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NORMATIVE GUIDELINES FOR THE MASTERING OF TECHNOLOGY IN IRON AND STEEL THROUGH TRAINING

Part I*

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* The views expressed in this paper are those of the authors and do not necessarily reflect the views of the UNIDO secretariat. This document has been translated from an unedited original.

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CONTENTS

Page

Page

Page

SUMMARY AND RECOMMENDATIONS

PRINCIPLES AND MEANS FOR THE MASTERING OF TECHNOLOGY IN IRON AND STEEL THROUGH PERSONNEL TRAINING

In our opinion it is possible to summarise the totality of these studies and their principal conclusions under the following three headings :

- what is the present position and the pattern of development of iron and steel technology ?
- how are the various aspects of mastering technology in the iron and steel industry to be viewed ?
- and, the clearly essential question, how is the technology in iron and steel to be mastered ?

1. THE CHARACTERISTICS AND COMPLEXITIES OF THE DEVELOPMENT OF IRON AND STEEL TECHNOLOGIES

The production of iron and steel involves a number of techniques or highly specific routes and processes involving the processing of a liquid metal at a high temperature.

As far as our purposes are concerned the principal characteristics of these technologies would seem to be :

- the relative rapidity of development taking place in these routes and processes,
- the progressive separation of the iron and steel industry into several different categories which make it possible for us to differentiate companies, in addition to those dealing with special steels, into a first, a second and, now, a third type,
- the importance of the "maintenance" problems (general maintenance, refractories, spares) in an industry which might be termed "self-consuming",
- and, finally, the concept of complexity in these various installations and its importance where the developing countries are concerned.

1.1. Developments in the iron and steel industry

It is widely appreciated that the iron and steel industry is a classical example of a heavy industry, but it is often forgotten that its technologies are developing much more rapidly than might be imagined.

The following are a few examples of this :

- the disappearance of the acid and basic Bessemer and the open-hearth processes for steelmaking, and the concentration of steel production on only two processes, oxygen refined steel and electric steel furnaces; these processes are themselves undergoing considerable development,
- the appearance of continuous casting which has now replaced practically all casting in ingot moulds and which is now in the process of leading to major changes in the design of steelworks,
- the appearance of new methods for iron ore reduction, in particular in the solid state ("direct reduction") and now also by processes involving the simultaneous processes of reduction and smelting ("reduction smelting"),
- the development of new mills, supplied from continuous casting plants and designed to meet the new needs of iron and steel users,
- and finally, with the same objectives in mind, that is to say that of meeting the needs of the market for iron and steel products, the major developments in finishing processes, ranging from improved quality control to various coating installations (using tin, zinc, chromium, plastics, etc.).

1.2. The separation of the iron and steel industry into several categories, amongst which we should distinguish :

- the classical or first type steelworks, an integrated plant based on the production of pig iron, in general with a blast furnace followed by converting it into steel using the oxygen process. Such steelworks are generally of large size (several million tonnes per year), and such works are now found based on "direct reduction" processes, often using natural gas. The products from these steelworks are generally flat rolled or heavy goods such as beams, plates, rails, etc.
- the mini-steelworks, that is to say plants of very much smaller size, ranging from annual capacities of 50,000 tonnes to 1 million tonnes, generally based on electric furnaces using scrap. They generally produce long products, and in particular light long products such as bars, wire rod, small sections, etc.
- finally steelworks of the "third type", more or less "self-centred", that is to say based on essential local needs; these may be simple rolling mills or the new types of plant described in the report, depending on research work which is still only just beginning. In the final analysis such companies could be little more than a "service centre for iron and steel products" in those regions which have only a small consumption of steel.

To the above should be added the distinction between normal commercial grades of steel and high-quality steels, in particular the special and alloy steels which introduce another parameter.

1.3. "Maintenance"

In all industries the normal operations of maintenance or, to be more precise, the "maintenance" of the enterprise so that it is enabled to continue operating, are clearly essential.

This is even more true in the case of the iron and steel industry which, as a consequence of the employment of furnaces (with their various problems, including those of the refractories used) or of equipment which comes into contact with molten metal (such as casting ladles) or with solid but hot metal (rolling cylinders and other equipment), may be termed "self-consuming".

This is why the problems of obtaining supplies of consumables, spares, etc. are of primary importance in the iron and steel industry and why the corresponding functions must be treated with the greatest care.

1.4. Complexity

All these concepts make it possible to arrive at a degree of quantification of the "complexity" of the iron and steel industry In our study this complexity is evaluated :

- firstly by the unitary complexity of a given operation or a sub-assembly, such as a rolling mill or a blast furnace,
- secondly by the combining of the complexities of the various unit operations which will make up the enterprise under consideration.

The study seeks to evaluate this complexity by means of simple rules for combining together these unitary complexities.

2. MASTERING TECHNOLOGY IN IRON AND STEEL

After this brief survey of the iron and steel industry and, in particular, its development we consider it essential to define what is to be meant by "mastering technology in iron and steel".

After considering how this concept is to be defined we will endeavour to answer the resultant questions :

- what iron and steel unit is being considered ?
- what has to be mastered ?
- where are the principal problems located in mastering technology in iron and steel ?

2.1. Mastering technology in an iron and steel plant

From what has been indicated it can be seen that "mastery" of an iron and steel plant involves not just making it work (including the "start-up" and "commissioning" phases) but also being able to design it and, in the final analysis, of being able to rebuild, renovate and modernise it.

From the outset, however, it is essential to emphasize that such mastery can apply only to one type of plant; it is not only too difficult but also undesirable to try to master all types of plant: commercial steels, special steels, alloy steels, flat products, long products, etc.

It is therefore necessary to select what one wishes to master, in terms of types of products and also of type of plant.

In this respect we must emphasize that it is highly advisable to start by "servicing" iron and steel products and then, in the future, to consider the possibilities opened up by "plants of the third type", that is to say by self-centred plants of small capacity, designed to meet carefully-defined local needs.

2.2. What has to be mastered ?

From what has already been said it can be seen that it is necessary to master not only the "metallurgy" techniques, which need to be fully mastered and which cover a group of different technologies of greater or lesser range according to the type of unit involved, but also to be able, in order to acquire this technological mastery, to manage effectively :

- the "downstream" aspects, that is to say iron and steel products, covering not only the metallurgical aspects but also all the sales and distribution aspects of these products,
- the "upsteam" aspects, covering raw materials, and in particular sources of energy,
- all the "maintenance" aspects, not only keeping the plant in operational order but also modernising it and keeping it at an acceptable global level with all the disciplines this involves, such as management, maintenance, supplies of spares, etc.

2.3. Where are the principal problems located in mastering technology in iron and steel ?

From the totality of this analysis it appears from our studies that this "system" formed by an iron and steel unit and its environment and infrastructures is a fragile one; there is a risk that it will "break" along lines of weakness which we have tried to define.

We believe that these lines of weakness are essentially linked to human factors, both inside and outside the plant.

Obviously these will tend to develop at the more delicate situations or work stations; in general these are those of "supervision" and of the more specialised operatives or technicians, both, as we must emphasize, inside the plant and also in the many infrastructures (enterprises, public or private services and departments, etc.) which form the environment of the iron and steel enterprise.

3. HOW IS TECHNOLOGICAL MASTERY IN IRON AND STEEL TO BE ACQUIRED ?

Having in this way more or less defined what is to be understood by technological mastery in iron and steel how is it to be acquired ? To make our question even more precise how are those countries which are least advanced in iron and steel, and those "new-comers" who still do not possess any iron and steel installations, to acquire this mastery ?

Before giving an answer to this question it is necessary to make two preliminary comments :

- care must be taken not to exaggerate the difficulties which this presents and it is necessary to demystify the problems it presents, avoiding the idea that iron and steel technology is both esoteric and extremely difficult for a "new-comer" to assimilate,
- it is essential to reduce, as far as possible, these difficulties by remaining modest in not seeking, at least at first, to solve all the problems and, in particular, to produce all types of steel.

Within this context it should be quite clear that a "new-comer" should only start in a carefully selected and well-defined sector or "target" area.

However even when mastering a single sector in the iron and steel industry it seems to us that three important conclusions emerge from our studies; these relate to :

- the effort which will have to be made by the new iron and steel producer himself, in addition to all that assistance which he can obtain, by various routes, from the world outside,
- the time needed for acquiring such mastery,
- and finally the role which will have to be played by the various engineering departments (studies and new works) in this acquisition of iron and steel mastery.

3.1. The efforts needed in the acquisition of technological mastery in iron and steel

At this point we must insist on the fact that true technological mastery in iron and steel cannot be bought, or sold, but must be acquired by the personal efforts of whoever wishes to obtain it.

However it is possible to facilitate this acquisition, for example by purchase, by training or by obtaining licences for processes, but the main effort must still be made by all those persons who are involved :

- firstly by all executives, from the directors down to the lowest grades,
- secondly by all the personnel of the actual iron and steel plant and also by all the executives involved in such a development in the country concerned.

3.2. The time needed for this acquisition of technological mastery in iron and steel

It has already been seen that this acquisition can only be effected by the men or women concerned by the problem, and it may thus be easily deduced that this is a slow process, that is to say one which will extend over several years.

The "effective scenario" which will serve to illustrate this evolution for the purpose of our study (even if it may, to some extent, be a caricature of reality) extends over a period of ten years !

3.3. The role played by engineering in the acquisition of technological mastery in iron and steel

In conclusion we wish to emphasize the role which the various engineering sectors must play in the acquisition of this mastery, that is to say through studies of routes and processes and in the construction of the corresponding plant and equipment.

Whether this takes place within the works (through the engineering sections responsible for design work or installations) or outside through various services or enterprises, they need to fulfil an essential function in two areas :

- either by assisting the works in its "maintenance" by keeping track of all the drawings and specifications of all the equipment, and of any modifications made to it,
- or by allowing the works to become modernised and so to acquire, by all possible "transfers of technology", various new methods and new products.

PLAN OF THE STUDY

VOLUME ONE

Part One : The problem and a methodology for the study of the conditions for technological mastery in the iron and steel industry.

Part Two : A technological approach to the concept of technical complexity in the various types of iron and steel plants. Description of a model for the study.

Part Three : Theoretical study of the complexity of industrial relationships in the iron and steel industry.

Part Four : The conditions and the routes for access to technological mastery in the iron and steel industry and in its environment ; guidelines for training.

VOLUME TWO

Annex to Chapter III : Key function evaluation sheets.

PART ONE

THE PROBLEM AND A METHODOLOGY FOR THE STUDY OF THE CONDITIONS FOR TECHNOLOGICAL MASTERY IN THE IRON AND STEEL INDUSTRY

CHAPTER I

THE FACTORS FOR SUCCESS OR FAILURE : CONCEPTS OF COMPLEXITY

After sociology had suffered many setbacks during the period from 1950 to 1970 when trying to find the laws and norms for development modern sociology now approaches such an analysis with greater humility and relativism. There are, perhaps, models which have some reference value but there are no absolute laws of development (of the type of "If one reaches a state A then one will inevitably arrive at state B after undergoing the process P") or even any conditional laws (of the type of "It is only possible to reach state E after having fulfilled all the conditions A, B, C and D").

In other words it is not possible to impose development, nor even to programme it with any certainty: one can only encourage or facilitate it, by showing to an increasing number of individuals those behavioural patterns which will increase their own development, since the development of a society results, as in the case of any living organism, from those interactions which give rise to positive resultants in respect of a very large number of parameters which condition individual behavioural patterns; in this way society will arrive at a change of state allowing stable progress which will then, of itself, generate development.

What concerns us in this study is the question of analysing and evaluating the sources of those difficulties which are widely encountered when grafting an iron and steel industry into a developing country; we are also interested in cases where this has been successful, not necessarily in the sense of a full utilisation of the installed capacity but rather of ongoing progress, however slight, towards such full utilisation. Such progress is an encouraging sign that the graft has not been rejected.

Certain setbacks are due to fundamental technical or economic faults in the original concept: for example inadequate local mining resources in the light of the intended process for producing the metal, or again a failure to match the production programme to the reality of the available market. There are not many cases of this kind, and they are not representative as far as our study is concerned: it may reasonably be assumed that such causes of failure could be eliminated by a minimal amount of serious concern regarding technical matters and policy before commencing the preliminary project.

Certain initial difficulties may be due to imperfections in details of the equipment, or again to adjustments in detail between units, such adjustments not having been carried out at the time of the reception tests or because, for example, they have not been contractually agreed with the suppliers. It must be admitted, in any case and as is well known in the industrialised countries, that iron and steel installations will sooner or later after they have been contractually tested inevitably need some adaptation, adjustment or supplementary work done to them when faced with the reality of operation under the permanent conditions (this is particularly the case with storage facilities for the raw materials, semi-finished products, products for despatch and spares of all kinds).

Consequently it must be accepted that operating companies must be able to improve their original installations. It must also be pointed out that our terms of reference exclude any judgements on this or that technological detail specific to the various suppliers, and this aspect of complexity will not be dealt with in our study except in terms of the necessity to associate, at a very early stage, the future operators with the general and detailed engineering. This is a point to which we will return. Having said this we will endeavour to identify, a priori, the various factors for success or failure, and then to consider the parameters of complexity in this industry.

1. The complexities of techniques

The technological complexity of the processes and of the circuits involved in the iron and steel inductry is a factor to be taken into serious consideration, since this industry is far from being one of linear and continuous circuits, handling and processing materials with simple physical and chemical properties.

The causes of this complexity are principally :

- the interlinking of the elementary processes, themselves complex, so requiring coherent working teams,
- the utilisation, within a component process such as steelmaking, continuous casting, rolling, etc., of a variety of technologies belonging to many chemical or physical sciences : metallurgy, electricity, mechanical engineering, mechanics of fluids, thermal, etc., calling many aspects of know-how into play,
- the fact that in each technology involved in the structure of an elementary process the physical magnitudes are very large : speeds, powers, forces, pressures, temperatures and even the tonnages, lengths, etc.; these condition the operators who, starting to work in this industry, need to handle, control and domesticate them whilst at the same time ensuring their own safety as well as that of the equipment,
- the fact that the iron and steel industry adds another specific characteristic to these degrees of complexity which it shares with other heavy industries: it is "self-consuming" at practically every stage of the process, and this leads to an ongoing struggle to ensure that the materials produced are not spoiled by the wear on the production equipment and, reciprocally, that the latter is not irreparably damaged by the product: nothing better has been found than steel when rolling steel, whilst the so-called refractory materials are only relatively so when the physico-chemical constraints operating in the finishing furnaces are taken into account.

2. The complexities of the human functions

To the above four causes there correspond some fully specific fields of action :

- the first demands a general organisation, an overall control, a spirit of synthesis, a multidisciplinary level of intelligence and a sense of collective effort,

- the second requires extensive knowledge, both theoretical and practical (maintenance, for example) together with its methodical application.

- the third can only be overcome by long and practical training, by the acquisition of an instinctive understanding of the phenomena involved, coupled with a continuous alertness (a spirit of awareness in respect of safety and economies) towards all possible deviations, errors or incidents, together with great self-control in regard to all technical functions,

- the fourth means that, unlike any other industry, the term "maintenance" implies in the iron and steel industry a totality of vigilance, of competence, of joint efforts and industrial discipline from an army mobilised to maintain the correct balance between equipment and materials with a view to simultaneously safeguarding productivity, quality and safety.

It is hardly exaggerating to say that an iron and steel unit needs, if it is to function properly, to be constantly regenerated if not rebuilt; this therefore demands real competence in engineering in addition to competence in operation, maintenance and management. Unhappily it is this point which seems to us to be frequently neglected in training programmes, generally because the buyer is not sufficiently alerted to this important aspect of technical functions.

In this brief analysis we have chosen not to take into account the degree of automation or of "sophistication" of the different processes since this, in our view, is a second order effect: each reduction in the functions of the operator is accompanied by an effective increase in the functions of the "maintenance operative" and the "quality controller" (from the point of view of "mastery of the process").

An intrinsic technical complexity, and the complexity of the human tasks to be provided for, coordinated and managed, are the inherent characteristics of an iron and steel unit, however simple it is, in regard to its technical operation.

But the unit will not operate unless the commercial and administrative tasks are fully and regularly carried out, following clear procedures suited to the socio-cultural environment in which the unit is to operate, so as to allow :

- surveys of the market for the products, and a study of market trends,
- recording of orders,
- surveys of the market in raw materials, and their purchase,
- surveys of the market for spares and their purchase as a function of consumption statistics,
- the management of stocks or raw materials, semi-products, products and spares,
- analytical accounting and cost analysis and control,
- the management of personnel and training activities,

- progress chasing,
- the establishment of a control board, giving the management reliable and coordinated information as needed for making correct decisions.

These non-technical tasks are generally left out of the training programmes during the phase when the project is being built up, together with preparation of the various procedures. It must be admitted that it is not easy to do this; whilst the technical functions and procedures are determined by the process and the equipment - and for this reason are of a universal character - the non-technical functions and procedures will be a unique pairing of, firstly, the universal exigences specific to the iron and steel industry and, secondly, the way in which the local industrial economy operates. We will be carrying out a special analysis of this point in our study.

New clients always think in terms of surrounding themselves with technical assistance (which may be good or ineffective) but for most of the time they forget that they are just as inexperienced in matters of commerce, administration of the enterprise, planning, scheduling, personnel management, etc., etc.

It is clearly not the supplier of the equipment, nor even the general entrepreneur responsible for the engineering, the construction, the commissioning and even sometimes the training of the personnel who can be responsible for these tasks. He is not asked to be responsible, nor is he structurally in a position to do so. Nevertheless serious problems can hinder the progress to full production of the unit - and even the commissioning and testing phases, although these only imply a minimal level of management.

In sum, therefore, it would seem that the complexity of the individual tasks of all technical and non-technical orders and which, harmoniously joined together and managed, should result in normal operation, is the most important factor to be considered: it involves not only the factors relating to competence but also those of social behaviour patterns suited firstly to work inside the plant and, secondly, to the industrial and economic environment.

Everything that has been said above relates to the works, as seen from inside.

But it is also necessary to analyse the external parameters influencing success or failure: if there is one industry which bears heavily on its environment and yet is also dependent on that same environment it is the iron and steel industry, even in its mini or micro forms:

- energy, in sufficient quantity,
- communications (roads, railways, telecommunications, an airport in the proximity,
- urban, educational and cultural infrastructures,
- the pre-existence or not of local industrial or artisan-level activities, or of serious projects to encourage harmonious development, since there is nothing more economically dangerous for a region than to depend on a single industry which will perhaps not prove to be a pole of attraction,

- the adaptation of administrative regulations to facilitate the necessary relationships between the iron and steel industry and the sources of supplies, of recruitment (with an eye to personnel turnover, which is often considerable) and of the acquisition of know-how (contacts with other countries, congresses, training courses, etc.).

From this first chapter, in which we have given a general overview of the concepts of complexity in the iron and steel industry and in its environment, there emerge two factors which appear to be intimately linked to :

- the complexity of the processes and the equipment, which has to be matched by a high level of know-how,

- the complexity of management, which has to be matched by a high quality of industrial behaviour, not only at individual level but also in teams structured and organised on the basis of procedures suited to the environment.

Technical complexity will be the subject of the second part of this study, illuminating the third and fourth parts which will be devoted to the complexity of the team and to the conditions for access to technological mastery.

CHAPTER II

THE ACTORS INVOLVED IN SUCCESS OR FAILURE

Who are the actors whose behaviour will bring great weight to bear on the future of the project ?

In the developing country purchasing the project :

- the national and regional public authorities, in regard to their policies and administration,
- the promoters of the project, if they are different from the public authorities,
- the executives nominated for the execution of the project, on the Buyer's side, both for the construction phase and also for the phase of industrial commissioning,
- the technical personnel, at all levels, recruited at the time of launching the project so that they may be trained and prepared for the start-up of production,
- the sales, administrative and managerial personnel, at all levels, recruited on the basis of their special knowledge but not generally given a period of training specific to the iron and steel industry,
- the technical personnel recruited at a later date, often after the period of commissioning, and whose training depends essentially on the technical and teaching skills of those taken on at an earlier date and who will pass on their social behavioural patterns,
- the local suppliers and entrepreneurs and public or private services.

In the presumably developed country selling the project :

- the public authorities, inasfar as cooperation agreements or the opening of special lines of credit involve them in the project, and always by the existence and influence of a diplomatic representative in the buying country,
- the loan agencies, initally assisted by the bodies which they have appointed to study the feasibility of the project,
- the suppliers of engineering facilities and equipment and the constructional enterprises,
- those leasing the processes and suppliers of technical, administrative or management know-how.

<u>It may be assumed that the best chances of success are to be found when all the categories of actors in the development have acquired, after a certain period of time for the maturing of the project, sufficient joint motivations and a consensus of opinion on the complexity and complementarity of their contributions and their responsibilities.</u>

It is enough for just one of the links in this fabric to give way and, as a result, for the development not to take place, or not to achieve the expected level.

In every project for an iron and steel industry in a developing country the challenges become even more acute whenever :

- the project policy of the DC becomes more ambitious in the choice of the size of the plant, the complexity of its production programme and the proposed quality range of the products,
- the plant of the present type is grafted into an industrial or artisan-type fabric which has only just been developed, or is in a very early stage of development, both in respect of the consuming and supplying industries, transport and communications networks, etc.,
- the market is defined in prospective terms, or of an accelerated development policy, without time being given to the consuming sectors of the population to become the actual motive forces behind the market,
- the population is only able to make available for recruitment, and hence for training, those persons whose behavioural patterns, whatever level they are required to occupy in the hierarchy, differs too widely from the normal type of industrial behaviour required by the complex organisation (thought patterns and relationships permitted by the pre-existing culture or cultures and the resultant social system, together with the macroscopic variables due to their origin and to the structure of the authorities and the existing administrative personnel, to ethnic and religious parameters, etc.).

