question is the more extensive relation between design of the technical system and the new problems raised by the location of the installation in circumstances which are very different from those which the designer had in mind when he designed the technical system. In effect, the designer refers, in a relatively specific way, to his own historical and geographical conditions, unless his attention has been specifically drawn to the different characteristics of the future installation. In general, it can be considered that *all machines are cultural*, like any object produced by man.

Lots of examples could be taken to show the importance of the geographical factors to be taken into consideration at the time of technology transfers: physical geography (earthquakes, typhoons, climatic variations, water regimes), geography of energy and transport, geography of health (endemic diseases) and industrial geography. Of course, the last point is essential. The concept of the *industrial fabric* (Boucher 1983) is worth extending in such a way that, before a company is set up, it is possible to assess the advantages and disadvantages of the region and the location, to plan the reinforcements which are necessary - but expensive - and to make technological choices which are compatible with local realities. Rubio (1990) showed the joint importance of the social fabric and the industrial fabric in the Philippines.

The Cognitive Qualities of Production Staff

The *mediocrity of staff* turned out to be a poor explanation. The most blatant proof of the universal industrial capacity of the world's populations is perhaps given by the *anthropo-technological islands* (Wisner 1977): factories, airports, banks or hotels which operate everywhere thanks to autochthonous staff with a remarkably uniform result in all countries.

However, more often this is the result of a deliberate and rather expensive policy of multinational companies. This policy is only justified economically in a limited number of specific cases. In addition, these companies, which operate according to an organization that is totally foreign to the country, contribute little or nothing to general industrial development.

Dos Santos (1985) gave a very striking demonstration of the accurate reproduction of behaviour which can be obtained at the time of a transfer.

In a normal working situation for workers in a metro control room, what differentiates the series of movements of the eyes (change of direction of the glance) is not the place of work, Paris or Rio de Janeiro, but the previous experience of the operator as a metro train driver. Santos also points out that the differences in behaviour between Paris and Rio become considerable in the case of incidents due to the poor quality of the organization transfer, as will be seen further on.

The central question, that of the cognitive capacities of diverse peoples, was dealt with extensively by Meckassoua (1986). He showed the very remarkable control capacities of the central operator in a brewery in Bangui. This illiterate operator, raised in a village where farming on burn-baited land, pottery, hunting and fishing were practiced, was capable of constructing an operational representation that was more vast and more complex than the corresponding operator in France. The extent and the complexity of the representation were necessary in Bangui due to several flaws in the technical system: bottles of unequal dimensions imported from a neighbouring country, quality of the glue of labels which did not correspond to room temperature, manual emptying and filling of crates done in poor conditions and an imperfect visual check of impurities. Meckassoua's study underlined the fact that *more* cognitive capacities were needed for the proper operation of a system which had been rendered imperfect by the transfer conditions.

Furthermore, mention could be made of the work of Feuerstein (1980) who, in the space of two years, managed to turn miserable emigrants from the desert into efficient tractor drivers and repairers. As this author writes:

> Apart from their specific content, different cultures provide an entire (mental) structure inside which the direct contact and the experience of objects and events can be organized, interpreted and understood. Recognition of the past and anticipation of the future constitute cultural demands which enable the human system to adapt while evoking representative processes, making it possible to project oneself beyond the immediate universe of observation and direct action ... The language of instruction and the level of technological sophistication of a given culture are not determining for the efficiency of mediatized learning. Whether a child learns to build a canoe or a transistor radio, he should simultaneously learn to plan and use the appropriate strategies, to understand how the parts are linked to the assembly and to draw logical conclusions. In addition to the specific contents of each task or specialty, whether writing a computer program or tracking an animal, the information has to be organized, operations have to be performed and a whole set of complex activities has to be integrated with a system of rational and significant actions'.

However, we shall see that the existence of these *universals* of human operational thought should be revealed to the person who possess them so that they can be applied to situations other than those where they were acquired. As we see it, this is the essential task when it comes to training adults.