From the above brief analysis it can be seen that no mention has been made of technical competence as being amongst the most important parameters which condition the success of a gamble on an iron and steel development. In fact experience shows that with suitable teaching and, certainly, with much effort, the acquisition of the minimum technical ability to operate and maintain iron and steel equipment can be achieved during the period of construction of the works, that is to say roughly within three years, starting from the initial selection of personnel who can almost always be found within a developing country. We have, however, clearly stated :

- the <u>minimum</u> technical level,
- for the operation and maintenance of the <u>equipment</u> (and not of a plant or, a fortiori, a complex).

This makes it possible to consider the phase of start-up and tests on the installations which result in acceptance, releasing the constructors of the plant from their obligations. This is necessary but <u>is not sufficient to move on to the phase of industrial operation</u> during which the plant must, after a period for running-in the equipment and the working teams, achieve the economic objective established by the promoters and those lending the capital.

This is the point at which there intervene, with as much importance as the competences involved in the purely technical field, a large number of parameters, both internal and external to the plant, which have generally not come under prior consideration, either voluntarily or otherwise.

It is in fact surprising to see how, in the case of practically all projects, the market and feasability studies are launched, verified, restarted and become the object of sensitivity tests, handing many rationally identifiable parameters, that is to say those which are customarily measured and processed in the developed countries.

But all this takes place as if all those concerned, the authorities, promoters, bankers, advisors and entrepreneurs (both in the case of the Buyers and also in the case of the Sellers) assume as an evident and also as a 100% probable fact that the grafting of an iron and steel plant, into any place in the world, will be successful as from the moment that :

- a market has been demonstrated,
- the selling price of the products has been fixed,
- the cost of the investment does not exceed a certain figure,
- the cost of the "Technical training" associated with the possibility of start-up (generally very much less than 10% or even 5% of the cost of the plant) has been contractually provided for and that its realisation is possible during the phase of the engineering and the construction of the plant,
- that the operating costs are acceptable, being generally based on the functions and manpower levels which are, statistically, observed in the countries selling the technology, but are also based on the wage levels in the developing countries,
- etc.

In other words "Since experience has shown that it would work in the developed countries on the basis of these measurable economic parameters then it must also work anywhere else."

And even "by extending the technologies of automation and of computer control the chances of success are increased because the importance of human intervention is reduced".

It is too easily forgotten that "anywhere else", that is to say in those countries where industrialisation is well established, iron and steel activities have not been grafted on but have been slowly developed on an artisan-type socio-economic model, followed by manufacturing, before becoming the industry which we know today, being the natural fruit of an acceleration in general economic activity, itself born of the scientific activity of the 19th century.

At no time was this heavy industry (in every sense of that term) in advance of the environment which created it.

The same does not apply when it is a question of grafting this heavy industry (heavy in every sense of the term) on a developing socio-economic body, where it is seen as a foreign body, disrupting an equilibrium which is still fragile.

The graft may take poorly, or not at all; what is even more serious is the fact that it may be the cause of a deterioration of the economy which it was intended to advance through its own development.

Why is this ?

How are cases of unsuccessful grafts to be treated and, in particular, how are the "new-comers" to be prepared so that a graft will succeed ?

What supplementary evaluation factors must be placed in the hands of the actors involved in success or failure - and particularly made available to those taking the decisions - so as to increase the chances of success ?

This is the objective of the fundamental study on complexity which has been undertaken and which will, finally, give to the term "training" a meaning which is much more complex and extensive than is generally attributed to it.

CHAPTER III

GUIDELINES FOR A STUDY OF THE CONDITIONS FOR TECHNOLOGICAL MASTERY

Before examining, in Chapter 5, the specifically methodological aspects for carrying out this study it is necessary that we clearly define the subject, the general plan and the principles of approach which are envisaged. The content and the limits of the launching phase will emerge clearly from this.

1. The subject of the study :

The universe of an iron and steel plant, considered as a complex system to be mastered.

1.1. The complexity of the equipment and the machines, together with the levels of technological applications involved, do not form the subject of the study. This "hardware" is, nevertheless, described in Part Two (see below) in order to fix ideas and to make it possible to locate man in his work environment.

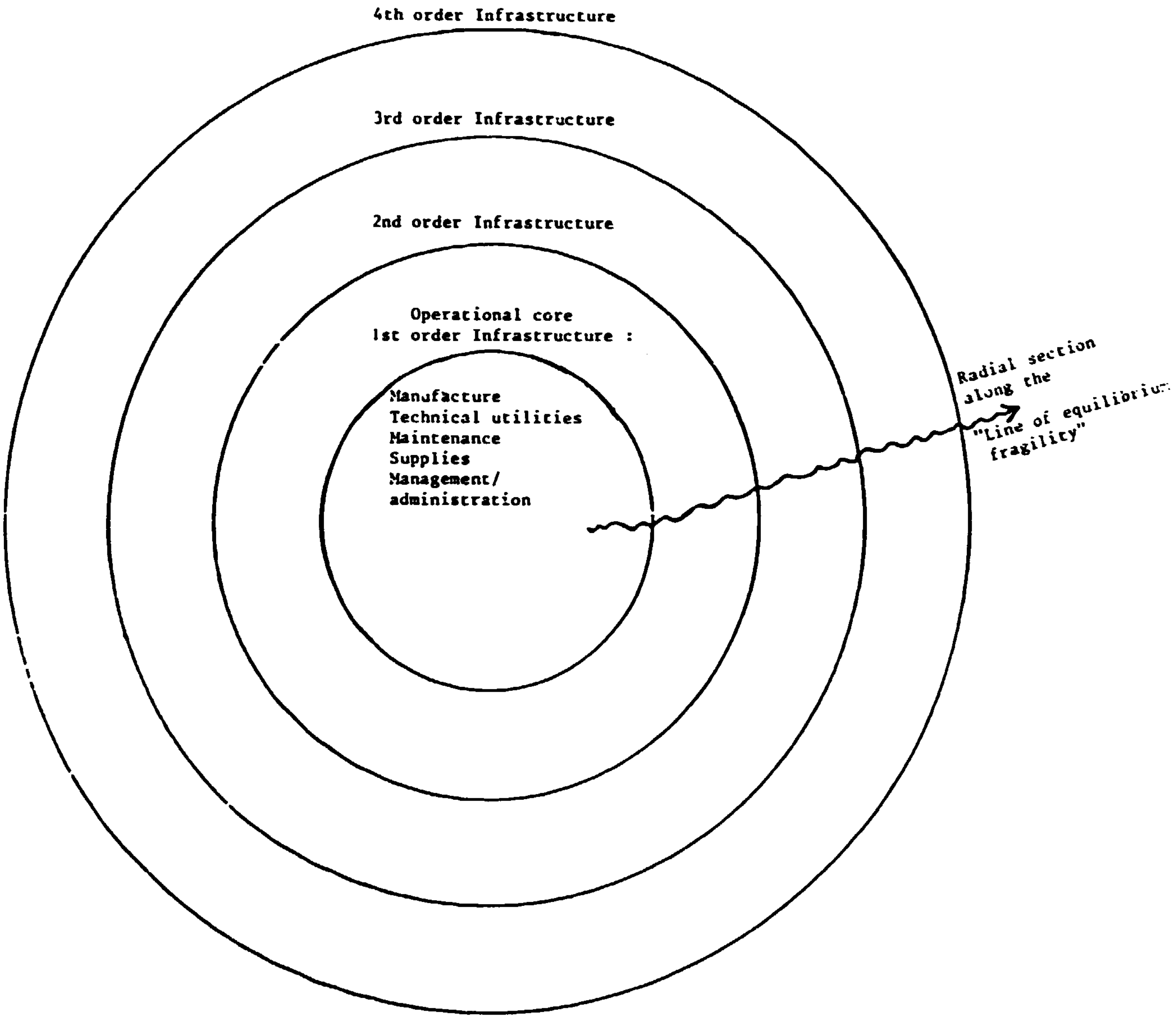
1.2. The subject of the study is the system of the complexity of very diverse human tasks, directed towards the service of the processes, the equipment and the units and, more broadly, of the industrial function of an iron and steel plant within the economy of a developing country. It is thus the complexity of the "software" which is both necessary and sufficient if the grafting of this industry onto a developing economy is, itself, to generate development.

1.3. The physical system under consideration forms a universe consisting of several concentric levels, as may be seen in Figure 1. These are :

- the central, operational, core, as exists in all factories throughout the world, that is to say -
  - . the operators linked with the manufacturing processes (process units) and the direct technical services related to them (utilities units),
  - . the technical and non-technical personnel linked with the first order infrastructures, such as :
    - laboratories and quality control,
    - maintenance workshops and stores,
    - management, sales, buying, administration,
    - accounting/financial,
    - social services, recruitment, training, health and safety and internal security.

- the peripheral systems linked with the second order infrastructures, which are necessary but which are not necessarily integrated vertically in the plant -
  - the u-ban environment with all its socio-economic and cultural facilities,
  - the system for transporting the personnel,
  - availability and delivery (but not the production) of electrical and thermal energy (electricity, gas, coal, fuel oil) and industrial or drinking water,
  - availability and delivery (but not production) of lime, fluxes and refractories,
  - specialised training centres.
- the peripheral systems linked with the third order infrastructures, which are generally not integrated vertically in a steelworks in an industrialised country -
  - mines, quarries, works producing lime and refractories,
  - collection and preliminary sorting of scrap,
  - port,
  - airport in the proximity,
  - railways, roads, conveyor systems from the mines, quarries and the port
  - electricity power station or hydro-electric scheme,
  - pumping station for raw water and primary treatment,
  - industrial installations for the utilisation of slags and other by-products,
  - industrial installations for the utilisation of excess gases,
  - networks for the distribution and retail sale of the products (steel stockholding centres),
  - customs' clearing station and bonded transit,
  - buying branches on the markets for raw materials and spares,
  - non-specialised training centres.
- the fourth order peripheral systems which are never integrated with the works -
  - public administrations and public services,
  - customs,
  - banks,
  - public or private educational establishments,
  - research centres.

Figure 1 : THE IRON AND STEEL PLANT AND THE VARIOUS ORDERS OF INFRASTRUCTURES : THE CONCENTRIC LEVELS



* See text in Chapter 4.

1.4. Within this universe, with its several levels, it is the relationships inside the central core and the relationships between this central core and the peripheries which are of interest to us.

In fact the relationships are not unidirectional and it would be better to speak of interactions. In a cosmic system the introduction of any new body modifies the initial laws of equilibrium, and the introduced body is modified in the search for a new equilibrium, if such an equilibrium does in fact exist.....

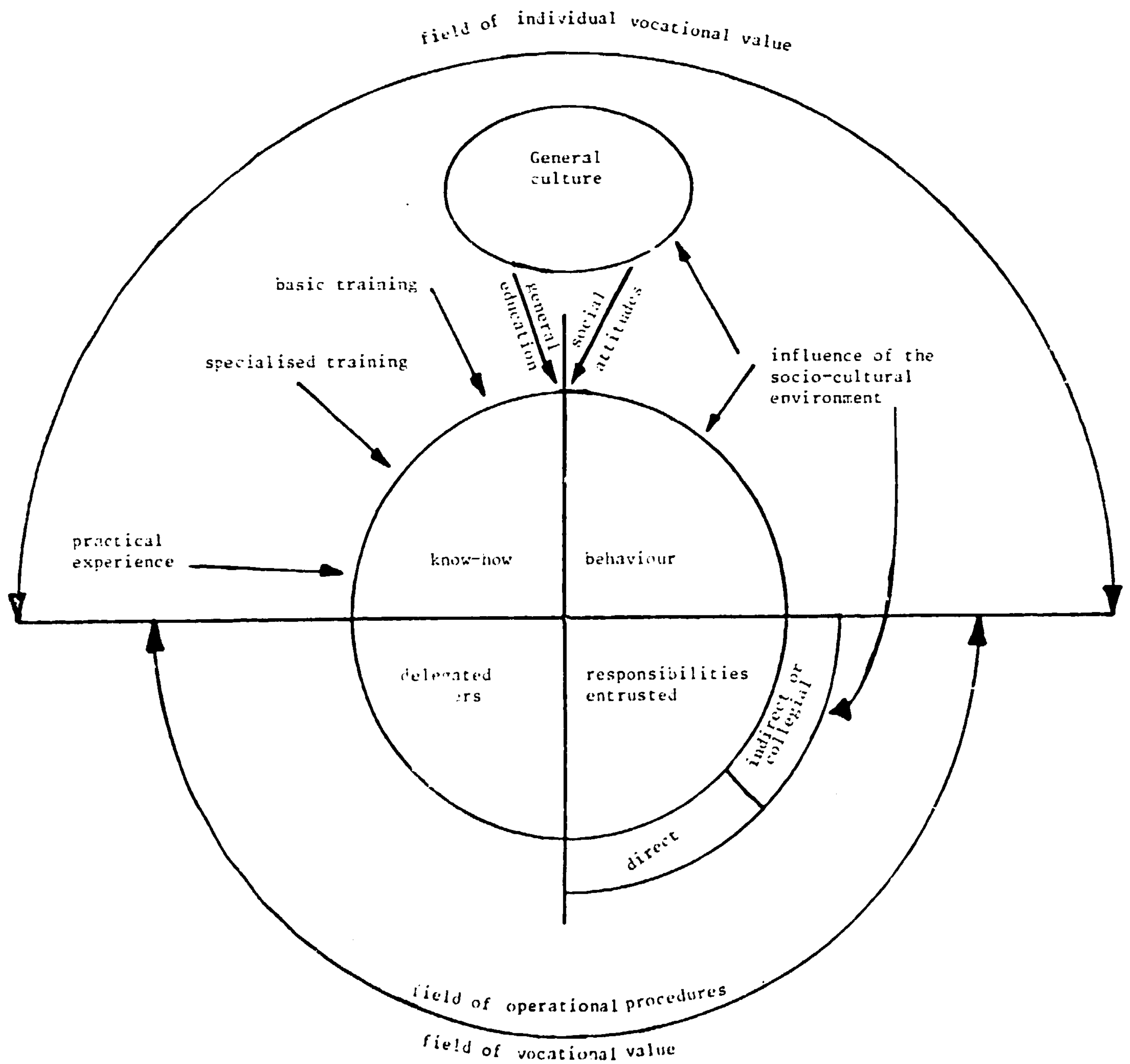
Whether this exists or not our observational position is located as a priority in the central core, and only exceptionally on the periphery.

1.5. The universe examined in this way is thus a complex system of functions, firstly within the central core and secondly in the inter-relationships between it and the peripheral systems. The elements in this system are persons, or groups of persons, possessed of know-how, directed by certain behavioural norms, entrusted with certain individual and/or collective powers which result from the limited responsibility which is given to them (see Figure 2).

The four essential variables of the functions may be defined as follows :

- know-how, that is to say the level and content of the ability needed to exercise the function.
  The components of this are theoretical knowledge and practical experience.
- behaviour - or better dynamic attitude - is the manner in which the function is exercised, more or less efficiently, within a complex system of relationships - the procedures and regulations in force cannot of themselves take the complexity of this concept into account. Behavioural norms are not all written: a human being is the bearer of the total socio-cultural basis created by the history and the traditions of his civilisation, which is also expressed in group behaviour. We will see, for example, that amongst the behavioural parameters the ability to see ahead, so important in the iron and steel industry, does not always exist in the socio-cultural basis. It is susceptible to being educated, and should form part of the training.
- powers, that is to say the capacity for freedom of action attributed to the function, not only for exercising the function within its sub-system but also outside it, in relation to the other sub-systems, in order to ensure a balance of interests. Powers are always regulated by written procedures.
- responsibilities are the counterpart of powers, being duty counter-balancing rights. Responsibilities are established in the "job description" of the function. They have two aspects: direct responsibility (this is why the function exists) and indirect or collegial responsibility, which is participation in a more overall responsibility entrusted to a Department, a Division, a Directorate, etc.
  Whilst direct responsibility may be characterised by verticality, indirect responsibility is characterised by horizontality: it ensures the coherence of activities in the complementarities.

Figure 2 : THE FOUR VARIABLES CONDITIONING THE EXERCISE OF AN INDIVIDUAL FUNCTION



The vertical route is one of hierarchy: it is the route through which orders and instructions travel from above downwards and by which the operating reports pass from below upwards.
The horizontal route is a functional route: it is the route by which information of value to the functions passes.

1.6. If it is to operate in a stable manner, and is to generate progress, the system needs to be both whole and homogeneous, with the need to develop a certain vertical/horizontal equilibrium:

- whole, in the sense that all the functions in the operational core and in the peripherals have to be ensured,
- homogeneous, in the sense that the quality of exercise of the functions must not be too variable from one point to another in the total system,
- balanced between vertical integration and horizontal diversification of the economic vocations. A plant which is established in an environment which is incomplete or of low reliability may be led to integrate vertically too many of those peripheral functions whose intrinsic nature is to be horizontal in order to favour the general development: such functions then become "captive", diverted from their true vocations and a mono-industry becomes established as a state within the State. This is the iron and steel tumour which becomes practically uncontrolled and ends up by bleeding the country to death instead of developing it.

2. The general plan of the study and its limits

2.1. Strategy

The successful development of a society would appear to advance, at one point in time or another, through the development of metallurgy and, in particular, through the development of the iron and steel industry.

The second part of this study (see below) establishes a number of reference points in the multiplicity of process routes, and establishes the first guideline criteria. For the study of complexity it defines a standard model, on the basis of which a maquette of the iron and steel industry universe may be established and tested.

Chapter 1 has broadly defined the parameters which condition the success or failure of a graft of this industry on an economy undergoing development.

Chapter 2 has defined where and how the responsibilities for the success or failure of this graft are located.

After having sketched out, at the start of Chapter 3, the components of the iron and steel industry universe it is necessary for us to begin the study of complexity by a research strategy, leading to the plan of the study with its various stages and also the actual methodology; this will be considered in Chapter 4.

The image of a graft has been invoked several times in previous chapters; it will serve us in developing the strategy. A graft may fail to take, or may take poorly or, and this is even more serious, it may be the cause of a degradation in the stock onto which it is grafted. Why is this ?

When faced with such a problem of compatibility biologists and doctors adopt an approach which is simultaneously theoretical and experimental when treating cases of obvious incompatibility (therapy) or when preparing new subjects for grafts (prophylaxis).

In our field the problem presents itself in this way: how are the obvious maladies in iron and steel development to be treated, and how are "new-comers" to be prepared for a successful graft ?

The initial approach obviously involves observing the existing maladies and establishing a complete and correct diagnosis (clinical picture). But it is not possible to establish a complete and correct diagnosis except on the basis of a model of the healthy system; this model will at the same time be descriptive (anatomy), dynamic (physiology) and mechanical (biology).

Quantification of the systems of equilibrium is important, since the dosage of any therapeutic or prophylactic treatment will depend on this. Testing the model on guinea pigs makes it possible to verify or correct the model qualitatively and quantitatively and so to improve it.

This approach continues by a process of iteration, from theory to testing and then from testing to theory, and is suited to our enterprise; it is a lengthy task which has to be carried out in methodically programmed steps.

The number of parameters which are implicit in the system and the multiplicity of relationships, together with the educable but irrational content of the latter, form a highly complex whole which it is not possible to analyse completely at the outset.

In the overall system we will proceed by way of a "radial section" through the chains of key functions which, from the centre of the operational core towards the periphery, will serve to measure the specific complexity of the links within the plant and between the iron and steel industry and its environment (and vice versa) and which will highlight those factors which are essential for the functioning of the system.

From radial section to radial section we will produce an increasingly complete representation of the system, the more so when the horizontal links between the sections are established and when, at each point of the system, the relative importance will be revealed of those parameters which condition our four variables (know-how, behaviour, powers and responsibilities) so as to ensure sufficient reliability in the actions, that is to ensure what is termed technological mastery.

The implementation of the elements of this analysis will be carried out in Chapter 4 which is devoted to the methodology.

IMPORTANT NOTES :

Our approach does not assume the a priori establishment of an organigram of the plant: in effect any organigram results not only in an identification of the functions but also of their grouping in an optimal manner so as to achieve, at any given moment, the best possible performance within the relational system, and it is well known that organigrams evolve in time. It is also to be noted that those plants in the industrialised countries which exhibit the best performance are also those which are contantly carrying out research into the adjustment of their organigrams to meet the conditions of the present moment.

One should not therefore be surprised if during our study the particular emphasis is mainly placed on the functions of the supervisory staff and less on those of the engineers or middle and higher executives: the task of the latter consists of ensuring that the best conditions always exist for the exercise of the supervisory functions (foremen and shift leaders, technicians and junior management).

2.2. The extent and limits of the present study

2.2.1. In the second part a survey of the various process routes which are possible in the iron and steel industry, and an approach to the concept of technological complexity.

2.2.2. In the third part, introduced by Chapter 4 below, a theoretical study of complexity, for a given plant model, in those relationships which ensure technological mastery :

- the choice of a radial section in the complex system,
- a synoptic description of the systems and the relationships involved in this section,
- evaluation sheets and relational diagrams for the key functions relating to this section,
- diagrams of the inter-relationships between the key functions in the operational core and an evaluation of the levels of importance of the parameters on know-how, behaviour, responsibility and powers,
- research into the laws governing these parameters and the conditions for technological mastery,
- an extension of these laws to cover the plant/environment inter-relationships,
- a synthesis of the conditions for technological mastery.

2.2.3. In the fourth part a definition of the rules to be complied with for access to technological mastery, with recommendations for training activities, a comparison of scenarios and the conclusions.

CHAPTER IV

METHODOLOGY FOR THE STUDY OF THE COMPLEXITY OF FUNCTIONS

1. PRELIMINARY THEORETICAL STUDY OF THE COMPLEXITY SYSTEM - General notes.

1.1. The basis for the reasoning is a model-project for a semi-integrated mini-steelworks forming the first part of a development, defined in this manner :

- production : 80,000 t/year of concrete reinforcing rod and small merchant sections, from melting scrap in an electric furnace;
- the works comprises :
  - the manufacturing units, essentially a scrap yard, an electric steelworks with continuous casting of billets, a rolling section with provision for future additions and diversifications, and a despatch section.
  - the technical functional services linked with production or directly supporting it: laboratory services, quality control, energy services, fluids, transport, general stores facilities and maintenance, all generally termed "utilities",
  - no unit generating electrical energy, nor one producing process water,
  - management and administrative services.

To repeat our definitions given at the beginning of Chapter 3 this is a mini-steelworks consisting of the operational core and the first order infrastructure. In itself this plant forms an internal system which has its own complexity (see second part).

1.1.2. This model-project exists within an environment (second, third and fourth order infrastructures) with which it forms an overall complexity system.

1.2. LINES OF EQUILIBRIUM FRAGILITY (See Figure 1, page 20)

1.2.1. In this overall system there exist chains of relationships from the centre of the operational core to the furthest extents of the peripheral systems, simultaneously involving relationships of the vertical (hierarchic) and horizontal (functional) types, at all levels. As in all chains their strength is that of the weakest link.

1.2.2. Amongst these relational chains, firstly within the operational core and then between the operational core and the peripheral infrastructure, some may be identified by their primordial importance for the equilibrium of the overall system: we term them "lines of equilibrium fragility" for the simple reason that, in developing economies and particularly where the iron and steel industry is concerned, whilst their reliability is of vital importance their fragility carries with it a mortal risk. This is the more so in developing countries where, unlike the situation in more developed countries, four contradictory phenomena occur with a greater or lesser degree of influence :

- the various stages of the peripheral infrastructures are all in the apprentice phase, at least when compared with the operational core,
- human resources with the minimal level of know-how are, at the present time, very limited,
- behavioural patterns resulting from traditions and the socio-cultural environment make it difficult (if not impossible) to put into immediate effect the procedures used in the developed countries,
- imports of raw materials and spares are subject to restrictive rules.

This means that all the "safety nets" which may exist in the developed countries do not exist and will have to be continuously woven and created.

<u>1.2.3.</u> On the basis of experience three lines of equilibrium fragility can be identified immediately: all three concern supplies, since it is here that the major risk is located :

- supplies of raw materials,
- supplies of spares,
- supplies of skilled personnel (human resources).

For the purposes of the study we have chosen the line of supplies of spares (human resources).

<u>1.2.4.</u> In order to elucidate the method let us consider, schematically, the relational circuits for supplies of spares (refractories, engineering, electrical, electronic and instrumentation goods) to the <u>continuous casting workshop</u>, and simply remaining within the works (see Figure 3).

This operation, when it proceeds satisfactorily, does not involve the engineers or executives, except for signing undertakings or for settling internal differences: they have other tasks to carry out. Everything should proceed normally at the level of supervisory staff and the specialised technicians or office staff.

The following personnel are involved in these activities :

- in the continuous casting process -
  - . the senior foreman in charge of continuous casting (CC),
  - . the chief operator of the CC machine,
  - . the gantry operator,
  - . the foreman of the casting line,
  - . the grading operative,
  - . the ladle operator (tundish),

. the preparer for distribution (tundish),

. the billet controller and cutter,

. the billet store foreman,

. the hydraulics and cooling lines supervisor,

. the foreman in the refractories workshop (preparation of the distributors, tundish and ladles),

. the stores foreman for steelmaking/CC refractories,

- at the continuous casting maintenance sectoral level -

. the foreman responsible for CC maintenance,

. the supervisor in the office for preparation and scheduling of CC maintenance,

. the CC sectoral stores foreman,

. the pumps supervisor,

- at the general maintenance and engineering and new works level -

. the supervisors of the spares groups (mechanical, electrical, electronic, instrumentation, refractories),

. the technicians specialising in spares.

- at supplies/stock control level -

. the supervisors of the specialised supplies section (mechanical, electrical, electronic, instrumentation, refractories),

. the specialised principal buyers,

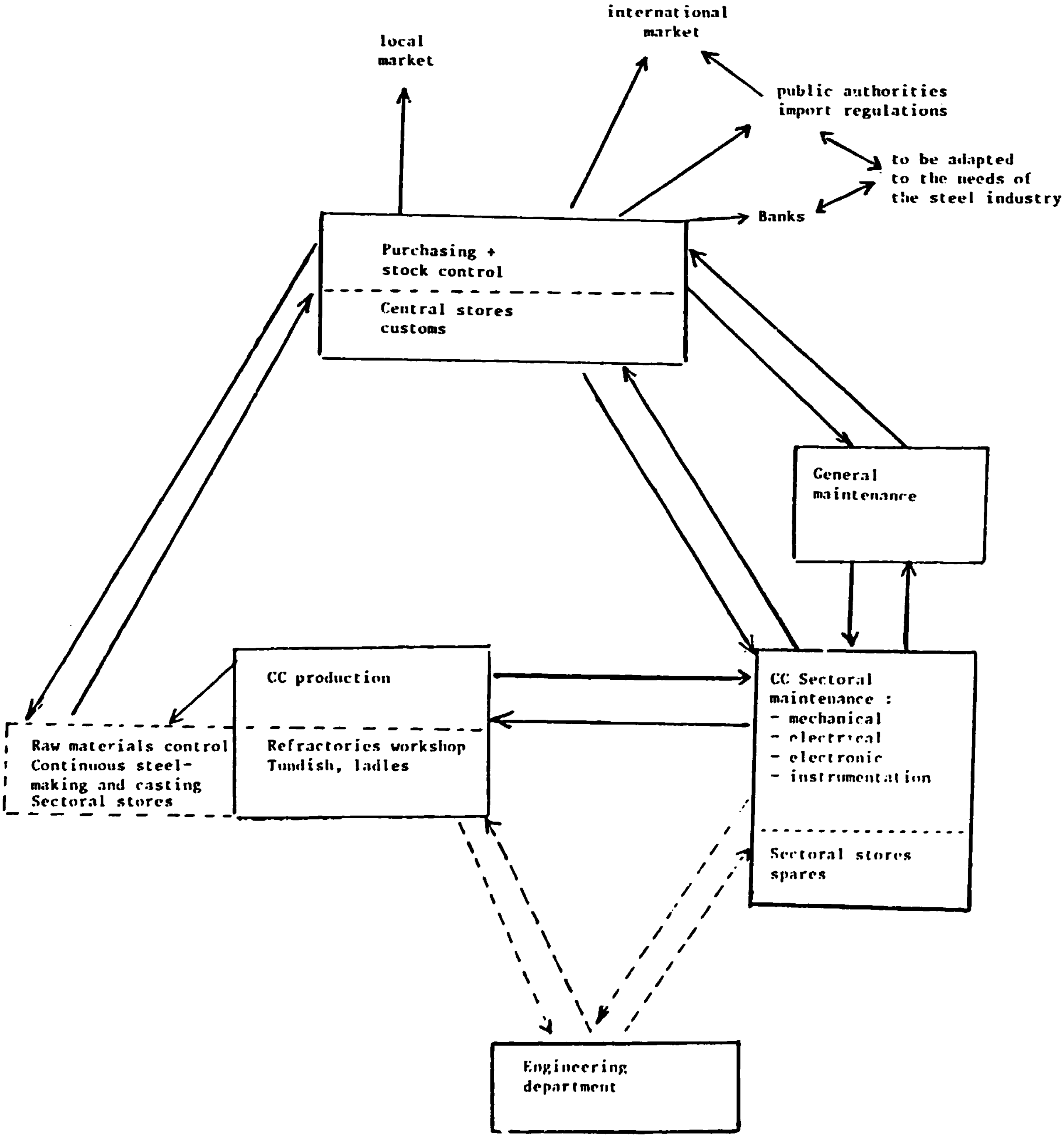
. the head of stock control,

. the head of automatic stock re-ordering.

1.2.5. It can be seen that, along and around the line of equilibrium fragility, a fairly large number of functions, generally modest within the hierarchy, form key posts.

It is necessary to evaluate these separately so as to quantify their internal complexity, and then to evaluate the overall complexity of the system which they all represent around the line of equilibrium fragility.

Figure 3 : THE PROBLEM OF SUPPLIES OF SPARE PARTS



1.3. EVALUATION OF THE KEY POSTS

1.3.1. The method of evaluation of a function (or of a key post) relies on an analysis of the fundamental requirements in terms of know-how and behaviour linked with the exercise of powers which it assumes and of the direct and indirect responsibilities which result from these powers.

It will be seen here that this is effectively an analysis of the demands of the post and not an evaluation of the capability of a given person to fill this post; the latter approach is reserved for later when, in the particular case of a project, it is a matter of forming a team, using the human resources as they are available. This involves on the one hand the reality of the moment and on the other the model of complexity to be achieved; having these one is better able to draw up personalised training programmes in all the compartments of know-how and of behavioural patterns.

1.3.2. The following will be established for each key post :

- the definition of the function, showing :
  - . the direct and indirect responsibilities,
  - . the immediate objectives (for example over an 8-hour shift) and the longer-term objectives (for example the management of a group),
  - . the greater or lesser complexity of the vertical and horizontal responsibilities,
  - . the degree of autonomy (powers) in regard to the possible consequences of this autonomy and of the control to be exercised, a control which may be more or less immediate; this leads to the concept of reliability which accompanies the post.
- the quantified evaluation of the requirements for each function on the basis of fourteen criteria, graded from 1 to 5, the grading 5 indicating the highest level of requirement for the criterion under consideration.

1.3.3. The fourteen requirement criteria for each key post are divided between criteria of know-how, criteria of behavioural patterns, criteria of short-, medium- and long-term responsibility and criteria of power.

1.3.4. The fourteen criteria are as follows :

1.3.4.1. Five criteria of know-how.

a) Basic, general and technical knowledge. This criterion makes it possible to evaluate the level of scholastic knowledge necessary for occupying the post. This level of knowledge is signified by the possession of a diploma recognised by the national education system in force.

b) Supplementary vocational knowledge: criterion making it possible to evaluate the level of vocational knowledge needed to fill the post. Such knowledge, which supplements scholastic knowledge is acquired either by experience on one or more work stations or by a training course.

c) Diversity of techniques in the function: criterion defining the number and magnitude of the items of knowledge or concepts needed for filling the post. In practice most of the operational posts, even if specialised assume some intellectual processing of information, some of which is not directly linked with the field of specialisation of the post but which must be taken into account in the execution of the function. For example :

The foreman of the scrap-iron yard must, in addition to his metallurgical specialisation, also have basic concepts in the fields of analytical accounting and personnel management.

d) Type and complexity of the intellectual processing: this criterion evaluates the complexity of the reasoning to be carried out for a correct response to situations and problems which may be posed by the function, taking into account the diversity of the information, so as to arrive at a decision having a positive effect.

e) Type and complexity of physical processing: this criterion, analogous to the previous one in its nature, is concerned solely with physical actions (movements) involved in the function, the difficulty being linked in this case with the tolerance and synchronisation constraints (e.g. operating a gantry crane, operating a rolling mill).

1.3.4.2. Three behavioural criteria.

a) Degree of vigilance: this criterion is linked to the possibility of the appearance of information which is of value in the active exercise of the function, and consequently gives the vigilance rating needed.

b) Degree of contrast of the useful information: a criterion concerning solely the sensory aspect (sight, sound, touch) of the function, and evaluating the difficulties in the simultaneous or successive perception or input of all the information of value.

c) Reaction time: criterion evaluating the speed required in responding to a situation or to a problem.

1.3.4.3. Six responsibility and power criteria.

a) Diversity of the activities: this criterion evaluates the diversity of the objectives, and hence of the lines of activity of the function: rating 1 for a function which only involves a single repetitive activity, even if complex; rating 4 or 5 for the foreman of the billets store who must, in addition to his direct responsibility (selection, marking, storage scheduling and selection, stock movements between casting and the rolling mill, etc.) should have ongoing horizontal contacts for the sole purpose of forecasting and regulating materials flows upstream and downstream in the production line, and with the functional services (laboratory, quality control, etc.).

b) Type of pilot information for other activities: this criterion evaluates the degree of influence of the function on the programme of other functions, whether in the hierarchic or functional lines, by way of the information transmitted.

c) Diversity of the piloted functions: this criterion is directly linked to the number of functions subject to the influence of the function being considered, and through the information transmitted.

d) Position of the controls external to the function: this criterion evaluates the autonomy of the function in terms of the distancing of the controls exercised from outside on the work being carried out. (The work of a gantry crane driver is verified at the time, the work of a tundish preparer for continuous casting is verified during casting, the work of a scrap sorter is verified after a certain number of castings from the electric furnace, the work of a foreman is judged on statistical data which are processed monthly, etc.).

e) The imputation of consequences: this criterion evaluates the possibility of imputing to the function the "traces" (positive or negative) left by the exercise of this function. As such an imputation becomes more difficult so much the more will the function be valorised by this criterion: it is a criterion evaluating the reliability demanded by this post.

f) Precision of directives: this criterion evaluates the degree of initiative left to the function; as the directives become more detailed so the post requires less in the way of capacities for initiative.

1.3.4.4. In regard to these fourteen criteria for the evaluation of a function it may already be seen that : (See Figure 4)

- five fall within the strict domaine of know-how acquired by basic instruction and specialised instruction, and also by vocational experience;
- three fall within the domaine of individual and collective behaviour, largely the resultant of education and of the influence of the socio-cultural environment;
- six fall within the domaine of the equilibrium to be found between the allocation of powers and of the attribution of responsibilities, that is to say within the domaine of the procedures adopted, but which are adapted both to the demands of the functions and to the demands of collective behaviour as they prevail within a given socio-cultural environment: this marriage of exigencies is not the smallest factor in complexity. This is represented in schematic form in the following diagram.

SCHEMATIC ANALYSIS OF THE COMPONENTS OF A FUNCTION

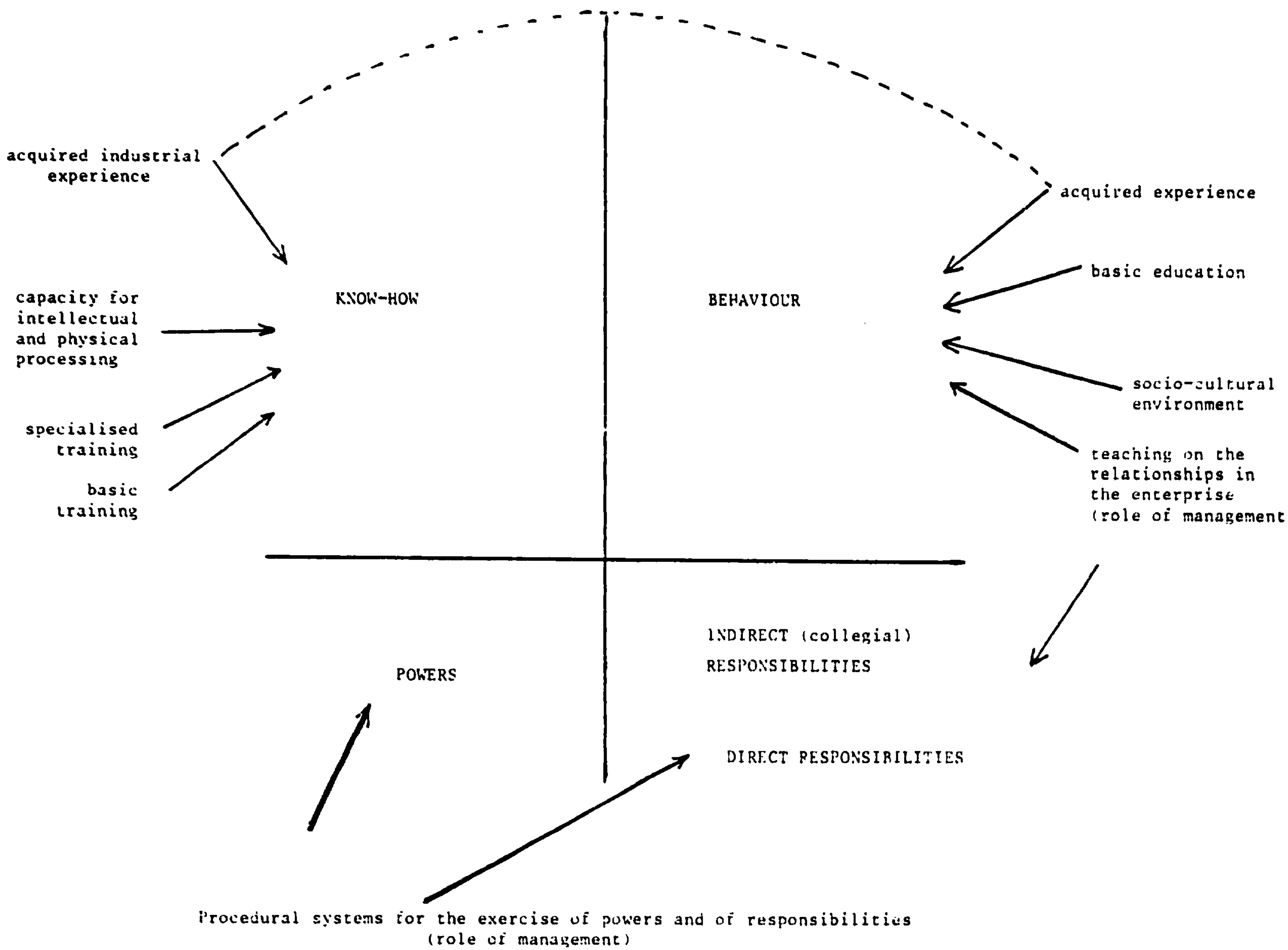


FIGURE 4

1.3.4.5. Along each line of equilibrium fragility, as defined in paragraph 2 above, we have identified about twenty functions which are directly involved.

To each of these functions may be attributed an evaluation grid for the exigencies, consisting of 14 criteria ranked from 1 to 5 and divided up into three fields (know-how, behaviour, responsibilities/powers).

Each function may, therefore, be represented by a quantified grid of exigency criteria, with a summation by points for each field and for all the fields being considered: every function thus has its "weighting" in terms of know-how, in terms of behaviour and in terms of responsibilities/powers.

Along and around a line of equilibrium fragility one may also add the weights of different functions, in each field, and finally as a grand total where all the fields or domaines are considered together.

Such summations constitute an initial measurement of the internal complexity of operation of the plant, seen from a "radial section" which goes from the operator to the supplies function, the latter being located on the frontier between the plant and its environment.

We now have to consider how the quality of the environment may risk modifying the levels of evaluation of certain functions.

1.4. THE INFLUENCE OF THE ENVIRONMENT ON THE COMPLEXITY OF INTERNAL FUNCTIONING OF THE PLANT

1.4.1. Summary of the directing concepts

We have already established in Chapter 3 that the environment of the plant may be described as satellite systems of services and/or sources of supplies and distribution with which the operational core of the plant must maintain ongoing and efficacious relationships if it is to be able fully to fulfil its economic mission.

We have classified these satellite systems, termed peripheral infrastructures, in a total of four orders, the first order being assumed to be incorporated in the plant (direct utilities and general services) whereas the fourth order can never be so incorporated since it involves, by definition, State services or departments.

As far as the second and third order systems are concerned these constitute functions which the plant can, in the final analysis, incorporate vertically, but not without running the great risk, by substituting them for economic functions of the horizontal type, of becoming deflected from its proper function and of inducing, around itself, a trend towards industrial and artisan-level desertification.

1.4.2. Identification of the factors of influence of the environment

As with the evaluation of the exigencies of the individual functions in the plant so we will proceed here by the evaluation of exigencies for the satellite systems.

What is required from a peripheral infrastructure ?

a) Competence, that is to say know-how in the vocation and adequate equipment.

b) Efficacy, in terms of quality of service and the shortest possible reaction time.

c) Reliability, that is to say the continuing and regular nature of the service.

d) A degree of physical proximity of the decision-making and contact levels, greater or lesser according to the ongoing or episodic nature of the relationships to be r intained.

e) A degree of proximity of behaviour, that is to say both a certain degree of sharing major economic interests and a certain consensus on policies adapted to development and also a common desire to solve practical problems efficaciously (a desire, and not just goodwill).

f) Relationship procedures which are compatible with the development objectives.

We find effectively the same major classes of criteria which we have used in evaluating functions in the plant :

- know-how in a),
- behaviour in e),
- the equilibrium between powers and responsibilities in b), c) and f).

To these are added the concept of physical proximity, d), which does not pose any problems within the limits of the plant but which has a considerable impact here when evaluating the complexity of operation.

To illustrate the above we may take an example which is located on the line of equilibrium fragility for supplies of raw materials and spares, as has already been examined.

The Buyer function in the plant is in contact with the local market and the international market. In order to fulfil his mission the Buyer must "traverse" one or more orbits of the peripheral infrastructures and must "retraverse" them when returning with his purchase.

In practice the scenario may be as follows :

a) Is the raw material or part to be obtained available on the local market ?

Utilisation of the general information systems, of the efficacy of the sales departments of the local suppliers, local transport, etc., that is to say of the infrastructures of the second and/or third order.

b) The part or the raw material is not to be found on the local market: it is now necessary to "pierce" the peripheral infrastrctures of the fourth order, to prove the need to import, to obtain an import licence after having carried out investigations and negotiations with the local representatives (if there are such) of the foreign suppliers(that is of the 2nd and 3rd order) or again after having appealed to a buying branch abroad, or even after having gone there in person to investigate the matter (air transport, passport and visa, foreign currency for travelling: infrastructures of the third and fourth order) - obtaining the letter of credit for payment (bank: fourth order), sea or air transport for the materials or part purchased (third order) and customs clearance (4th order).