The high level of abstraction and the operability of *Pensée Sauvage* (to use the expression of Levi-Strauss 1962) has been the subject of impassioned debates for the last 100 years about *Micronesian navigation* (Hutchins 1983). However, in the vast majority of cases, industrial staff come from a culture which produces ancient and refined techniques (Wisner 1984b, 1985b).

These considerations may appear useless to those who are already convinced of the universality of human cognitive capacities. However, it should be underlined that only ethnological approaches (Goodnow 1976), and now the cognitive psychology used in ergonomic work analysis, can highlight the intellectual capacities which are expressed in activities that are specific to a people. The old approach using tests applied to samples from two different populations is often disappointing since it appears that the *culture-free* test is a myth. The very situation of the test is the school type and, due to this, is found linked to the academic form of intelligence (Neisser 1976) and not the *natural* form of intelligence which is used in daily professional life (Charlesworth 1976).

In order to get an idea of the value of the test methods, one could read the interesting report by Loehlin *et al.* (1975) in their book *Race Differences in Intelligence*. In fact, studies of this type often concern black and white populations in the United States where the existence of different cultures is combined and where there is *natural deprivation* of many blacks. This expression by Feuerstein designates the result of an insufficient relation between the individual and the culture of his own ethnic group due to illness and misery as well as family and ethnic dislocation.

Thus, we donot consider that cognitive capacities differ considerably from one people to another. But, of course, this is not the same as regards abilities. The great effort made in the last 40 years to improve the quality of technology transfers is situated in the field of training (*e.g., see* Maguerez 1966). Later on, we shall see what ergonomic work analysis can contribute in this field.

Dishonesty of Transactions or Cultural Misunderstandings

The dishonesty of transactions appears obvious to certain analysts of the situation of the *Third World*. Without denying a deliberate effort to deceive, which should be denounced, we would like to insist on the wrong representations of technology transfer possibilities. The errors are made by the seller as much as the buyer in terms of their cultural belonging. That is why we can speak of *Anthropotechnology* for the field which concerns us.

As such, in a French paper mill, the automatic device used is monitored by a team of four workmen who are well trained through school and experience (Sagar 1989). They can consult the supervisors or the engineers who are also stable and competent. In the Kasserine paper mill, there are only half the number of workmen while they have the serious task of replacing defective automated systems with non-verbal communications, in addition to the fact that there is a high turnover of supervisory staff, meaning that they are unable to acquire the necessary skills. Perhaps, in this mill, they have not understood the importance of the cognitive activity of workers and may be they considered that the physical activity did not justify a higher number of staff. Whatever the reason, in this case the number of staff planned in the transferred organization was reduced to a dangerous level in Tunisia. This is probably the origin of certain operating defects in the system transferred.

In other cases, an important part of the system was not transferred. Most often, this concerned maintenance and repair. For example, although the operating documents of the Paris Metro were translated and

transferred to the Rio de Janeiro Metro, this was not the case for maintenance and repair. It seems that the latter were not covered by a contract. It is true that in this field the seller does not always have the knowledge that can be organized and encoded, and the buyer is not always convinced of the need to follow recommendations whose cost might appear huge. Unfortunately, deterioration of complex systems is the price of the negligence of such an important part of operation.

However, the ergonomic analysis of cases where the factory only operates properly on the day it is inaugurated under test run conditions highlights some of the unfair aspects of transfers. In most cases where a factory or a production system is delivered on a *turnkey* basis, the contract actually states that this shall not be considered as performed until a demonstration has been given of the operating capacity of the system: *this is the test run*.