All this has to be carried out, in one way or another, either with speed and facility (in the case of the industrialised countries) or again only by expending much time and resources, with the total cycle between the request for purchasing and the arrival of the goods in the stores sometimes taking several months. In the latter case the plant is compelled either to maintain a considerable minimum stock or to increase very considerably the importance and the level of know-how of the Buying/management function, but still without having any assurance of stable operation whilst accepting a further increase in internal complexity, an increase in complexity which is "useless" for the plant since it is reflected in a reduction in productive activity, rather like a reactive or wattless current.

Between the plant and its environment there is thus action and reaction, a well-known phenomenon in the physical sciences. But the phenomenon is certainly more complicated, and it is necessary to seek a more representative analogy in the biological sciences. Our approach needs to integrate all that the term biological equilibrium, or again ecology, includes in the way of complexity: whilst the life of the plant can only be assured above a certain level of internal and peripheral complexity, any increase in internal complexity resulting from the effort to replace a lack of peripheral complexity (or diversification) can result, over and above a certain tolerance towards imbalance, in the economic degeneration and death of the plant, and this may, in turn, result in degeneration at its periphery

1.4.3. Quantification of the necessary level of complexity in the peripheral infrastructures

1.4.3.1. For each infrastructure we have defined six criteria for exigences in 4.2. above. Each of these criteria will be ranked from 1 to 5, the highest ranking representing the maximal exigency for the life of the plant.

We have also drawn up a nomenclature for the infrastructures of the 2nd, 3rd and 4th order in Chapter 4 :

- 6 of the 2nd order,
- 13 of the 3rd order,
- 5 of the 4th order (but these may be further detailed if necessary).

In total therefore there are between 20 and 25 infrastructures.

Proceding in the same way as for the plant functions one can add, along a line of equilibrium fragility, the exigency coefficients on the one hand for each infrastructure and on the other by criterion, and can then arrive at the grand vertical/horizontal total.

These partial or general totals express the exigency level of the infrastructure, or again a measure of the infrastructure complexity which is demanded by the iron and steel industry.

1.4.3.2. If the complexity of an infrastructure falls below a permissible level the iron and steel industry will be penalised by this lack, in one way or another: it is even more penalised when it has no power to replace a defective environment.

It is obvious that its power of replacement at level 4 of the peripheral infrastructure is nil, whilst at level 2 it is considerable, even if penalising; at level 3 all possibilities of replacement are theoretically available, but are dangerous both for the plant and also for its environment.

Note will be taken of this comment when considering the levels of complexity which are needed on the part of the environment in relation to the levels of complexity of the functions which are needed within the plant, so as to arrive at a measure of complexity of the overall plant + environment system, that is to say that potential universe within which the iron and steel industry can be viable.

1.5. At the conclusion of the theoretical study of a quantified approach to the complexity of operation of the iron and steel industry along a line of fragility we will have a series of numerical tables.

All these numbers are significant as identifying values within a scale of exigences for the criteria of quality of service in the key functions.

From and around these values it will be possible to explore, in each case, the lower limits which demarcate the non-acceptability thresholds for each criterion.

All these values will, a priori, be chosen on the basis of experience in functional analysis in the industrialised countries. It will be seen, in the fourth part, that some adjustment to local conditions is desirable, and that this can only be carried out by self-training in a team already near to the conditions for technological mastery.

In this way the problem of rising to the state of technological mastery is presented in terms of maturation, that is to say in terms of the mastery of time: the decision-makers concerned with a project cannot hope to step around this obstacle, as will be shown by the scenario simulations.

PART TWO

A TECHNOLOGICAL APPROACH TO THE CONCEPT OF TECHNICAL COMPLEXITY IN THE VARIOUS TYPES OF IRON AND STEEL PLANTS : DESCRIPTION OF A MODEL FOR THE STUDY

INTRODUCTION

This second part is purely descriptive: it is intended, as we pointed out in the first part, to clarify ideas and to identify the framework within which the conditions for technological mastery are to be studied.

We will first of all carry out a rapid survey of the present situation of the iron and steel industry from the technological point of view and of the trends which may be identified as a function of the markets to be satisfied. In the examination of the various production routes we will be considering, separately and successively, two divisions in a steelworks, corresponding :

- firstly to the production of steel, and
- secondly to the processing of this steel to arrive at semi-finished or finished steel products.

Subsequently we will attempt a broad classification of the various types of steelworks on a scale of the complexity of their structures, so as to identify the position of the model steelworks within which our study will be located.

Finally we will provide a brief description of this model steelworks as it could be found in a profitability study.

CHAPTER I

THE TECHNIQUES FOR PRODUCING STEEL

It will be recalled that, if we leave on one side the research work on producing steel by electrochemical or low-temperature chemical methods, all existing methods, or these under development, can be divided into (Figure 1) :

- A classical route where the ore is first of all reduced to iron, at the same time as the metal is melted, together with the gangue (which is removed in the form of a liquid slag) before converting the liquid primary metal into steel, in general by oxygen converting.

- A route in which reduction and fusion are dissociated: the reduction is carried out at a "low temperature", that is to say below the melting point temperature, a process termed "direct reduction", the solid primary metal then being converted into steel in a fusion steelworks, in general using an electric arc.

1. EVOLUTION OF THE CLASSICAL ROUTE

Although it is difficult to summarise the history of this development it may be said that the principal motivations for it were :

a) Economies on the cost price, which had their effects -

   - on capital investments and on amortisation by calling into play the scale economies resulting from steelworks of increasing size;

   - on personnel costs by increasing productivity at all stages of the the process. These efforts have been facilitated by technological developments which make it possible to reduce the manpower needed but raises the level of knowledge required.

b) Economies in regard to energy needs (that is to say also on the cost price); energy costs have become increasingly important and this has resulted, in this route :

   - firstly to economies in the energy used in each unit, in particular when producing the primary metal in a blast furnace;

   - secondly by recovering all the energy in the excess gases (from the coke ovens and blast furnaces or, now, from the oxygen converters) and even the exhaust gas from the throat of the blast furnace by envisaging using the latent heat of the slags, etc.

The totality of this evolution has resulted in :

- "modules" (that is to say a chain of the most powerful units available at any given moment) of increasingly large tonnage,
- appreciable economies in both labour and energy.

But it has also resulted in :

- an increasing complexity in the integration of units and in the gas and solids circuits, and
- increased capital investment costs, in current currencies.

c) Improvements in the quality of the products: that is to say the liquid steel from the twin viewpoints of :

- the regularity and maintenance of the properties of the products, from casting to casting, that is to say the accuracy of the various component levels,
- an improvement in this quality by, for example, reducing the levels of metalloids, P, S, etc.

The appearance and development of ladle metallurgy and continuous casting have certainly made great contributions to this development....

2. Developments in ELECTRIC FURNACES and in DIRECT REDUCTION

Here we find, particularly in the industrialised countries, two quite different trends :

- firstly the continuing development of electric steelmaking which is explained essentially, and apart from the production of certain special or alloy steels, by the rapid growth of the mini-steelworks. This rapid growth has been due, as is well known, to :
  - . the limited capital investments needed by this process,
  - . the low consumption of energy, limited to some 500-600 kWh per tonne of steel,
  - . the abundance of scrap-iron, the price of which, apart from some short-term fluctuations, has been steadily falling.
- secondly the efforts made to develop new direct reduction processes. These efforts are directed towards finding more economical routes than the classical route, at least where medium-sized capacities are involved.

This has led :

- firstly to the development of a whole series of direct reduction processes,
- secondly to a considerable expansion of these techniques, although this is relatively limited when compared with the total world production of steel.

It will be noted, however, that whilst electric steelmaking continues to develop rapidly, despite the crisis, in the industrialised countries, direct reduction is only developing very slowly: there are two reasons for this :

- scrap is abundant and cheap,
- pre-reduced ores, with the high cost of natural gas, have considerably higher cost prices.

3. COMPARATIVE DATA

In the present situation it is possible to draw up a comparison of these two (or possibly three) routes for producing steel by utilising the following five criteria :

a) Capacities and investment costs

The classical route in the industrialised countries is becoming increasingly the one used in the mega-steelworks, with capacities of the order of 2m to 4m tonnes/year per module, that is to say for a line consisting of :

. a coking unit
. an agglomeration unit
. a blast-furnace
. an oxygen converter.

This results in very large capital investments if such high capacities, such as a 4m tonne/year module (or multiples of this) are retained.

For a mini-steelworks the investments are very much smaller, but this involves :

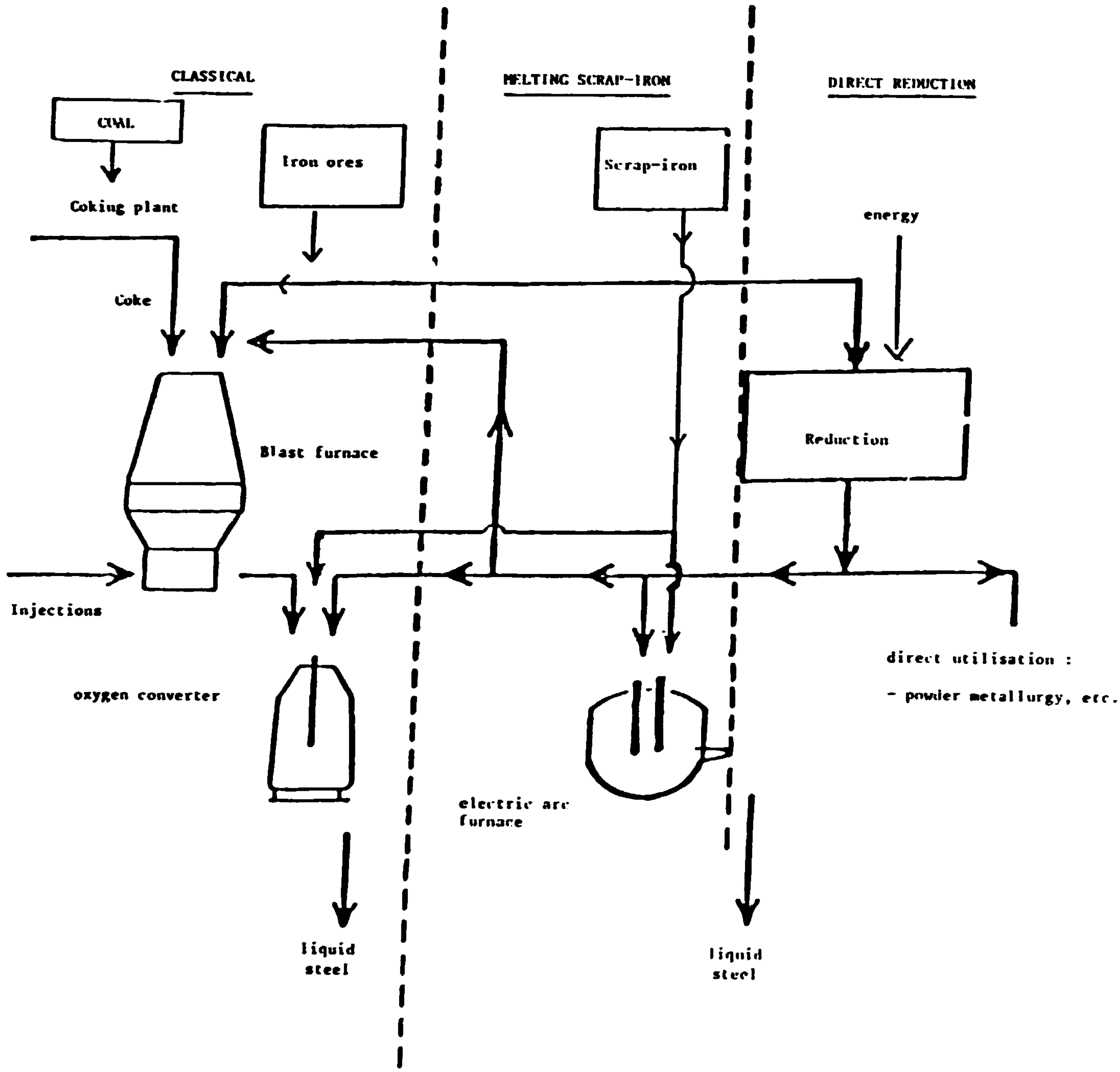
. limiting production to the lighter long products,
. starting from scrap-iron.

b) Energy

The very large differences in this respect arise from the fact that the different routes use totally different sources of energy.

We thus find ourselves faced with two possibilities for producing liquid steel, one based on the heavy and costly route, reserved for the very large producers, and the other much lighter route, better suited to small and medium capacities and less costly, particularly if this route is shortened as far as is possible by feeding the electric furnace with scrap-iron.

Figure 1 THE VARIOUS PROCESSES FOR PRODUCING STEEL



CHAPTER II

MANUFACTURING STEEL PRODUCTS

In our approach to this problem we need to start from the following three points :

- a survey of the principal iron and steel products,
- the market for these various types of iron and steel products,
- and the various types of rolling mills.

As far as the developing countries are concerned these points give rise to a series of conclusions which will form the fourth part of the chapter. To this we will add a fifth part on cold-rolling and finishing processes.

1. THE IRON AND STEEL PRODUCTS

It is necessary to bear in mind that there are, apart from the generic term of steel in the singular, a whole range of iron and steel products which may be classified in three main categories :

- the crude products : liquid steel intended for casting and ingots,
- semi-products : products generally obtained by rolling (or at the present time by continuous casting) and intended to be converted into finished products. The conventional terms for this are blooms, slabs, billets and sheet bars,
- finished products : rolled products, the converting of which has been finished in the steelworks and which now forms the subject of iron and steel trading.

It is possible to distinguish, within the class of finished products :

- flat products, including large flats, plates and sheets (flat or on reels) which are either hot- or cold-rolled, and strips,
- long products, including sections such as beams, merchant goods or bars, special sections, wire rod, railway equipment (rails, sleepers, etc.) and sheet piling.

We will be examining in greater detail those products which have the widest range of uses such as sheets, merchant bars and beams.

A) FLAT PRODUCTS : plates, flat or reeled sheets and strips

It does not seem to us to be necessary to repeat here the general definition of sheets and strips, but we will simply summarise the present sales classification of hot-rolled sheets and plates, specifying their dimensional limits and the relevant standards and tolerances.

Present classification of sheet : hot-rolled sheet and plate

The producers have introduced into their price lists a classification which takes present rolling processes into account, and which divides hot-rolled products into two categories :

Hot-rolled sheet : This term covers all those hot-rolled flat products which are supplied in the form of reels of any width or thickness, or sheet of 8 mm thickness or below and with widths of 1850 mm or less (these are in fact sheets produced on a continuous rolling mill).

Plates : The term plate is applied to hot-rolled flat products supplied in the form of plates with a thickness of more than 5 mm or with a width greater than 1850 mm (these are plates produced on a four-high stand).

B) LONG PRODUCTS : beams and merchant bars

The following is a brief summary of the most widelv used products :

- Merchant goods
  . small U-sections
  . rounds
  . squares
  . flats
  . symmetrical and unsymmetrical angles
  . symmetrical T-sections.

- Concrete-reinforcing bars

- Beams
  . IPN
  . IPE
  . IPE-R
  . HE
  . UPN
  . UAP

In regard to the classification of these products we can make the following general comments :

Merchant bars :

a) Limiting dimensions of sections

The various types of merchant goods have to comply with certain maximum and minimum dimensions which separate them from other categories of sections: the dimensional limits for some common products are given below :

- small merchant U-sections have a height of at least 30 mm (special sections boundary) but less than 80 mm (beams boundary),

- rounds are supplied in lengths and have a minimum diameter of 5 mm,

- the boundary between rounds - concrete-reinforcing rods and wire rod: the term wide rod is restricted to products supplied in coils.

Wire rod straightened and delivered in lengths is classified under merchant goods; however in the case of products for concrete, formerly classified as merchant goods, these are now regarded as a separate category: smooth rounds may be supplied in coils, and are then termed "smooth rounds in coils".

- flat bars have a minimum thickness of 3 mm and a maximum width of 150 mm, a limit which separates them from the large flats. They are delivered in straight bars (flat wire rod is always supplied in coils).

b) Other recent modifications in the classification

Certain products previously classified as merchant goods are now listed as special sections: this applies to angle irons with equal fins and to unsymmetrical T-sections with fillets.

Beams :

Height limits for sections

The term "beam" is restricted to sections with a height of at least 80 mm (for example an 80 mm UPN is a beam but a 70 mm UPN is a merchant section).

2. THE MARKET FOR THESE VARIOUS TYPES OF IRON AND STEEL PRODUCTS

If we consider the growth of the consumption of iron and steel products as a function of the development of a given region we find great divergences between the data obtained from different countries and periods.

However there are general trends such as :

- the influence of the population of a given zone, region or country which may be served by a steelworks. However if we restrict ourselves to liquid steel this is of little interest.
- to go a little further it is necessary to envisage a certain type of breakdown of the consumption of iron and steel products. For this purpose we have taken the model in Table 1, basing ourselves on the following data :

- Assuming a figure of 10 kg crude steel per person and per year, or
  8 kg products per person and per year,

  divided into :

  62.5% long products (50% light long products, including 37.5% bars) and
  37.5% flat products

These figures can vary considerably, particularly in the case of oil-producing countries which need welded or weldless tubes (or flat products used to make tubes locally).

- Assuming a figure of 100 kg crude steel per person and per year, or
  80 kg products per person and per year,

  we may find one of two cases :

  In the case of a country without an automobile industry divided into -

  50% long products (of which 37.5% light long products and 25% bars) and
  50% flat products

  Or in the case of a country with an automobile industry divided into _

  40% long products (of which 25% light long products and 20% bars) and
  60% flat products.

These are, quite obviously, only <u>trends</u> which serve to highlight the general possibilities, every region being a special case.

3. THE VARIOUS TYPES OF ROLLING MILLS

When converting raw steel into steel products the method most widely used is rolling, with forging or direct casting only accounting for very much smaller tonnages. If we return to the range of iron and steel products cited above we can distinguish a series of types of rolling mills.

It should be remembered here that rolling consists of a series of operations designed to convert the ingot, by successive stages, into the finished product of predetermined form. Each of these phases is separated from the next by the reheating of the intermediate product in furnaces of various types (pits, pushers, with walking beams, etc.).

There is a very wide range of final shapes, from simple geometrical shapes such as round, square, rectangular, trapezoidal, etc. to more complex shapes such as beams, rails or sheet piling.

A rolling mill consists essentially of one or more "stands", structures which support the cylinders between which the metal passes. Linked in pairs these cylinders rotate in opposite directions, pulling the product through and progressively compressing it. When products of rectangular section are being produced the cylinders are smooth; for other shapes they are channeled.

Roughing mills were formerly used for the first operation of roughing out the ingot, in a blooming mill for long products and in a slabbing mill for the flat products. These are two-high stands, that is to say with two reversible cylinders, allowing the ingot to pass in both directions. These are very powerful units since they must be able to absorb the total production of steel ingots in the steelworks. At the present time they are being increasingly replaced by continuous casting to produce the slabs, blooms and billets as semi-products, these then going to the actual rolling units.

These products, in particular the slabs and billets, are generally handled on heavy rolling mills. These mills generally produce intermediate products such as strips, billets and sheet bars. However certain heavy mills produce large finished products, such as beams, rails, large round sections and sheet piling, directly.

The medium and small rolling mills provide the final rolling.

Technical development in rolling has resulted in continuous rolling mills. With these there is no break between the passes through the various stands of the mill. The metal is drawn out, flattened or reduced in diameter according to the product concerned, and at the end of its passage it is rolled into reels in the case of sheets or into coils in the case of wire rod. Its speed increases as it passes through the mill; it can rise to 90 kph in the case of sheet and 200 kph (125 mph) in the case of wire rod.

There are continuous mills for sheet production (they are thus called "continuous wide strip mills") and for the production of narrow strips, wire rod and merchant goods.

For completeness it should be noted that the steelworks processes by far the greatest part of the steel produced by rolling. The rest is supplied to the forging and foundry industries which convert it using other processes.

Forging is the oldest technique for converting steel. At the present time the equipment used for forging consists of hydraulic presses capable of exerting very considerable powers of up to 10,000 tonnes, having replaced the more brutal steam drop-hammer and, even older, the water-driven drop hammer. Forging can be used to transform ingots into rough forms which can then be machined by the engineering industry.

Steel can also be moulded, like cast iron. Foundries receive the steel in liquid form or as ingots which are then remelted. Casting can be used to manufacture products of complex shapes.

Returning to rolling Figure 2 shows schematically the principal types of rolling mills, whilst Figure 3 indicates the mean annual capacities of these principal types of mills.

Table I : APPROXIMATE MODELS OF THE EVOLUTION OF THE CONSUMPTION OF IRON AND STEEL PRODUCTS AS A FUNCTION OF THE DEVELOPMENT OF A REGION

Crude steel : kg/cap. / Products : kg/cap.	10	50	100		500	
			a	b		
Total	8	40	80	80	400	
Long products	5	25	40	32	150	(37.5%)
(of which :						
light products	(4)	(20)	(30)	(20)	(100)	(25%)
of which :						
bars)	(3)	(15)	(20)	(16)	(60)	(15%)
Flat products	3	15	40	48	250	(62.5%)
Weldless tubes	-	-	-	-	---	
(Welded tubes are included under the flat products)						

(a) Country without an automobile industry

(b) Country with an automobile industry

Figure 2 : ROLLING STEEL

After it has been reheated the ingot passes through the successive "stands" of the rolling mill where it is rolled out by the cylinders which progressively give it the desired shape and thickness: smooth cylinders for the flat products and channeled cylinders for the sections. Cold rolling makes it possible to reduce even further the thickness of certain sheets whilst at the same time giving them certain special physical properties.

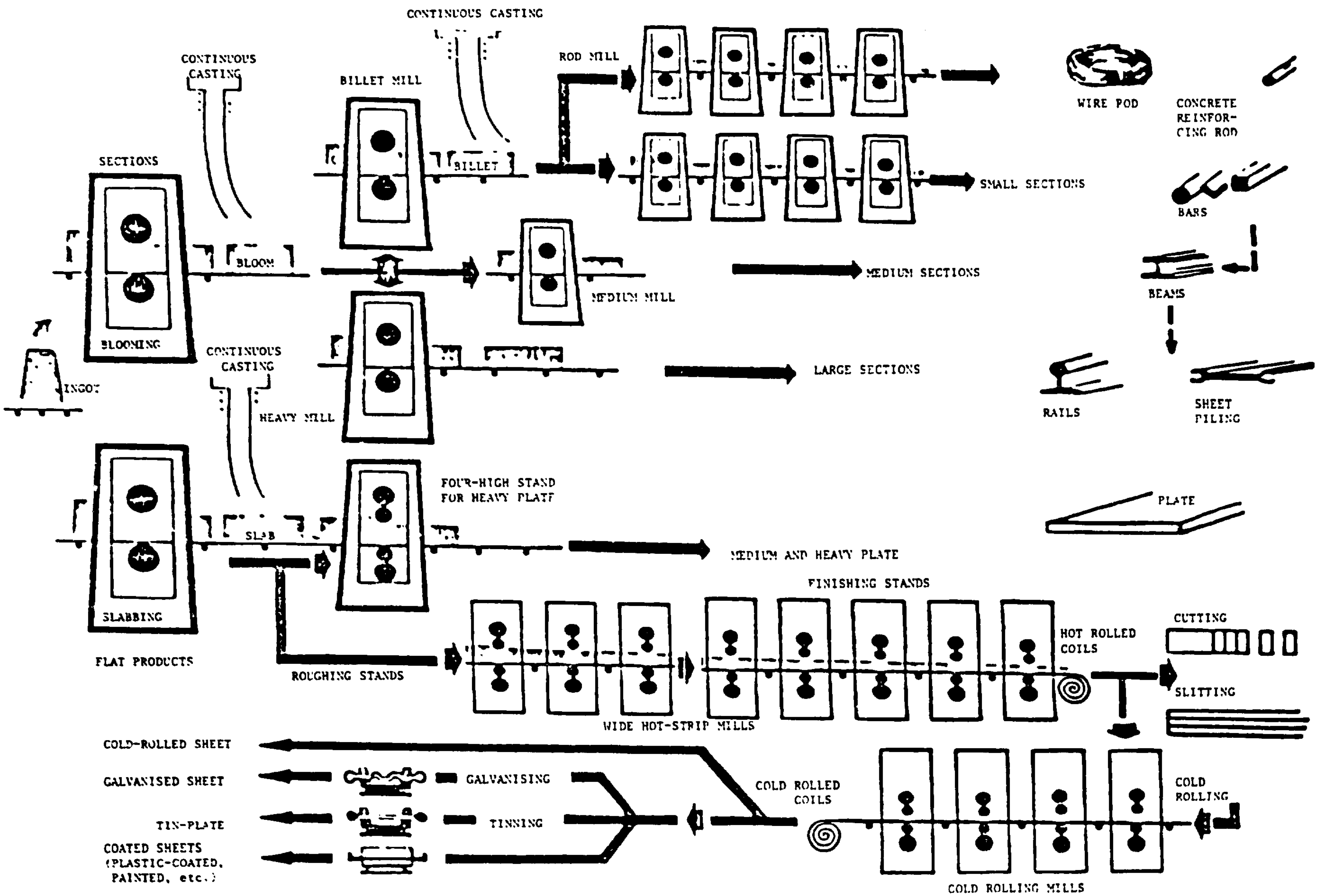
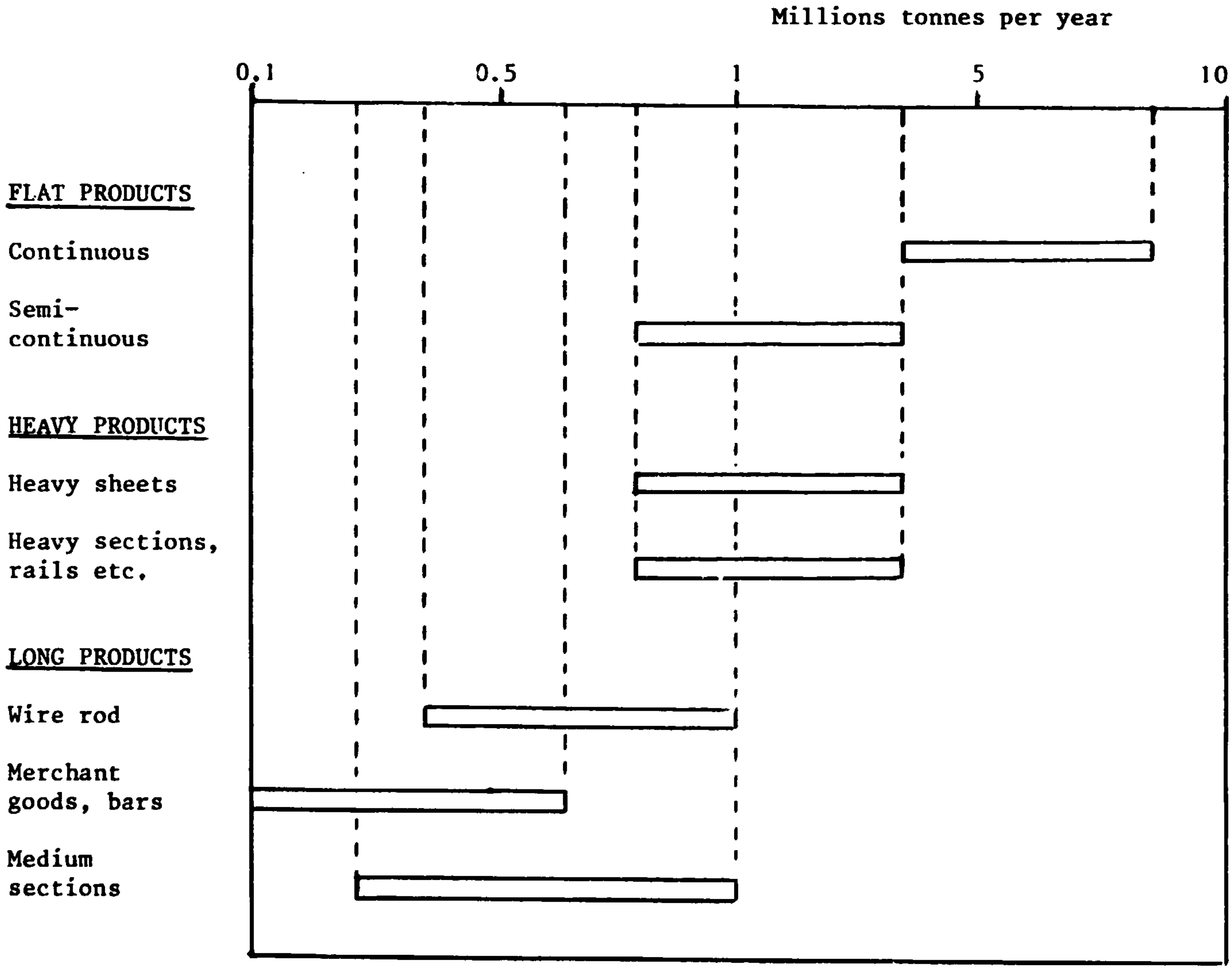


Figure 3 : MEAN ANNUAL CAPACITIES OF ROLLING MILLS



CHAPTER III

THE IRON AND STEEL REQUIREMENTS OF DEVELOPING COUNTRIES

If we return to the very simplified "models" it will be seen that, as we have indicated, we may attempt to apply them to provide some orders of magnitude to the various situations which may be characterised by :

- the population of the zone (region or state) being considered, and
- its state of development, which may be characterised by the per capital consumption of crude steel each year.

This allows us to draw up the following tables :

- Table II : covering flat products,
- Table III : covering light long products, and
- Table IV : covering bars.

If we then compare these with the mean basic data for rolling mill capacities the following conclusions appear very clearly :

- it would be difficult to envisage plants for the production of flat products unless there is a large population and a fairly advanced stage of development (see the two areas marked on Table II),
- it is very much easier to envisage the production of light long products, such a merchant rods and bars: the case of wire rod is already more specialised (see Table III). In the case of round concrete reinforcing rod can find the following solutions (see Table IV) :
  - . conventional routes in mini-steelworks, or
  - . more arguable in the case of micro-steelworks.

Table II : SPECIFIC NEEDS, IN TONNES/YEAR, FOR IRON AND STEEL PRODUCTS FOR VARIOUS CHARACTERISTICS OF A GIVEN ZONE

FLAT PRODUCTS

Crude steel per capita kg / Millions inhabitants	10	50	100	
			a*	b*
1	3,000	15,000	40,000	48,000
5	15,000	75,000	200,000	240,000
10	30,000	150,000	400,000	480,000
50	150,000	750,000	2,000,000	2,400,000
100	300,000	1,500,000	4,000,000	4,800,000

Zone of semi-continuous (or Steckel ?) mills: 300,000 (10 kg, 100 million inhabitants); 750,000 (50 kg, 50 million inhabitants); 150,000 (50 kg, 10 million inhabitants).

Zone of semi-continuous, three-quarter continuous or continuous mills: 1,500,000 (50 kg, 100 million inhabitants); 2,000,000, 2,400,000, 4,000,000 and 4,800,000 (100 kg a* and b*, 50 and 100 million inhabitants).

* see Table I, p.49

Table III : SPECIFIC NEEDS, IN TONNES/YEAR, FOR IRON AND STEEL PRODUCTS FOR VARIOUS CHARACTERISTICS OF A GIVEN ZONE

LIGHT LONG PRODUCTS

Millions inhabitants \ Crude steel per capita kg	10	50	100	
			a*	b*
1	4,000	20,000	30,000	20,000
5	20,000	100,000	150,000	100,000
10	40,000	200,000	300,000	200,000
50	200,000	1,000,000	500,000	1,000,000
100	400,000	2,000,000	3,000,000	2,000,000

Solution of mini-steel-works type (See bar mill only in Table II-9)

Solution of the mini-steelworks type

Various solutions are possible, with several rolling mills

* See Table I, p.49

Table IV : SPECIFIC NEEDS, IN TONNES/YEAR, FOR IRON AND STEEL PRODUCTS FOR VARIOUS CHARACTERISTICS OF A GIVEN ZONE

BARS (ESSENTIALLY CONCRETE REINFORCING RODS)

Millions inhabitants \ Crude steel per capita kg	10	50	100	
			a*	b*
1	3,000	15,000	20,000	16,000
5	15,000	75,000	100,000	80,000
10	30,000	150,000	200,000	160,000
50	150,000	750,000	1,000,000	800,000
100	300,000	1,500,000	2,000,000	1,600,000

Small simplified train for micro-steelworks ?

Solution of mini-steel-works type

Various solutions are possible, with several rolling-mills

* See Table I, p.49

CHAPTER IV

THE STRUCTURES OF THE POSSIBLE STEELWORKS

If we consider the data in the previous chapters it can be seen quite clearly that there are :

- any number of steel production processes which can be adapted to a very wide range of local contexts,
- that iron and steel needs are not the same throughout the world; they evolve with time, having very different structures in terms of both quantity and quality, ranging from the industrialised countries on the one hand and the developing countries on the other.

It is now necessary for us to examine the two situations separately.

1. THE INDUSTRIALISED COUNTRIES

Broadly speaking such countries have :

- major needs, with per capita consumptions of several hundred kg per year: with countries having 20 to 100 million inhabitants this can rapidly lead to total consumptions of 10m to 50m tonnes/year,
- up to 60% of the total being represented by flat products, the balance being made up of -
  a) long products (rails, girders, etc.)
  b) long light products (bars, wire bars, small sections etc.)
  c) tubes.

Table V shows clearly the result of such a situation :

- the steelworks based on the blast furnace has become a <u>mega-steelworks</u> of several million tonnes a year, and specialising in flat products and, sometimes, heavy products such as rails and girders,
- small and medium-sized steelworks based on the blast furnace, when they have not been able to undergo the above transformation, are beginning to disappear, being replaced by mini-steelworks based on scrap

2. THE DEVELOPING COUNTRIES

Here, as we have already seen, the needs are different :

- the overall total tonnages are limited except in the case of the largest countries (India and China) or the most developed countries (Brazil and Korea),

- with a greater demand for small products, such as concrete reinforcing rods, than flat products in the case of those countries which are just beginning to develop.

Under these conditions the developing countries, with the possible exception of the most populous and highly developed countries (Brazil, China, India, Korea, etc.) find themselves in a much more difficult situation than that of the industrialised countries since :

- as a result of a lack of markets they cannot envisage very large works producing flat products, and
- as a result of a shortage of scrap they cannot envisage medium-sized mini-steelworks.

It is therefore necessary (see Table VI) to try to identify the best "cases".

Schematically, therefore, it may be said that there are two types of works differentiated both by their structure and also by their capacities.

It may also be seen that steelworks based on the blast furnace-converter route are technological monsters for several reasons.

The most important reason is that these works consist of a succession of units operated by men of different trades. At the furthest point in the process are the units responsible for receiving and storing the raw materials - coal, iron ore, lime, etc. - with the main function of handling enormous quantities of products.

Another large unit, the coking plant, deals solely with the problem of producing coke from coal. The steelmen are found at blast furnace level and at the stage of producing the liquid steel, their object being to obtain a metal of a given chemical composition to be passed on to the continuous casting unit, which forms the critical point between liquid metal and solid metal.

Finally there are the men operating the rolling mills who work on a solid if hot product, and whose concern is with the standard of the physical properties of the final product.

This brief survey shows the juxtaposition, the dependence and the exigences of liaison, and hence the difficulties encountered in achieving the harmonious functioning of these heterogeneous units. Such difficulties are increased by the gigantism of these production units and the need to maintain continuity of production.

What is the position with a mini-steelworks based on electric steel production ?

If we envisage a unit of the order of 100,000 tonnes it is clear that the scale reduces certain problems, but it is mainly its design which makes it a simple and more "modulable" unit.

Such a unit is shown schematically in Figure VII which shows the three parts of a more or less completely integrated steelworks.

One must not obscure the fact that such a steelworks already represents a complex assembly since it involves :

- a direct reduction unit,
- an electric furnace with continuous casting,
- a bar mill with a reheating furnace.

In order to carry out a detailed study we felt that it was desirable to consider, initially, a semi-integrated steelworks; this does however involve putting together different trades and, consequently, implies fairly complex relationships.

In order to make our ideas concrete we will take the specific case of a steelworks with the production programme shown in Table VIII, and comprising three possible stages of development.

Later on in the study we will take into consideration the rolling mill of the first stage, which has a capacity of 82,000 tonnes of rods and merchant goods. The steel is supplied from a 90-tonne electric furnace, fed with scrap, and four continuous casting lines producing billets of 120 x 120 mm cross-section and from 6 to 12 metres in length.

This small semi-integrated unit has the advantage that its structure allows a full study of the complexity of operation in the iron and steel industry, and that it is the type of steelworks which meets the needs of the majority of those countries which have a market for iron and steel products which is still limited in size.

Table V : THE TWO TYPES OF STEELWORKS IN THE INDUSTRIALISED REGIONS

Capacity, tonnes/year \ Processes and routes	"Classical", with blast furnace and oxygen converter	With arc furnace, using scrap	With arc furnace and direct reduction
Less than 100,000	These plants are disappearing	Development of mini-steelworks for long products	Difficult : Technically too small
100,000 to 1,000,000	(cont.)	(cont.)	Difficult : Not economic
1,000,000 to 5,000,000	Development of large steelworks for flat products		Difficult : Too large
More than 5,000,000	(cont.)		(cont.)

Table VI : THE TWO TYPES OF STEELWORKS IN THE DEVELOPING REGIONS

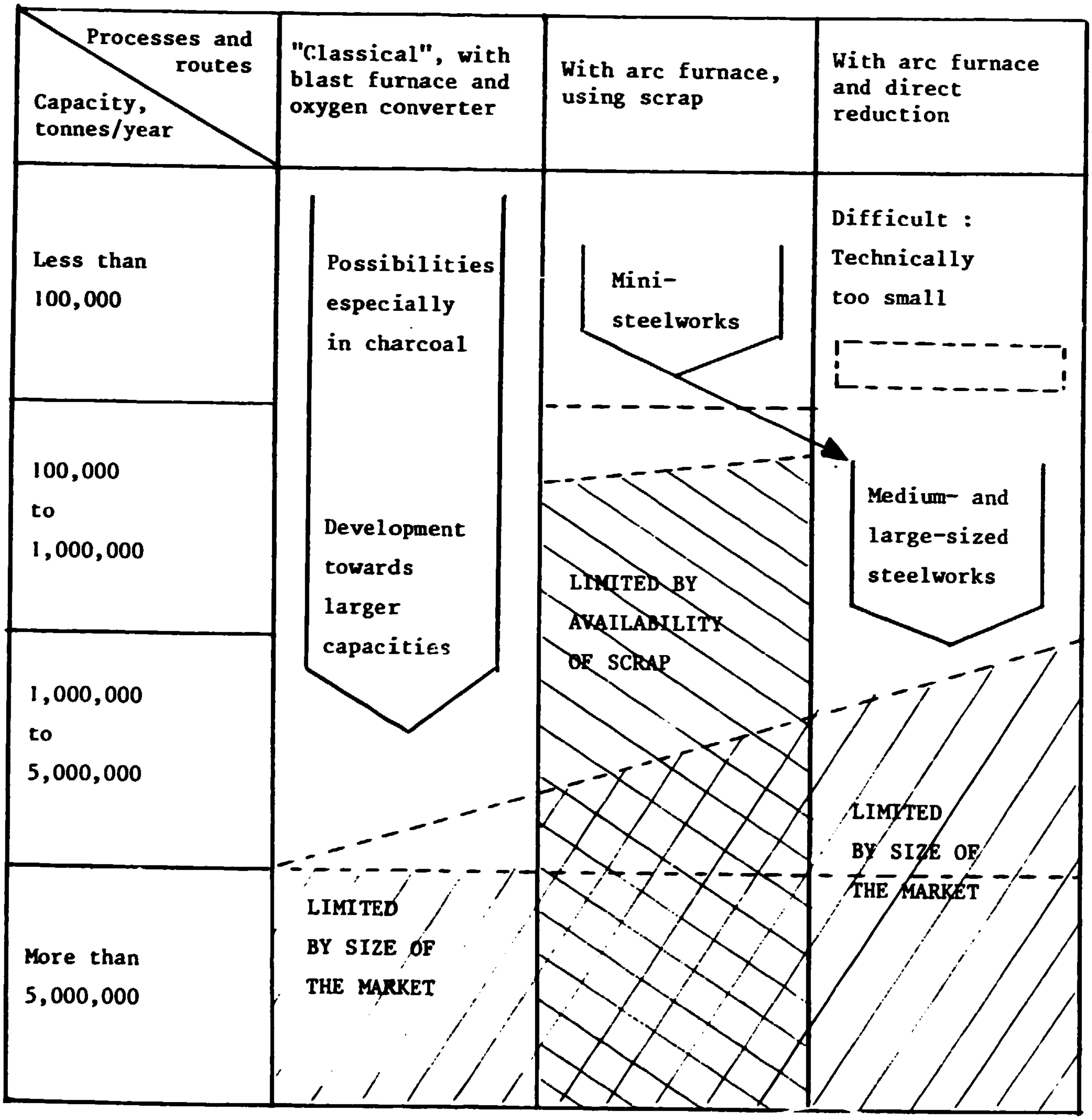
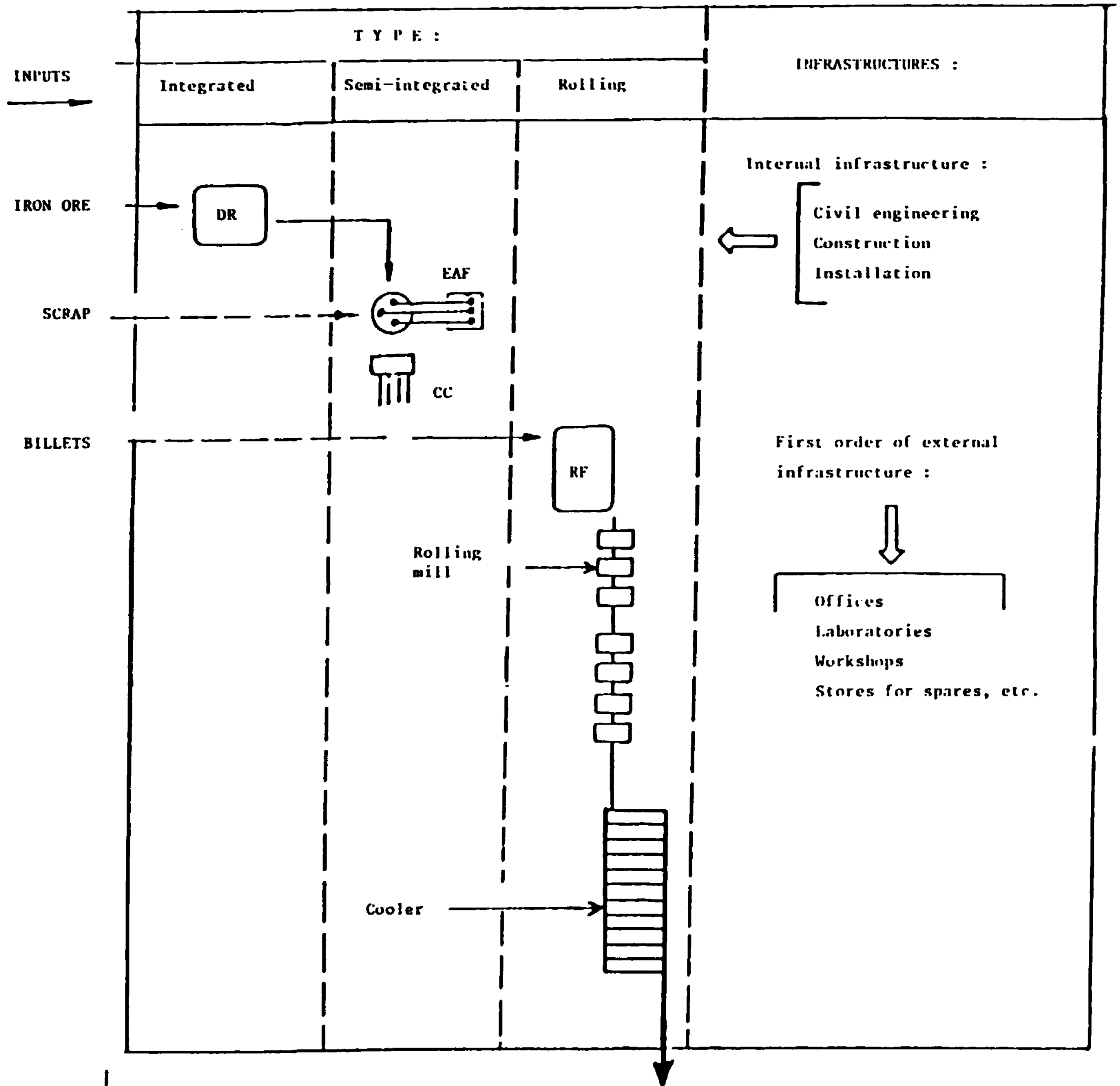


Table VII : SCHEMATIC CONFIGURATIONS OF VARIOUS MINI-STEELWORKS



OUTPUTS

DR : Direct reduction
EAF : Electric arc furnace
CC : Continuous casting
RF : Reheating furnace

Bars or wire rod or small merchant goods, etc.