A team from the seller country is sent to the buyer country for the inauguration. It consists not only of staff who are experienced in operation and maintenance of the system but may also include staff from the design office who had the opportunity to make a few changes in the initial system. This team, which is of an exceptional quality, is capable of operating the system. But the day after they leave, nothing works any more because the local staff who replaced them is far from having the same theoretical and practical knowledge, even if they have been given serious training, which is not always the case. For the seller, the contract has been respected and for the buyer it hasn't. The origin of this serious misunderstanding is linked to an under-estimation of the cognitive activities of monitoring and maintenance of the system, but also to the insufficient awareness of operating difficulties linked to the installation which was mentioned previously.

These facts explain why it is necessary *to redesign the systems* rather than transfer them to industrially developing countries.

A REDESIGN METHOD

The error common to both parties is that they fail to understand to what extent the technical system, the organization of work and the training programmes are marked by the representation which their initial designers have of the general situation of the future factory and the characteristics of the workers. This implicit representation often turns out to be very different from reality itself when designers and users come from the same country, or even the same company.

Daniellou (1986) rightfully consecrates a third of his new course on the ergonomics of automated production to a prior analysis of the situation. In the case of a technology transfer, this analysis is all the more necessary and should be extended. It should be a study basis for both parties, the buyer and the seller, a situation which is rarely the case nowadays.

A study of the *anthropo-technological islands* shows that a system which operates in the same way as in the country of origin can be built in a country which is very different from the designer country, although it would be very expensive. Most of the time, the massive investments and high operating costs which are necessary for construction of the isolate are impossible for financial reasons. Very often, they are not even envisaged through ignorance of or contempt for local difficulties. Some

people consider that these difficulties, which will be studied later on, are redhibitory and blame industrialization, therefore the necessary industrial development. Yet, there are nations throughout the world which want to carry out the industrialization by managing to get the system they buy to work properly and by making profits so that they can invest again.

Naturally, the ideal situation would be to monitor, from the start, a complete industrial design process, like the one described by Daniellou. But the price of design and production of the equipment makes such a process impossible. This is all the more true in industrialized countries where every effort is made to incorporate elements from the old system in the new system. This is why a transfer of equipment can only be accepted on condition that it is redesigned. This is *Ergonomics in the project planning of a factory for export* (Wisner 1976a), the main difficulty of which lies in the transfer of organization (Wisner 1984c, 1985a).

Among the stages of redesigning a factory for export, the following should be distinguished: an in-depth analysis of the situation of the buyer country, the characteristics of the importing company and the planned installation location, the study of similar existing situations, the projected reconstitution of probable future activities, the consequences which these prior stages have on the choice of technology and the modification proposals, the design of buildings, the supply of fluids and transport networks, the organization of work, training programmes, and the contractual conditions of the final inspection of delivery. Each of these themes is very important and deserves detailed explanations which could be given here.

The important questions relative to the choice of technologies, in particular those concerning the degree of complexity of checks and automated systems, raise a difficult problem in which an objective analysis is associated with political or even ideological considerations not to mention commercial and financial considerations. This combination is not easy to analyze but deserves to be. But, in any event, in the case of redesign of a technical system, which we prefer to a simple transfer, financial resources are most often limited, not only for construction of the original technical systems, but also for the studies necessary to make substantial changes in the arrangement. At the very most, perhaps the physical differences of the worker populations (body measurements, cardio-respiratory capacity, muscular strength; Wisner 1987) should be taken into account sometimes.

Here, we shall limit ourselves to mentioning a few aspects of work analysis, training and the organization of work.

ANALYSIS OF WORK AND EXTENSION OF ERGONOMICS

To come back to the very action of the ergonomist, of the anthropo-technologist, the objects on which it is possible to act must be specified. For this reason, it is interesting to adopt the viewpoint recently developed by Pavard (1985) and by Pinsky and Theureau (1988).

According to Pavard, the main question for the ergonomist is that of the definition of pragmatic constraints. How can the technical system and work organization be designed so that the representation of the activity to be accomplished is clear enough to allow for efficient strategies at a

reasonable cost for the operator. For Pinsky and Theureau, the insistence on the operator's activity is all the greater since only the course of action should be considered. This course of action, which includes both the action on commands and the intake of information and communications, should consider all the work activities in an exhaustive way. Thus, the multiplicity of activities linked to the prevention and correction of incidents, the replacement of defective technical checks, and the search for information or events which he did not know, constitute the work of the operator just as much as the activity which is formally described and considered as essential.

Such a conception of ergonomics, and more particular that of work analysis, is precious when one studies systems that work in *dilapidated mode*, a situation that is very frequent in companies in IDCs. This is why the anticipated reconstitution of probable future activities (Daniellou 1986) should consider both the analysis of work on the system to be transferred, operating in a seller country, and the analysis of work on a similar system operating in the buyer country (Wisner 1976a).

TRAINING

For some time now, training programmes have been associated with technology transfers. Although some of them have been successful, many have failed and their authors have challenged the learning capacities of the future operators who were entrusted to them. We saw previously that these capacities cannot seriously be challenged. On the other hand, a training programme cannot be carried out without good knowledge of the cognitive tools produced by operator in their previous activities, in their own initial culture or in industrial-type activities. There is no operational *tabula rasa* in the mind of an adult.

So it is necessary to know not only the starting point but also the arrival point and the knowledge to be acquired. Yet this knowledge is often described in an incorrect way due to an arbitrary representation of the activities.

As we have just seen, the necessary skills can only be defined through an ergonomic analysis of the work in a company in the seller country using the transferred technology, and in a company in the buyer country using similar technology, as well as an analysis of work in the context of projected reconstitution of the probable future activity.

However, an important question remains unanswered concerning the activities themselves: how far should realism be pushed in the preparation for management of difficulties and incidents linked to the probable deterioration of the system due to the local situation (electrical power cuts, lack of spare parts, poor quality raw materials). If dilapidated operation is considered as accidental, we shall continue to train operators how to control a fictitious system: work of adaptation that is difficult, long and dangerous has to be accomplished almost secretly by learner operators when they come out of a training center and have to control the real technical system (Aw 1989). If, on the other hand, we consider the dilapidated mode as inevitable, we should develop the training programme in relation to this situation. This is a brutal demonstration of the *errors* made at the time of technological choices. This contradiction cannot be tolerated by those who made the choices.

On the other hand, at the time of a change, it is sometimes possible to analyze the causes of deterioration, to drop certain automated systems, to restore others to full operation and to develop a realistic training programme in terms of the new situation.

In fact, this is a very abstract approach; the types of deterioration are very many, and variable although some are more frequent and stable than others. The solution to these contradictions is probably found in the considerable importance given to the treatment of situations of the partial defectiveness of various elements of the system along with training in the non-dilapidated situation.

We also think that the training methods intended to upgrade the operators from their initial knowledge to the necessary skills still suffer from excessive empiricism. Considerable theoretical work still remains to be done in the field of cognitive transformation in the adult.

For example, Feuerstein (1980) considers that the role of the teacher is essential in order to make the trainee pass from the stage of manipulating objects and to that of obtaining imaginary manipulations. He insists on the importance of the development of technical vocabulary: tools, parts and operations should be properly named. Inversely, Sinaiko (1975) shows that, in certain cultures, the fact of knowing the vocabulary and the name of objects and operations appears sufficient for trainees who neglect execution and the actual work.

However, there is a field where empirical findings and theoretical explanations are very coherent, that of linguistic difficulties. Sinaiko (1975) shows, it is possible to achieve excellent performance on highly complex systems anywhere in the world if the oral instruction and technical documentation are fully understood by the operators. But this obvious condition has a very high cost: at least one year's training in the seller's language or very high quality translation. Mediocre quality translations and insufficient linguistic teaching leave confusion or errors which can be formidable when it comes to controlling or maintaining technical systems. Replacement of the text by images is not always better since the switch from a two-dimension to a three-dimension representation takes place under conditions which vary from one culture to another.