Table VIII : ANNUAL ROLLING PROGRAMMES (in tonnes)

	Stage 1	Stage 2	Stage 3	Notes
Round rod and concrete reinforcing rods :				
10 mm diameter	15,000			Divided between :
12 mm diameter	10,000			
14 mm diameter	10,000			33% smooth 67% high
16 to 40 mm diameter	20,000			
Sub-total	55,000	55,000	55,000	
Merchant goods :				
20 to 60 mm flats	3,000			
8 to 32 squares	4,000			
20 to 60 mm L-sections	12,000			
30 to 50 mm U-channels	8,000			
Sub-total	27,000	27,000	27,000	
Small sections :				
L 70 L 80 L 90		} 3.500		
IPE 80		7,000		
IPE 100		7,000		
IPE 120		3,000		
UAP 80		3,500		
UAP 100		5,500		
UAP 120		3,500		
Sub-total		35,000	35,000	
Wire rod				
5.5 mm diameter			32,000	
6 to 9 mm diameter			8,000	
Sub-total			40,000	
T O T A L S	82,000	117,000	157,000	

CHAPTER V

THE POSSIBILITIES FOR IRON AND STEEL CENTRES OF A THIRD TYPE

INTRODUCTION

If we refer back to our description of the modern iron and steel industry, that is to say :

- the production techniques described in Chapter 1, and
- the processing methods described in Chapter 2,

and without overlooking :

- the needs of the developing countries as described in Chapter 3, or
- the structures of various steelworks as described in Chapter 4,

it may be seen that one other dimension is lacking in this enumeration, since it has failed to describe (see Chapter 4) any steelworks other than :

- the large integrated steelworks, either of the classical type (i.e. based on coal and using blast furnaces and oxygen steelmaking) or based on "direct reduction" (i.e. using also electric steelmaking with, in most cases, natural gas), or
- the mini-steelworks, also based on electric steelmaking but generally of the "mono-product" type (usually light long products and concrete reinforcing rods, with the possible extension to wire rod and small merchant goods); on a small scale such a mini-steelworks is almost always based on scrap but may be integrated, in an appropriate context, with a "direct reduction" unit.

In this chapter we will add the iron and steel activities of a third type which operates on an even smaller scale of production: instead of the 1m to 5m tonnes/year of the large steelworks or 0.1m to 0.5m t/year of the mini-steelworks we are now considering the area below 100,000 or even 10,000 t/year.

It would seem to us that such a subject has to be approached in the following three ways :

- an examination of the problems of a region at the commencement of its development, a [illegible] possibilities of auto-centred strategies,
- the appr[illegible] arket" and of service centres for iron and steel p[illegible]
- the pos[illegible] ucing steel on a very small scale.

These thr[illegible] form the subjects of the three parts of this chapter.

1. THE PROBLEMS OF A REGION AT THE COMMENCEMENT OF ITS DEVELOPMENT AND THE POSSIBILITIES OF AUTO-CENTRED DEVELOPMENT

It must first of all be recalled that the classical iron and steel units, covering not only the large integrated plants but also the mini-steelworks, are only producers of intermediate goods, that is to say the products which are used by other industries and which are rarely purchased by the final user.

In an already developed region, such as the newer industrialised countries, and without forgetting the older industrialised countries, there are therefore existing links between the iron and steel industry and the consumers of its products or, more precisely, the various users of iron and steel products. Figure 4 shows these relationships schematically, and it may be seen from this that many problems are posed for a region which is only just beginning its development. These problems seem to us to be classifiable under the following three categories :

- will a classical mini-steelworks, even if of only small productive capacity at the start, not be too large for the market being considered ? This is the problem of the micro-steelworks (see 3 below) or of an evolving mini-steelworks...
- will it not in any event be necessary to impo[illegible] a number of iron and steel products, and will it not also be necessary to equip the plant so as to adapt these products for the local market, that is to say not only to have a purely commercial activity as steel stockholder but to go beyond this and to install means for the cutting, preparation and even the packaging and coating of these products ? This is what we will be examining in the second part.
- will it not be necessary to examine more fully than in the past the question of "product mix", that is to say the range and types of iron and steel products which are or will be needed, taking care not to base this mix on what is "done elsewhere", particularly what is done in the industrialised regions ? This is the point on which much study has been done concerning auto-centred developments: such work has, it is true, been criticised but it has also certainly been used when trying to achieve a better balance between the needs of a region and what can be provided by a specific iron and steel industry (see also the second part).

2. THE APPROACH VIA THE "MARKET" AND OF SERVICE CENTRES FOR IRON AND STEEL PRODUCTS

In the face of these problems we will now examine how certain functions, on the border of the iron and steel industry, could and should be carried out in the least developed regions. In this second part of the present chapter we will not be considering the production of steel (this will be the subject of the third part) but the utilisation of iron and steel products.

It is necessary to emphasize once again that traditionally, at least in the most industrialised regions, the iron and steel production process stops at the production of what are still intermediate products. If it is desired to develop a region it is necessary to be able to provide products which can be used on site.

In other terms, and in the case of a region which is only just beginning its development, the scheme shown in Figure 4 needs to be modified, and will become that shown in Figure 5 where it is possible to see three levels which seem to us to be clearly differentiated :

2.1. Iron and steel stockholders and merchants

In general, though not universally, these exist in many regions but need to be developed so that they are more in the service of and in contact with their customers; by this word we are designating not only the buyers of iron and steel products but also, and above all, the potential users, meaning those needs which are imperfectly expressed or not expressed at all.

There is thus a very important role to be played by persons in the region under consideration; they need to establish an "interface" between the iron and steel industry and the users of its products.

2.2. Service centres for iron and steel products

Over and above this role of distribution, and its commercial aspects, it seems to us to be necessary to emphasize those technical aspects which are often neglected. The user often needs products which are defined not only by the grade but also by dimensions; these may be :

- concrete reinforcing rods of specific lengths,
- a specific length of a small steel section (channel, T-section, angle, etc.).

It would seem to be necessary, therefore, to have locally available equipment which is often very simple, though sometimes more complex, so as to be able to cut the products to length, sometimes extending this to the cutting or slitting of sheets.

This role, which is sometimes that of a steel stockholder or merchant or sometimes that of a true distribution and finishing centre for iron and steel products, is often under-valued, and we feel it necessary to insist on its essential role :

- both in actual distribution, and
- also in the education and training both of the sellers and buyers of iron and steel products.

2.3. Small and medium sized iron and steel activities

Going somewhat further, and before examining micro-steelworks, it seems to us that the activities downstream of the iron and steel industry have often been neglected; these are even more lacking than the iron and steel industry itself in those regions just starting their development. It would seem that these may be divided into two fairly different categories :

- those activities which are classical in the industrialised countries and which rapidly become necessary in a developing region, such as wire-drawing and the manufacture of nails, screws, bolts etc. to name just a few examples, and
- those activities which already exist at artisan level in the so-called under-developed regions and which, too often largely unknown and neglected, supply everyday products. This is where it is possible to find the bases for auto-centred development which should not be neglected. Unless they are designed in another way the production units for machettes, knives and ploughshares and other basic tools must not be neglected; otherwise shortages will develop and it will be necessary to import parts which are, in general, essential and irreplacable...

3. THE POSSIBILITIES FOR PRODUCING STEEL ON A VERY SMALL SCALE

This survey would not be complete unless we include, as indicated in the introduction, those possibilities which can, or could, appear to produce steel on a very small scale of production. To make the point quite clear this concerns productions of less than 100,000 tonnes/year, and in fact we will be talking rather of 100 t/day, or 30,000 t/year, or even of 3t to 10t a day, or 1000t to 3000t a year.

Firstly we will recall all the points which oppose such a concept before going on to describe, by way of an example, the micro-steelworks in the area of 30,000 t/year, and the ideas which have been developed recently in Sweden in this direction.

3.1. THE OBSTACLES TO THE CREATION OF MICRO-STEELWORKS

To identify more clearly the problems posed by the design and construction of micro-steelworks we should recall the economic advantages of the "large units".

These advantages stem from two well-known laws :

- the law of scale economies, from which it may be seen that the cost of a unit increases more or less as the square of its dimensions whereas its production, linked to volume (in metallurgy, exactly as in chemistry), increases as the cube of its dimensions. This is the famous law of the power of 0.6 or 0.7 in the chemical engineering industry. This can be applied more or less to a blast furnace, a converter, a rolling mill and to a plant formed from these units. The graph in Figure 6 shows, for example, that it is possible to think, within a given context, in these terms when considering the cost of a large integrated steelworks, based on a blast furnace, a converter and a hot rolling mill (see also Figure 7).
- the law of increased productivity when personnel no longer have the role of manipulating materials or products, but have the role of managing mechanised (or even automated) units, and when the production of the unit under consideration increases. As a first approximation the total manpower remains constant within the unit as the production of the unit, or of the chain of units, increases, with the effects shown schematically in Figure 8.

As far as the consumption of energy or the quality of the products are concerned the advantages of gigantism are less obvious; but they do exist, or at the least there are no contra-indications in this resepct.

In other words it is necessary, when designing profitable micro-steelworks, to "cheat" in regard to these laws, that is to say :

- to remove certain stages from the long production chain, without overlooking the finishing operations and sales,

- to design new methods for simplifying metallurgical operations, and even to dispense with some of them.

3.2. MICRO-STEELWORKS IN THE AREA OF 30,000 tonnes/year

It is of value, in this panorama, to recall the fact that a whole series of micro-steelworks exist, often with many difficulties but also with a number of successes. Schematically they fall into two types if they are regarded from the point of view of their development :

- those which began as "re-rollers", that is to say as importers of billets; this was very often the origin of the Italian BRESCIANI. Subsequently these small rolling mills became "semi-integrated" with an electric furnace and a billet casting unit. Figure 9 shows the schematic installation of such a micro-steelworks, limited to rolling, in a developing region.

- those which have been designed from the outset with the combination of :
  . electric steelmaking (using scrap),
  . billet casting, and
  . a rolling mill.

  Figure 10 gives an example of such an installation in a developing region.

3.3. AN ORIGINAL CONCEPT FOR A MICRO-STEELWORKS OF ABOUT 1000 t/year

Within the framework of the research carried out by a major group of persons in Sweden a preliminary project for a "micro-steelworks" was drawn up, and this may be summarised by its principal characteristics as set out below.

The group consisted of about 250 persons; they worked over the period from 1978 to 1982 under the aegis of STU, and their work is summarised in a text of about 50 pages in English, entitled :

"THE PROJECT FUTURE STEELWORKS"
FINAL REPORT
STOCKHOLM, January 1983.

This is effectively the translation of the report in Swedish which has the reference 316-1983.

Each of these "steelworks of the future" (in Swedish "Framtida jarnverk") is the subject of a short publication in Swedish, illustrated with drawings, layouts and other figures, of about 70 pages in length. There are in fact five publications corresponding to each of the projects which are numbered from 1 to 5. The one to which we are referring here is numbered 310 - 1982.

The principal characteristics of these steelworks of the future are as follows (see Figure 11) :

- the production is based on scrap, by melting in an induction furnace and by "spray" casting, that is to say using a jet of the liquid metal which then solidifies in droplets on a plate (see Figure 12),

- the required products are produced by the simple cutting of this plate of steel (see Figure 13 and, particularly, Figure 13c),

- more interesting even than the technique is the underlying philosophy of this "steelworks" (if it is still possible to apply this term to it...); it has something in common with the Chinese "village factories" (which date back some twenty years or more) and with that of the kibbutzim in Israel, by which an enterprise is created within a small community so as to satisfy the greater part of its needs for iron and steel products.