Particular attention should be paid to the training of senior managers from the buyer country whose turnover, as we have seen previously, is much higher for multiple reasons. Many of these senior managers are engineers and specialists with an excellent international level, trained in the best foreign or national schools, but who have never had the chance to consider and acquire practices that are pertinent to the local situation. The only training documents they have are provided by the foreign company which sold the technical system. Most often, these documents are unsuitable, since they concern theoretical operation which is far removed from the real situation in the seller country.

The most serious point is that this theoretical training, like practical training acquired in their functions, is very volatile in view of the high turnover of managers. The expression of permanent training then takes on its full meaning. How can the essential technical documentation, often considered by the manager as his personal property, be conserved when the manager leaves? How can the content of his experience in the field be described? How can this knowledge be transmitted to successive waves of senior managers who will replace those who leave?

It could be surprising to see an ergonomist insisting on the role and training of senior managers while our analysis is often more concerned with the activities of operators. However, the study done by Langa (1993), in an oil mixing factory in Zaire, shows the extensive knowledge of the engineer who starts production and runs the factory. The phenomenon of the turnover of senior managers in many companies in IDCs is part of the main difficulties encountered in the industrialization of these countries. Furthermore, this phenomenon is present in certain companies in industrialized countries and, here again, requires policies for the prevention and treatment of this real company disorder.

REDESIGN OF WORK ORGANIZATION - THE CONTINGENCY THEORY

Recent progress has been achieved in two main fields in the redesign of technology which accompanies the transfer of equipment: one is that of the rebuilding-transformation of the equipment (Lund 1986), comparable to the ergonomics of arrangement which we have highlighted in chapter 8; the other is that of the organization of work due to work in the field, but also thanks to the adoption by anthropotechnology of a theory of organization which is very close to its conceptions and requirements. Robbins (1983) gave an excellent report on the *contingency theory*. (*see* Chapter 2).

Other authors have shown that the negative effects of repetitive work were just as formidable in an IDC as in industrialized countries. For example, Aktouf (1986a,b) compares the packing department of two breweries, one in Canada and one in Algeria, and, in both cases, notes the same suffering by workers. This suffering is also described by Meckassoua in packers in the Bangui brewery. Meckassoua also shows the great cognitive qualities of the drawer. These cognitive qualities, which are crushed by the so-called Taylorian organization, can be improved and also achieve the same excellent results in IDCs as in industrial countries if sociotechnical resources are used (Corlett 1980; De 1984). However, sociotechnics itself should be used in a precise way if reliability is to be maintained and improved (Quintanilla 1987).

However, we know that, on the one hand, these discussions concern mass production in particular and, on the other hand, the various organizational solutions are only effective in terms of concrete situations: this is the very basis of the contingency theory.

Contingency Theory

Joan Woodward (1965) was the first to show that the same organization was not equally suited to three types of *industrial technology*: unit, mass and process production. The three main dimensions of the organizational structure are *complexity, formalization and centralization* (*see* Chapter 2). For Woodward, unit production needs a low level of complexity, formalization and centralization: this is the small-scale production workshop. This model operates very well in the sector of maintenance and servicing in both industrialized countries and in certain companies in IDCs. On the contrary, mass production requires a lot of complexity, formalization and centralization of the organization: this is the Taylorian formula which is upset by its unbearable character for workers and its

economic and technical rigidity. Most of the work sociology debates over the last 20 years have concerned this production method. On the other hand, process industries only need a low level of complexity, formalization and centralization. For example, it is noticeable that in the case of the Brazilian distilleries mentioned by Abrahao (1986), the company which operates badly has a formalized and centralized organization, while, in companies which operate well, it is the opposite.