Figure 4 : HIGHLY SIMPLIFIED DIAGRAM OF THE USES OF STEEL

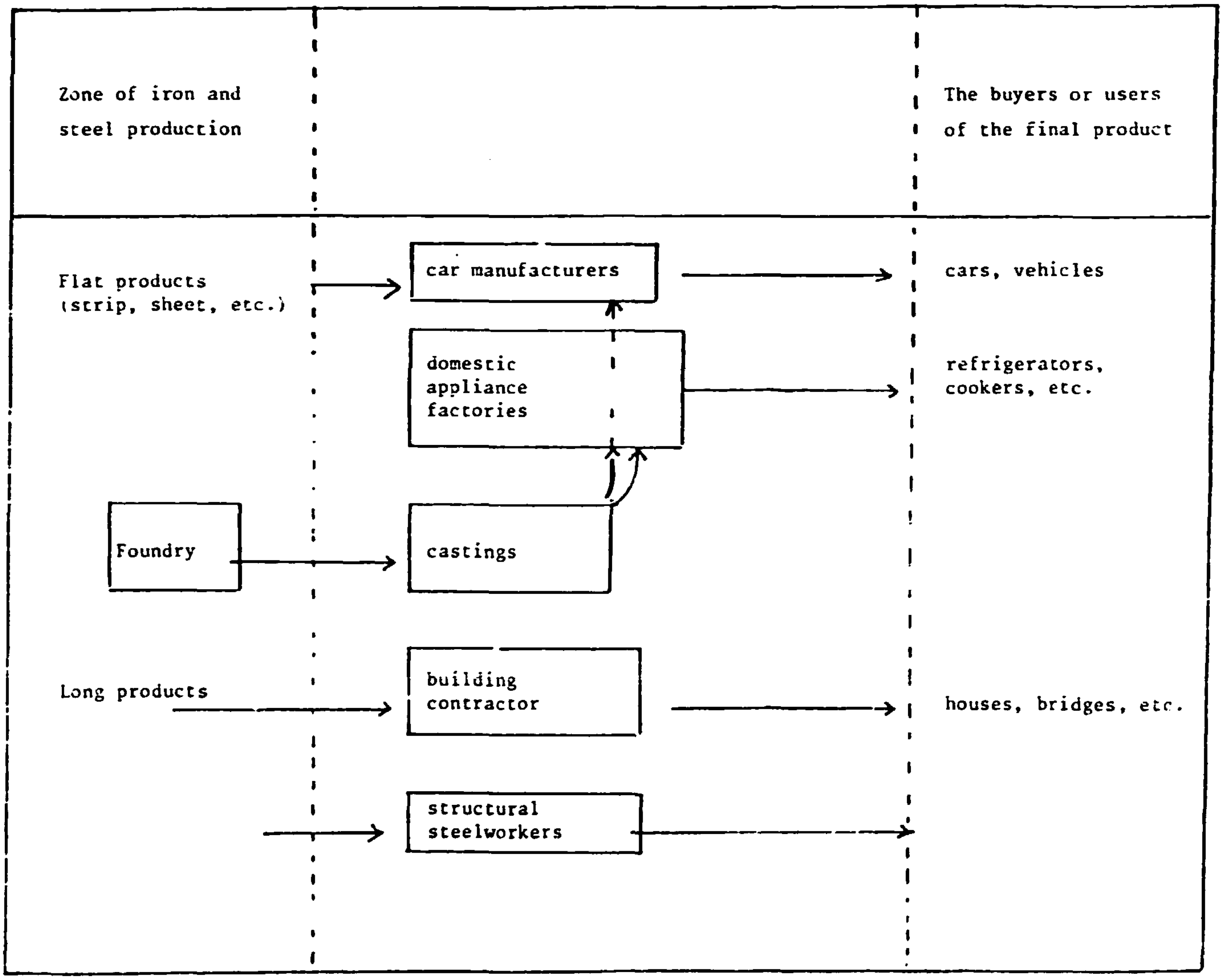


Figure 5 : DIAGRAM OF THE CIRCUITS FOR IRON AND STEEL PRODUCTS IN A DEVELOPING REGION

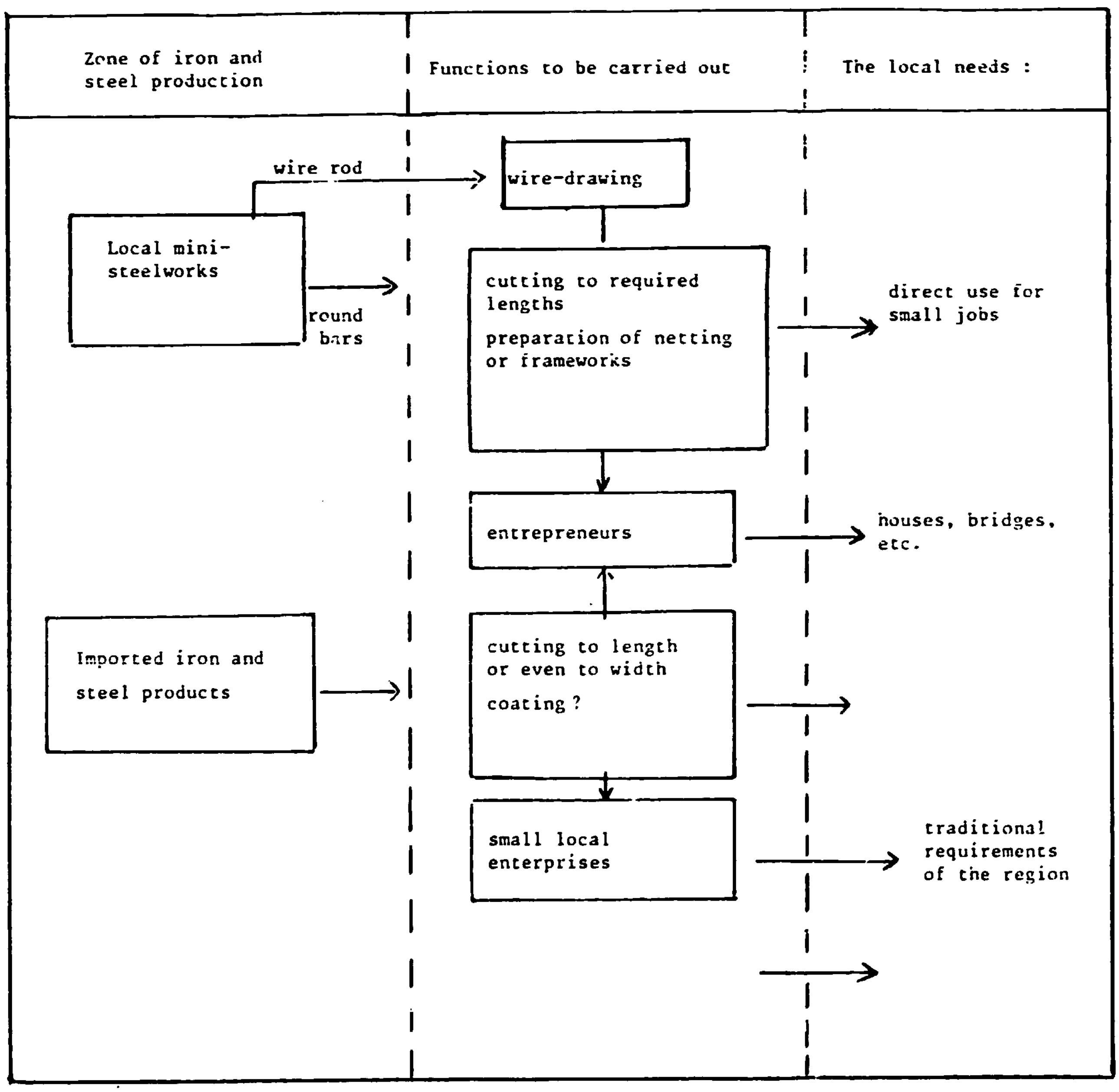


Figure 6 : CAPITAL INVESTMENT IN THE CLASSICAL ROUTE FOR THE PRODUCTION OF HOT-ROLLED COILS

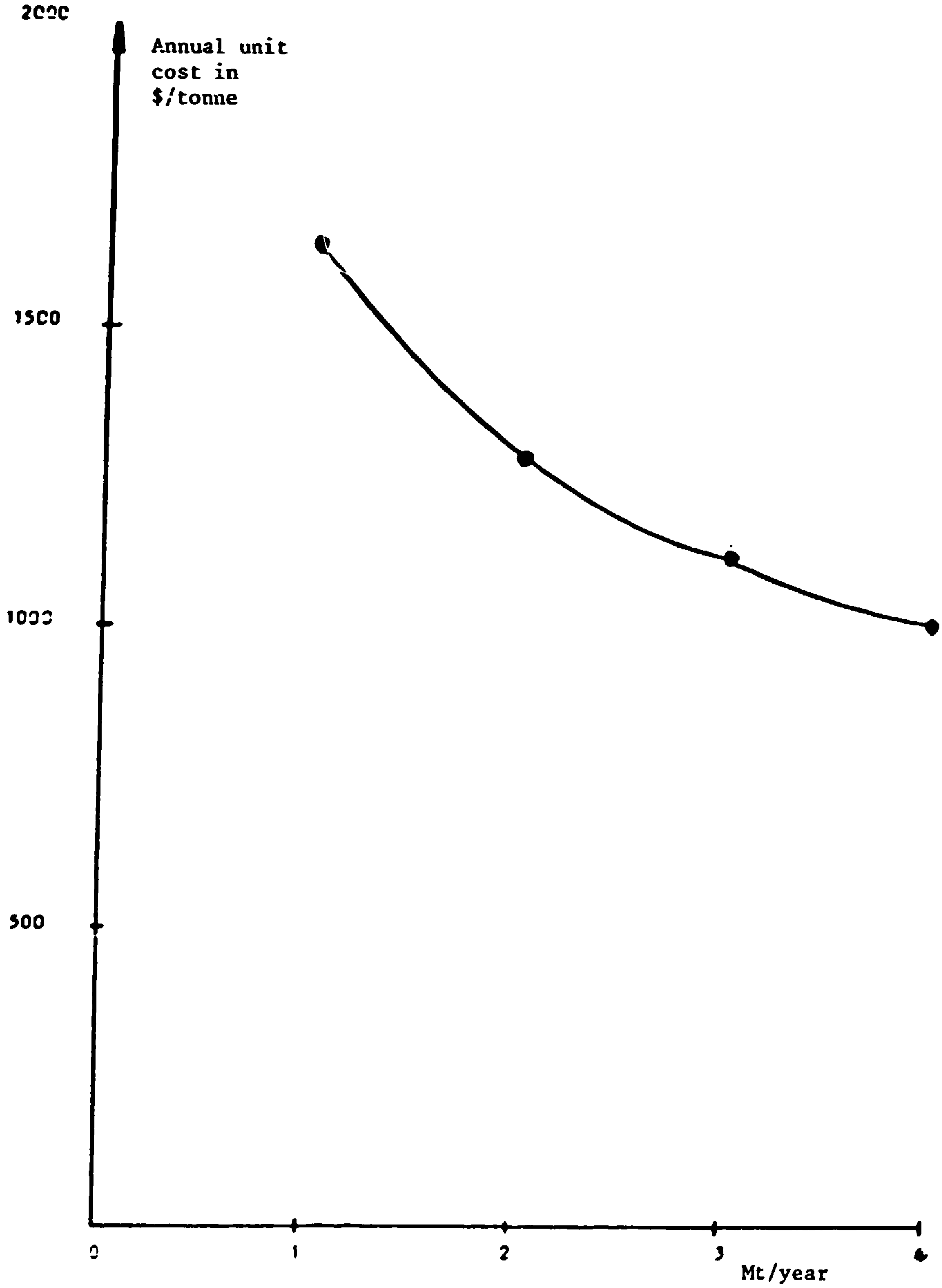


Figure 7 : CAPITAL INVESTMENT IN THE CLASSICAL ROUTE FOR THE PRODUCTION OF HOT-ROLLED COILS

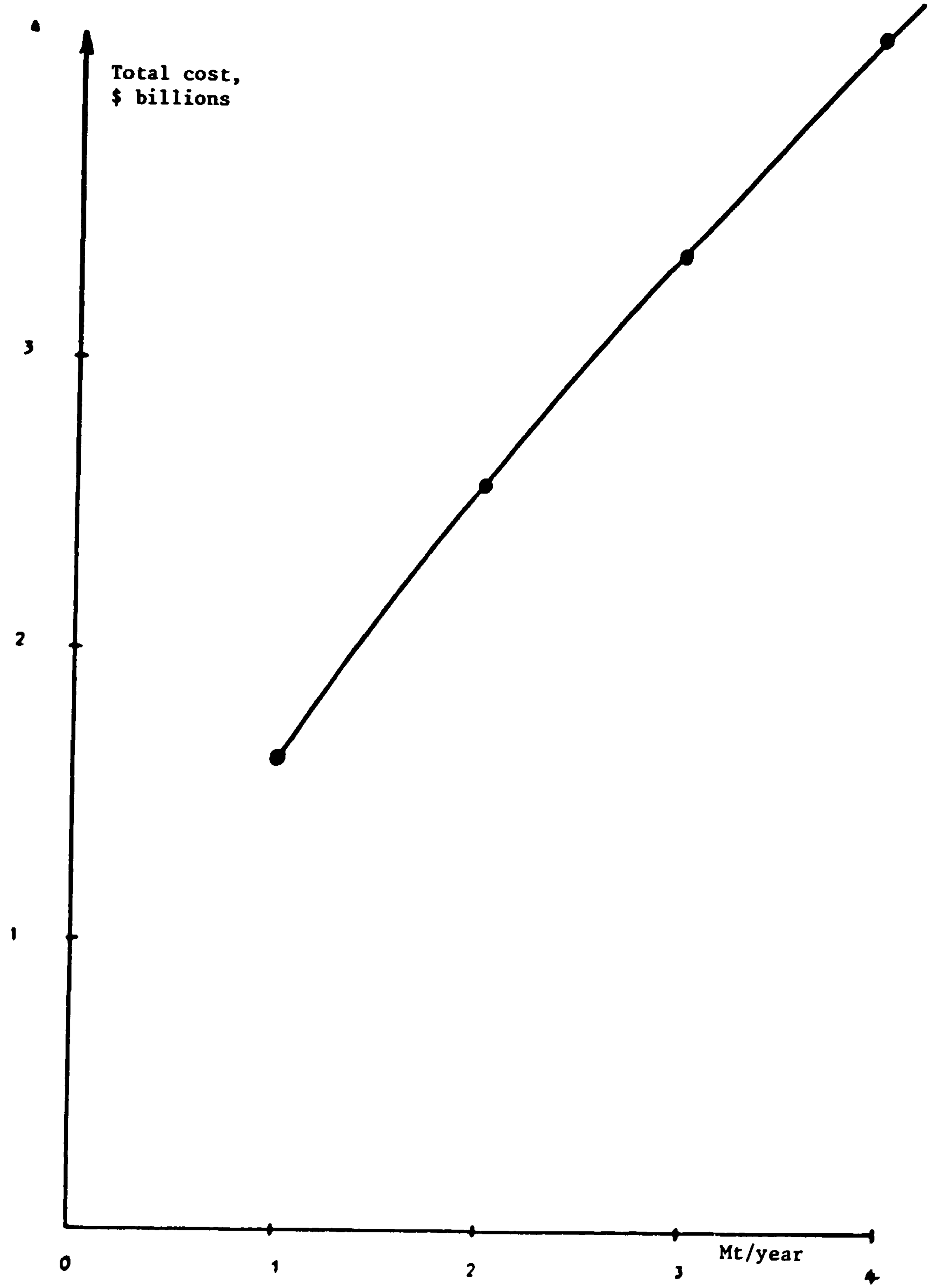
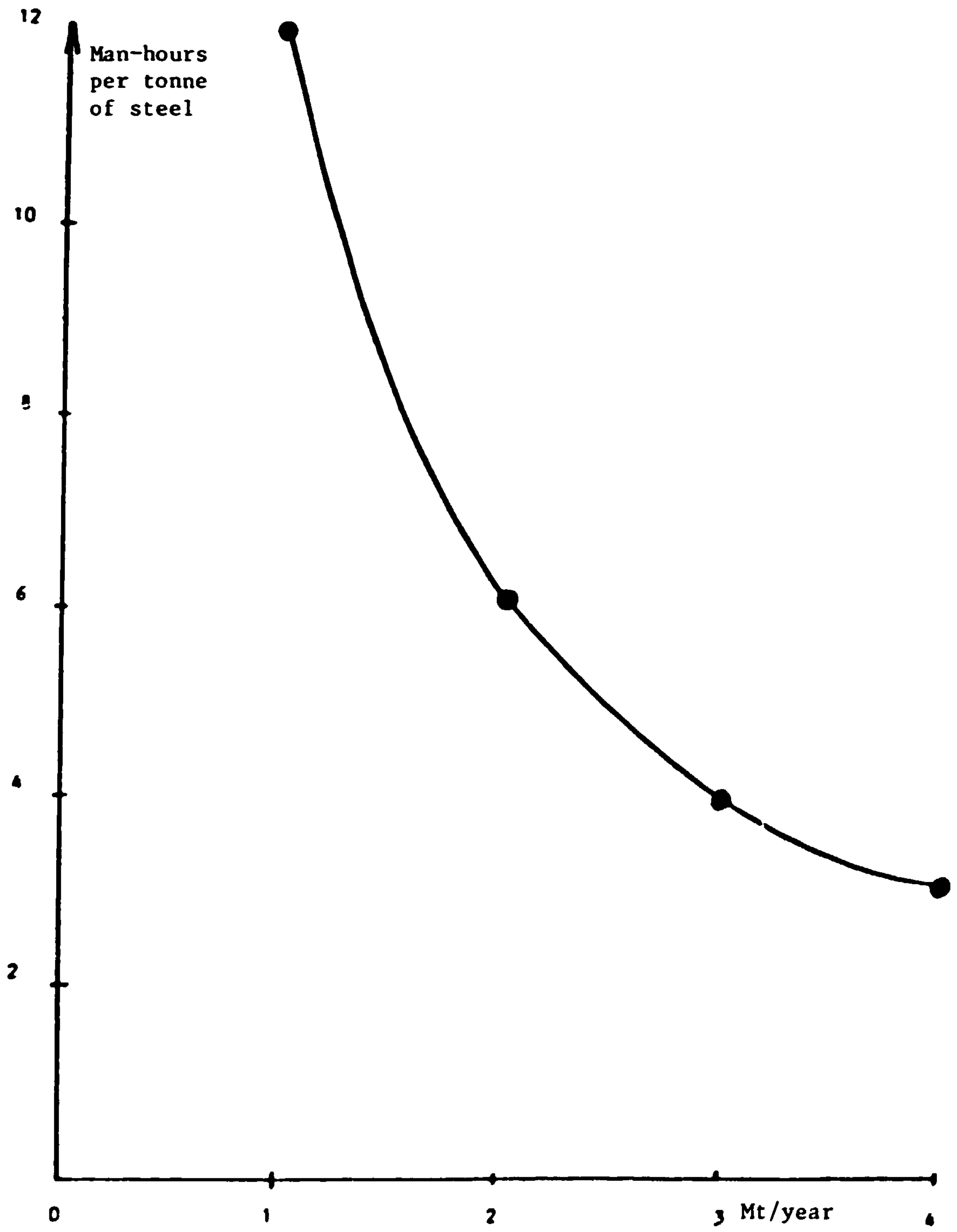


Figure 8 : THE PRODUCTIVITY OF LABOUR IN A CLASSICAL HOT-ROLLED COILS PLANT



Base : 6500 persons x 1800 hours/year for the chain of units considered.

Figure 9 : EXAMPLE OF A MICRO-STEELWORKS EQUIPPED SOLELY WITH ROLLING-MILLS OF 30,000 tonnes/year

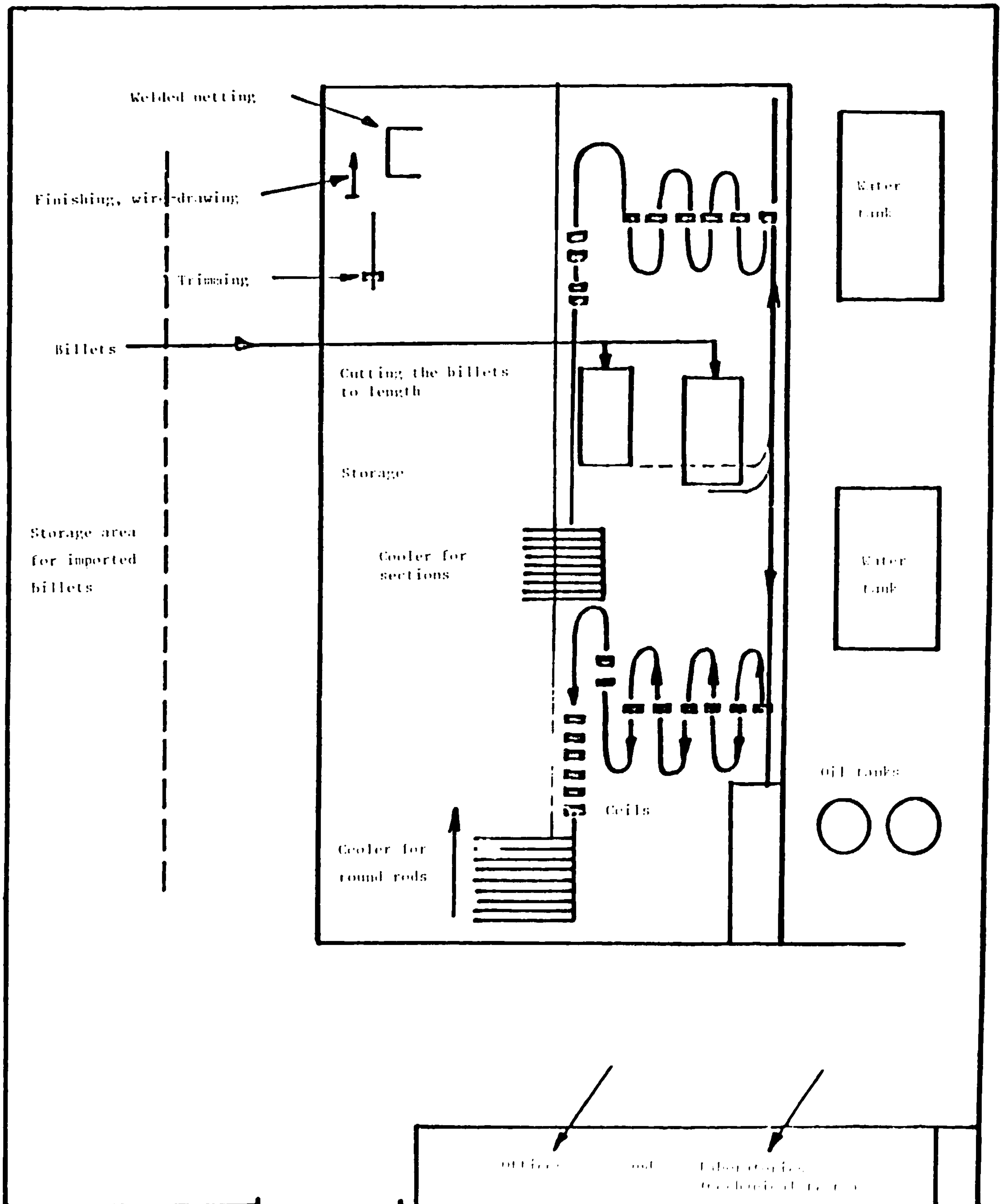
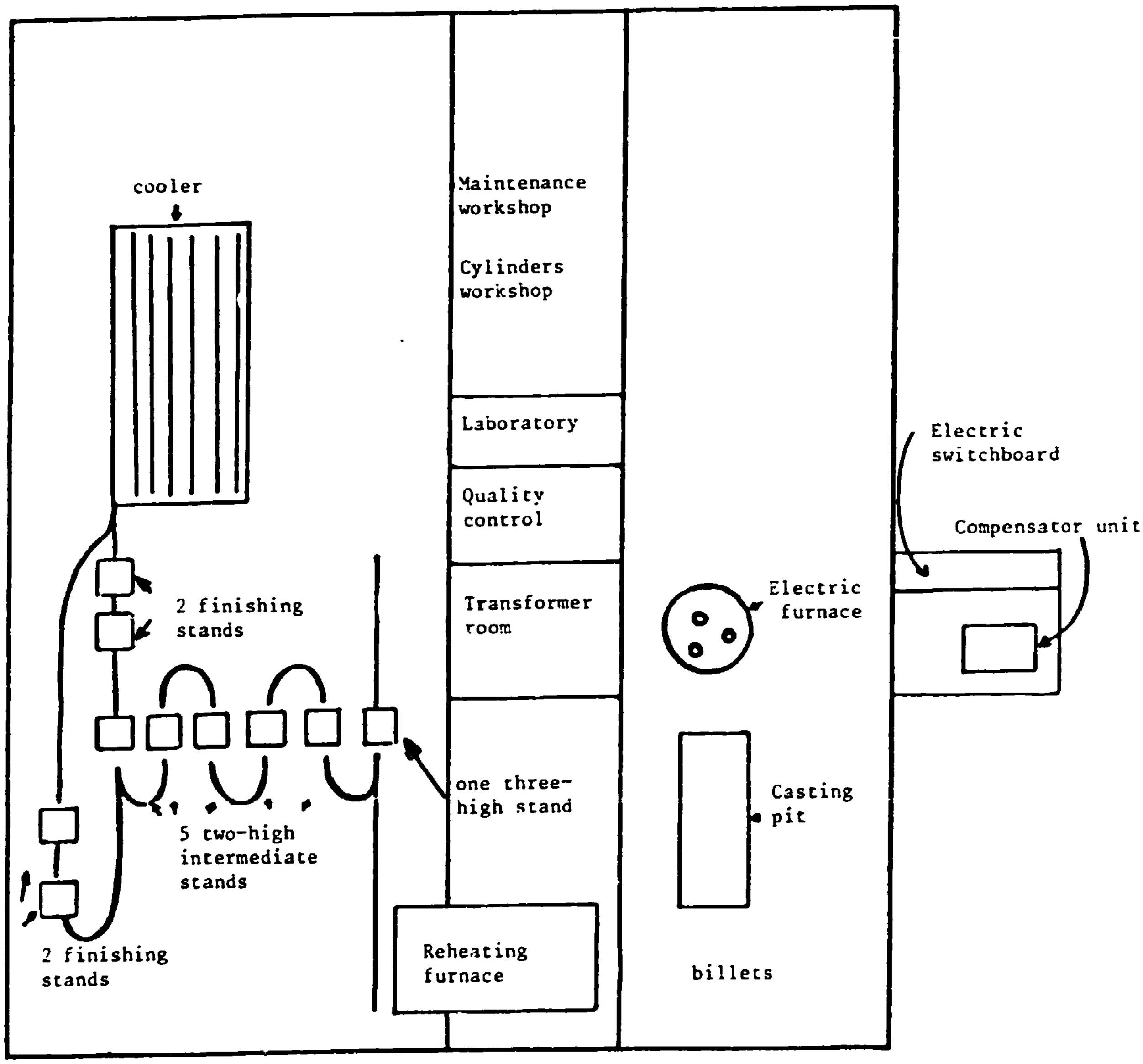


Figure 10 : EXAMPLE OF A SEMI-INTEGRATED MICRO-STEELWORKS of 12,000 to 36,000 tonnes/year*



* that is 12,000 t/year in the electric furnace and 36,000 t/year in the rolling mills.

Figure 11 : LAYOUT OF A 20 TO 500 tonne/year MICRO-STEELWORKS (FRAMTIDA JARNVERK 5)

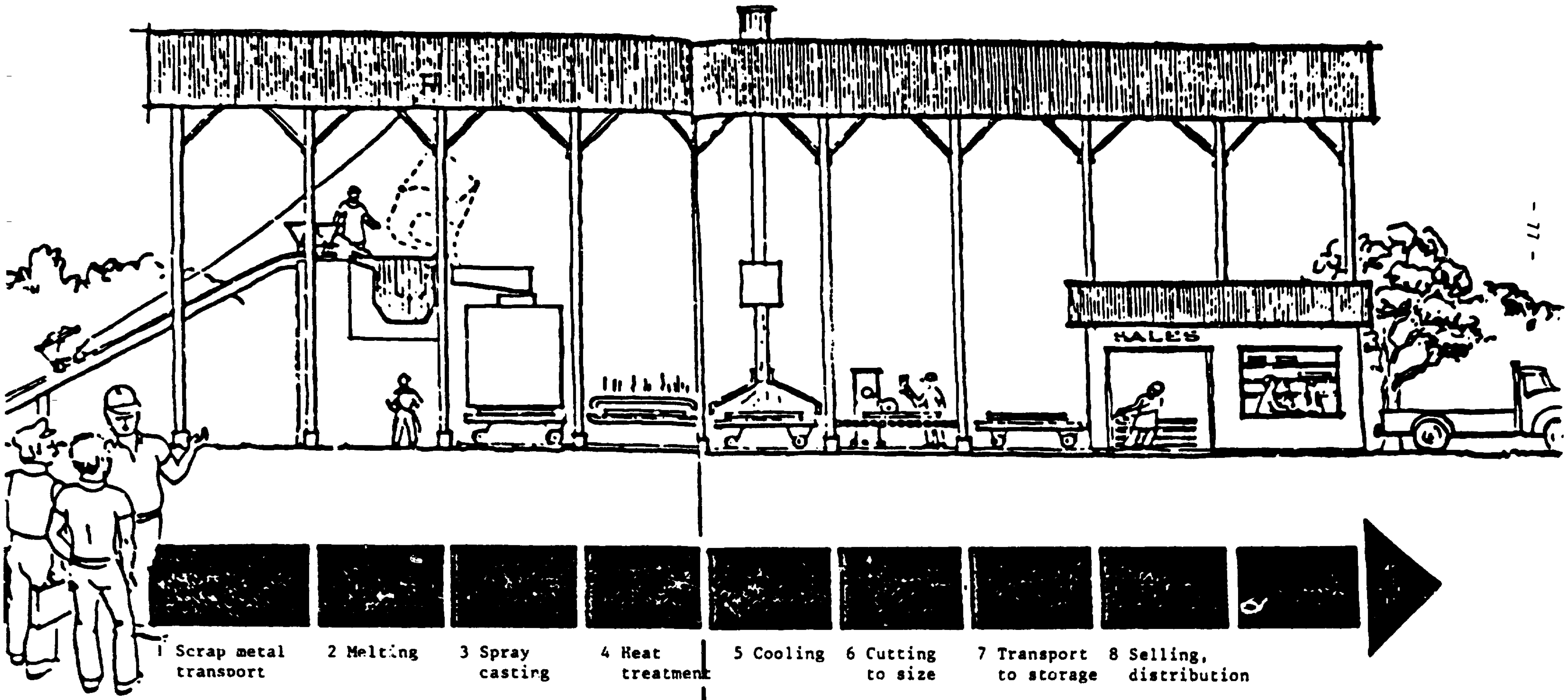


Figure 12 : THE SPRAY CASTING SYSTEM

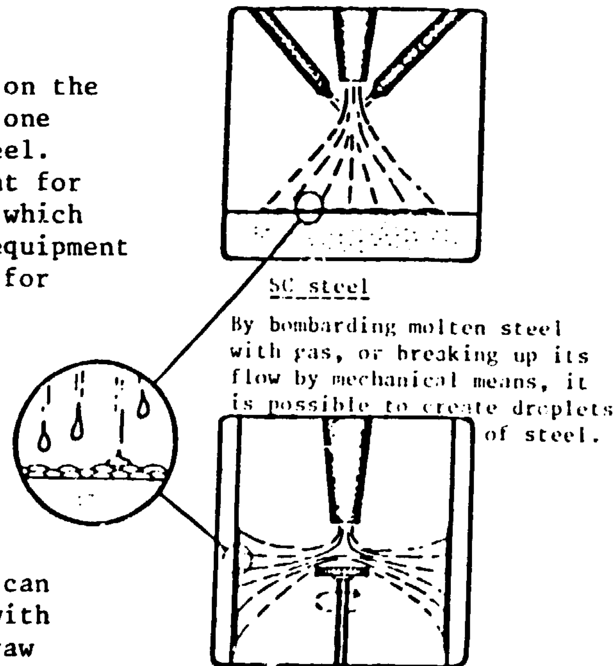
SMALL SCALE STEEL PRODUCTION

Steel is generally produced today in very large and very expensive industrial plants, requiring heavy capital investments. The technology used is based on converting iron ore or scrap metal into molten steel.