In the same direction as Woodward, Perrow (1967), who extended his field of observation to *service activities*, proposed other criteria for classifying technologies:

* Task variability measured by the number of exceptions to usual operation.
* Problem analysability depending on whether or not exceptions could be diagnosed by formal logic or by experience.

We consider that this classification by Perrow is a demonstration of the necessary character of a change of organization when the system operates in dilapidated mode in an IDC. In this case, the exception becomes the rule and the difficulty of the questions raised can only be solved by experience.

Unfortunately, in the most difficult periods in the life of a company, there is often a tendency to encourage the departure of the most competent operators. This was one of the remote causes of the Bhopal disaster. It is also a solution adopted where there are difficulties in the operation of chemical plants in Algeria and Senegal, with disastrous results.

Although the influence of technology on organization is essential, the role of the environment is just as considerable. If the term environment is taken as referring to the forces and institutions which can act on organization and on which organization has little influence, it is easier to understand why an organization designed in a country where the market is large and stable, where the government's industrial policy is consistent and where social relations only develop progressively, cannot be transferred to the profoundly different situation which often prevails in IDCs.

For Burns and Stalker (1961), rigid (mechanical) organizational structures are suitable for stable situations due to their high degree of complexity, formalization and centralization. But when a switch is made to an unstable environment, flexible (organic) structures are better suited. In this case, horizontal communications are suitable. The role of experience and knowledge is then more important than the hierarchical authority. Information is exchanged more than directives. Responsibilities are defined more than tasks.

Perhaps these considerations give a better understanding of why the work organization of the Paris metro, transferred to the Rio metro in a remarkable way, was unable to maintain the rapid turn-round of trains for long because, although the operators had a comparable quality level, the same could not be said for many aspects of the company's environment. Along the same lines, Vidal (1985) shows that the same type of construction cannot be done as successfully in certain villages in Brazil as in France because, for example, the cement suppliers sometimes advance cement deliveries to suit themselves without worrying about any water-free storage facilities on the site.

For Lawrence and Lorsch (1967), variations in the environment or, even more, their unexpected character, constitute critical elements. The authors classify company environments in terms of:

* The frequency of their changes.
* The clarity of information about these changes.
* The speed of information feedback about the response to changes.

They also underline the fact that each company activity has a different environment: for example, the environment of the commercial department is the market, that of production is the technical/ economical development, and that of the research and development department is the scientific situation. There are many examples of companies in IDCs where the difficulties come from confusions between two levels. For example, what purpose is served by the gigantic gantry cranes in the ports of Dakar and Casablanca? Certainly, they are admirably suited to the scientific and technical situation. But, from the economic and commercial viewpoints, their capacities are obviously excessive. Many automated systems are satisfactory from the scientific viewpoint and could achieve commercial success linked to quality if they were not unsuitable from the technical and economic viewpoint.

Although we have given some details of the effects of *technology* and the *environment* as determinants in the organization, the role of the other two rather obvious factors should not be minimized: the *size* of the company and its *strategy*.

In many IDCs, and more particularly in those which have adopted a determined planning policy, the creation of a company often corresponds more to strategic considerations than economic criteria. The aim of political leaders is to improve the technical level of the country by training nationals in new activities, creating a modern center in an under-developed region and developing a national industry in steel or cement, even if there is a threat of excess worldwide production. Under these circumstances, the economic constraint, which is usually determining in modelling the organization, becomes weak or even absent.

However, the current condition of the debt of IDCs induce other strategies which are more linked to the financial situation, are replacing the previous ones and are affecting organization in a way that is sometimes dangerous. As such, the purchase of supplies, spare parts, documentation and the services of experts can suddenly stop with the risk of accentuating the deterioration of the technical system.

The size, the strategy, the technology and the environment thus appear as determinants of the organization. Yet there is a fifth element which disturbs these logical constructions: *the struggle for power or a share of power*. Like Child (1972) we can also see just one factor in the combination of the strategy and power; the existence of the struggle for power in organizations explains the conflicting character of the official or unacknowledged aims of various power groups in the system, and the inconsistences of the organization which are due to contradictory logics. Most often, those who want to keep power organize the company in a rigid, centralized and formal way, even if the type of technology and the environment suggest an opposed organization. It could be thought that, for example, one of the reasons for the rigid structure which is wrongly adopted in the Goias distillery described by Abrahao (1986) corresponds

to a anxious concern by the management to keep control of the system, despite its poor level of skil'. It uses the power control strategies described by Crozier and Fridberg (1977) concerning knowledge, control of rules, control of communications and information, and relations between the system and its environment.

NATIONAL CONTINGENCIES

It may be considered surprising that an aspect of the environment which is considered essential by lots of authors is not mentioned here: the buyer country and its culture. There are a lot of texts which tend to class countries according to their major characteristics, as done, for example, by Hofstede (1980). This author uses four criteria: *hierarchical distance, control of uncertainty, individualism and masculinity-femininity*, thanks to which he can place in the same category countries that are actually very different. But this factorial point of view cannot indicate the complexity of each country. Each national culture can be considered from a point of view that is more respectful and more correct scientifically, by adopting a structuralist approach. This approach is presently showing its strength in Europe where the former features of nations are reappearing after the fall of regimes which tried to wipe out cultural identities.

The structuralist point of view of cultural identity is expressed in particular by monographs, like that of Morishima (1982), entitled in English *Why has Japan succeeded* and in French *Capitalism and confucianism, Japanese ethics and Western technology*. The great interest of this book is perhaps the comparative evolution of confucianism in China, Korea and Japan. From the same viewpoint, it is interesting to read the work of Mathieu (1987) on Indian industrial culture. This text is entitled *Taylor et Peters au pays d'Arjuna*. A lot of texts on national identity are far from having the value of those of Morishima and Mathieu and only leading to reinforcement of prejudices.

Some authors take opposite stances, denying any national influence on the organization of companies, or at least think that other contingent elements are sufficient to describe the environment. This is the position of Hickson *et al.* (1974) in a text entitled *The culture free context of organization structure*.

Authors, who are just as convinced as Mansfield and Poole (1981) of the importance of national characteristics, do not reach empirical results which confirm their hypothesis. There is perhaps a two-fold reason for this. First of all, national theories implicitly assume that a country has a homogenous culture. This is not likely to be the case with the major industrial powers whose vast territory, complex history and economic diversity do not lead to such homogeneity. To be convinced of this, just think of Brazil, China, India and the United States. Another vital element which rules out simple classification is the distance between formal and informal organization. For example, the study by Mansfield and Zeffane (1983) which compared the organization of companies in Africa, France and Great Britain, only takes into account the characteristics declared in the companies' answers to questionnaires and takes these answers as the description of real situations. Yet in countries with a Latin culture where there are usually a lot of hierarchical levels, decisions are often made at a very low level subject to approval which is given automatically at a higher level due to the very widespread practice of delegation of power.

Inversely, the apparent decentralization of power in Anglo-American organizations does not necessarily lead to greater freedom at the lower levels of the hierarchy which are subject to the powerful unwritten constraint of the standard practices of the company and society as a whole.

The relation between organizations and the countries where new technical systems are installed is a very difficult subject whose stage of progress is still not enough to establish any rules. The wisest approach is probably to analyze each case with the confirmed tools of the contingency theory.

CONCLUSION

Our hope is that a better ergonomic analysis of work, combined with better knowledge of the factors determining technical choices and organization, will enable company directors to see more clearly, to dominate their fears and to choose production, training and organization methods that are more in line with the demands of reality in the industrialized as well as in the industrializing countries. There is no successful passive transfer. Only a review of the design of the technical system will make the most of the immense latent cognitive capacities of company workers and give them a job that is worthy of them. This is the price that has to be paid for the economic success and the safety, health and living standard of the workers.

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