The molten steel is solidified into thick slabs which must be reworked several times over into thinner and thinner material.

This requires heavy equipment, a long and complicated process chain, high capital costs, high energy consumption and experienced workers. Such plants are not suitable where steelmaking is to be introduced on a relatively small scale.

Spray casting uses a technique based on the principle of converting raw material one drop at a time into semi-finished steel. The process requires melting equipment for the raw material and a spray tank in which the steel body is built up. Other equipment is also needed for heat-treating and for cutting the finished product to size.



Spray casting makes it possible to produce high quality steel on a very small scale: it also creates two other possibilities. Melting equipment can be designed so as to have a relatively low capacity, therefore requiring a much smaller power supply. The handling process can be geared to more manual procedures with less automatic equipment, since the raw steel plates to be processed are all of relatively low weight.

SC STEEL IS HIGH QUALITY STEEL

Carbide segregation in M35 high speed steel bar, 20 mm diameter, x100.	Carbide structure in SC M15 sheet, 6 mm thick, x 400.	Carbide structure in SC A7 sheet, 4 mm thick, x 400

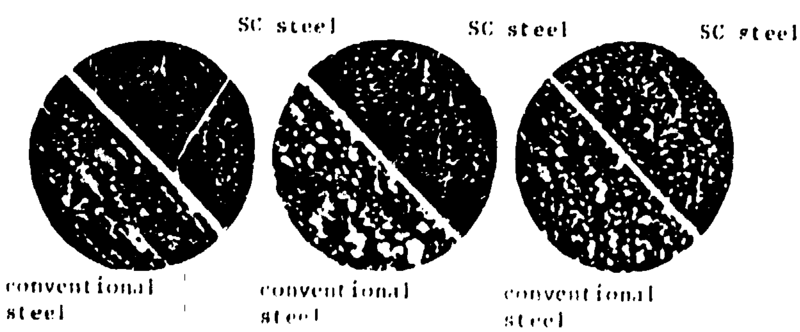


Figure 13a : SCRAP METAL TRANSPORT AND CROSS-SECTION OF THE BUILDING

PRODUCTION STATIONS

1 Scrap metal transport

The raw material, in the form of scrap metal, is transported to the SC plant and loaded into small rail-mounted wagons. The wagons are lifted to a height of about three metres above floor level.

2 Melting

The scrap is charged manually into the melting furnace which has a capacity of 500 to 2000 kg of molten metal. The quality of the metal is tested and adjusted by the addition of alloying elements such as carbon, silicon, manganese, chromium, etc.

An SC steel plant

The production of SC steel requires lifting equipment which need not be especially complicated. The building structure can be designed to carry an overhead crane, as well as protective roofing. Side walls may be added to produce a complete enclosure or may remain partly open, depending on local weather conditions and storage needs.

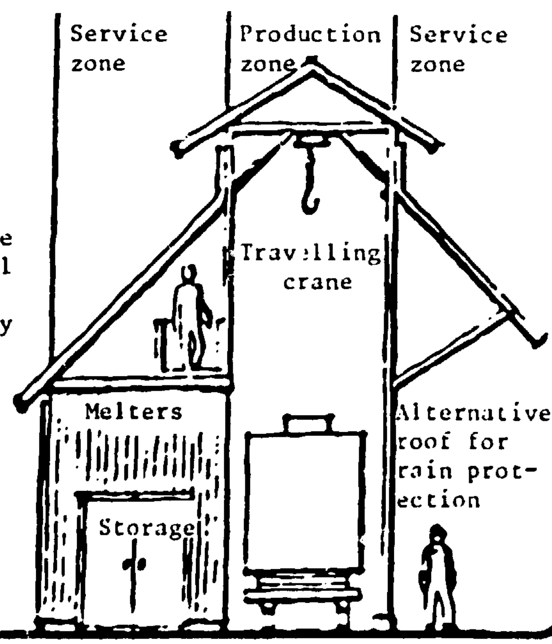
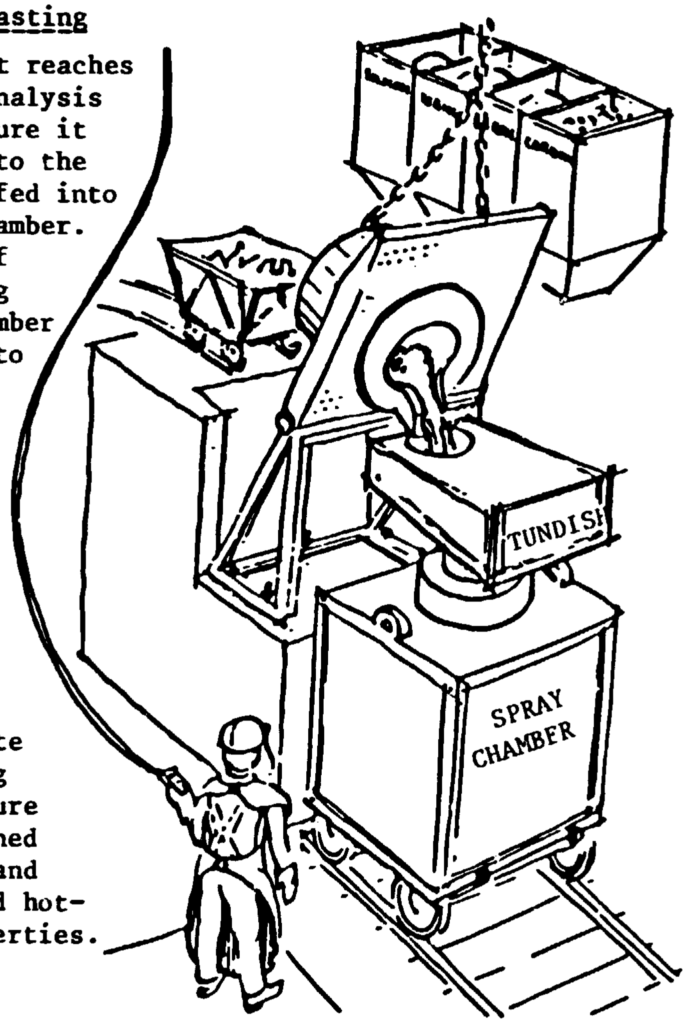


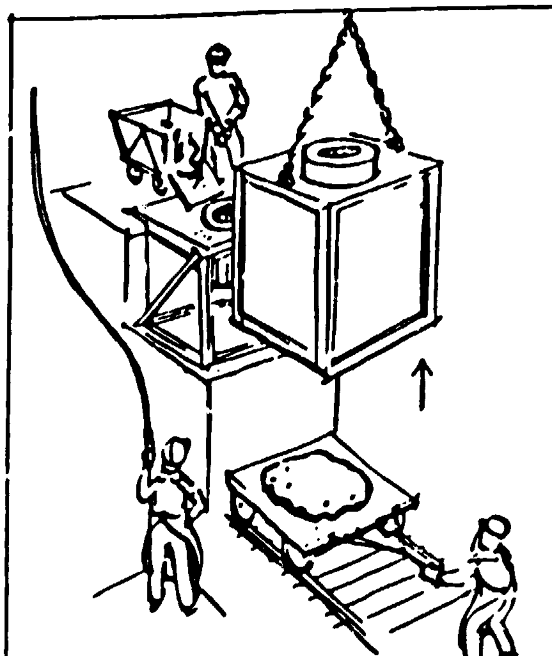
Figure 13b : SPRAY CASTING and COOLING

3. Spray casting

When the melt reaches the proper analysis and temperature it is poured into the tundish and fed into the spray chamber. The stream of metal falling into the chamber is broken into very small droplets; when thrown on top of each other with great force they form a solid steel body. Due to the rapid solidification rate the resulting steel structure is fine-grained and uniform and thus has good hot-working properties.



Pouring the melt



Lifting the spray chamber

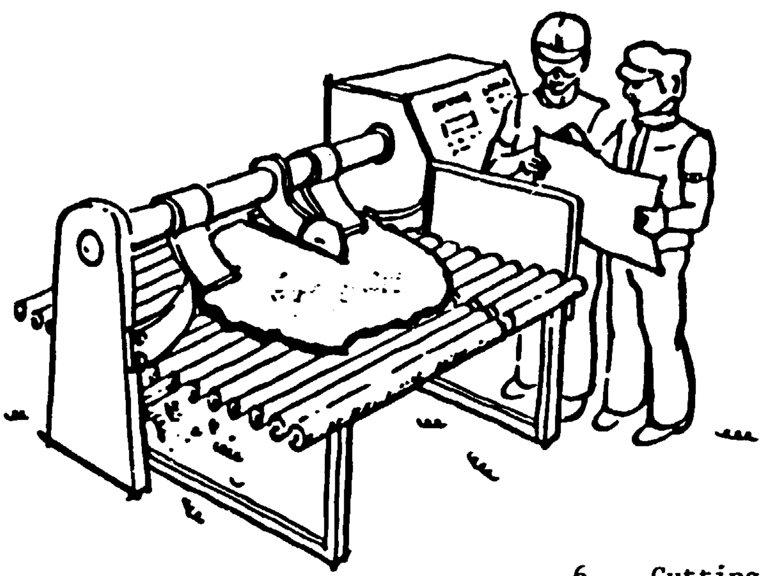
4. Heat treating (annealing)

The new steel is heat treated in order to produce the correct structure.

5. Cooling

The steel is cooled by air or gas which can be later used as a source of heat where there is a need for the space heating of office buildings, etc.

Figure 13c : CUTTING TO SIZE AND SELLING



6. Cutting to size

The cooled plate is trimmed and cut to the desired size.

Each plate can be specially cut to the buyer's requirements or cut to a standard size for storage.

7. Transport and storage

Storage can be combined with production or located separately as a customer service unit.

LOCAL STEEL PRODUCTION AND THE INDUSTRIAL COMMUNITY

The steel shop

A special shop should be created to display SC steels. This type of production facility is of special interest to two types of buyers; those looking for high quality steel and those with small orders who require special analyses and sizes of steel. The SC process makes it possible to return excess material to the melting pot, to produce special steels at a low price and to meet very short delivery times.

When a local blacksmith visits the plant and the sales shop he will have every opportunity of discussing steel qualities, hot working methods and even melting techniques with the plant personnel. He can also sell his own scrap or other scrap that he has collected.

CHAPTER VI

AN APPROACH TO THE QUANTIFICATION OF TECHNICAL COMPLEXITY IN IRON AND STEEL INSTALLATIONS

One can attempt to arrive at an approximate measurement of the complexity Cu of a unit operation, such as :

- the rolling mill (hot or cold in a single unit),
- an electric steelmaking furnace or an oxygen converter,
- a continuous casting machine, etc.,

by attributing a rating to it, such as from 1 to 10 or even higher if necessary, as a function (see Figure 14) of :

- the raw materials used (inputs) and their properties (and hence of their complexity, I,
- the production (or outputs), again in terms of quality and complexity, O,
- the size of the unit and its production in terms of tonnage, P,
- the structure of the actual unit, S,
- the very important links with the infrastructure, L, which indicates the greater or lesser needs, according to the unitary operations, to have :
  - water, gas, electrical energy and compressed air services,
  - the more or less easy or sophisticated maintenance services, including mechanical, electrical and, increasingly, electronic.
- the management itself, M, the value of which is established at a base value of 1 which can be increased, if necessary, as a function of the problems posed by the corresponding unit :
  - excess or by-products,
  - climatic or geographical constraints (distance),
  - the pattern of the order book (long or short runs), etc.

After having developed a mathematical definition of this complexity,

$$C = f(I, O, P, S, L, M, ...)$$

we set out, from our experience, an essay in giving ratings for the principal types of unit operations in Table IX. The fact that several ratings, or a range of ratings, are indicated comes largely from the factor O, that is to say the quality or the "complexity" of the production.

If we then move on to the total complexity Ct of an iron and steel plant it is necessary to make the following comments :

1). If there are several units in parallel, but not connected, for example several rolling units, the complexity is only increased in respect of management, and we estimate this to be one point per unit. In other words a plant which consists, for example, of two rolling mills (Figure 15) using semi-products from outside will have a complexity of $C = Cu_1 + 1$: this also applies to units which are only connected through solids, such as :

- the link between the coking plant and the blast furnace if we limit ourselves to the supply of coke from the first unit to the second with, obviously, the possibilities of intermediate stocking,
- the link between continuous casting and the rolling mill if we limit this to the supply of slabs, blooms or billets with, once again, the possibilities of intermediate stockaging.

2). If, however, the connection becomes much closer it is necessary to distinguish between (Figure 16) :

- the appearance of a gas transfer, as for example in the case of a more integrated link between the coking plant and the blast furnace where, in addition to supplying coke there are transfers of gases, often in both directions (coking plant gases and blast furnace gases). In such a case we then increase the complexity further by one point :

$$Ct = Cu_1 + 2$$

- the appearance of the transfer of liquid metal increases the complexity considerably, and here we assume that (Figure 16) :

$$Ct = Cu_1 + Cu_2$$

3). If certain shops (steelmaking, casting, etc.) include several units in parallel it is necessary to consider them separately and to take account of the links between them which may be of very different natures and, hence, complexity. We will consider some examples of this (Figures 17, 18 and 19).

Table IX : AN ESSAY IN GIVING RATINGS FOR THE UNIT COMPLEXITY Cu OF THE PRINCIPAL UNIT OPERATIONS

Unit operation	Cu rating	Comments
Rolling mill for general quality bars (concrete reinforcing rods)	2 to 3	Independent of the production
Wire rod rolling mill	4 to 5	with one pass with 2 or more passes
Combined bar, wire rod and small merchant goods	4 to 5	
Mill for medium sections	4 to 6	
Mill for rails, large girders, etc.	6 to 8	
Hot strip mill	5 to 10	
Four-high plate mill	6 to 10	
Descaling and pickling line (tandem or temper mill)	4 to 6	
Cold strip mill	5 to 10	
Galvanising line	4 to 8	
Tinning line	5 to 10	
Coil annealing furnace	4 to 5	
Continuous annealing line	5 to 10	

NOTE : A cold rolling line working on a diversified production and consisting of pickling, tandem mill, degreasing and preparation line, continuous annealing and annealing furnaces, temper mill and/or skin pass mill, galvanising or tinning lines, slitting, shearing and packaging lines and a despatch hall, with intermediate stockage areas, would lead to additions to the Cu values and to increases for management constraints (intermediate stock management and circuits) which would lead to the highest complexity values.

Table IX - continued

Unit operation	Cu rating	Comments
Direct reduction	3	1 unit
	4	2 units
	5	3 units
Electric arc furnace :		
1 unit for steel bars	4	
1 unit for more sophisticated steels (wire rod, flat products)	5	
2 units, according to case	5 or 6	
Continuous casting :		
1 unit, 3 or 4 billet lines	3	
1 unit, 6 billet lines or 1 slab line	4	
Oxygen converter :		
1 simple converter	6	
1 large modern converter	7	
Blast furnace :		
small BF (coke, charcoal)	4	
large BF	5	
Coking plant :		
simplified	3	
modern	5	
Iron ore agglomeration	3	

Figure 14 : THE COMPLEXITY OF AN IRON AND STEEL OPERATION

$Cu = f(I, O, P, S, L, M, \ldots)$

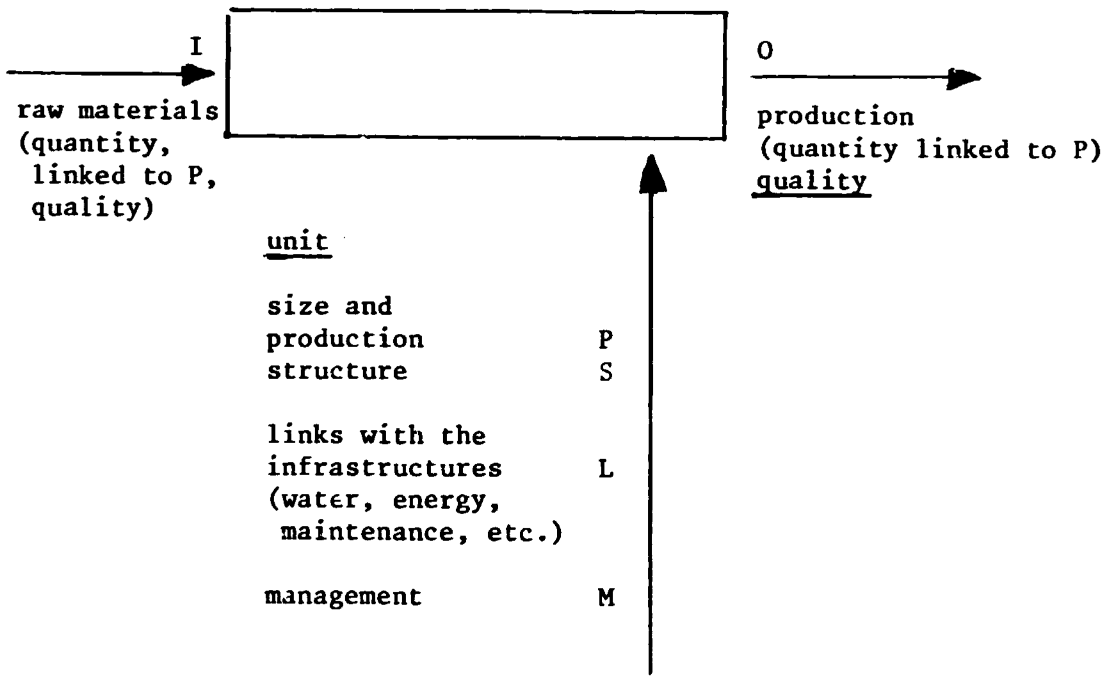
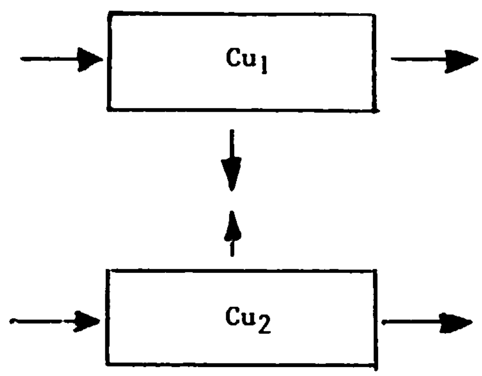


Figure 15 : THE COMPLEXITY OF TWO IRON AND STEEL OPERATIONS, SEPARATE OR IN PARALLEL

$Ct = Cu_1 + 1$

if $Cu_1 > Cu_2$



$Ct = Cu_1 + 1$

if $Cu_1 > Cu_2$

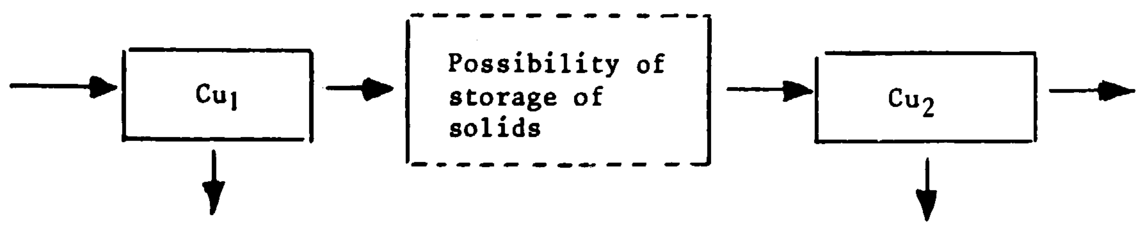


Figure 16 : THE COMPLEXITY OF TWO IN-LINE IRON AND STEEL OPERATIONS

By hypothesis $Cu_1 > Cu_2$

If only the transfer of solids (coke, agglomerates) is involved then the units are considered to be independent, and a single point is added :

$$Ct = Cu_1 + 1 \qquad \text{(Figure 2)}$$

If the transfer of a gas is involved this becomes a double management complexity and two points are added :

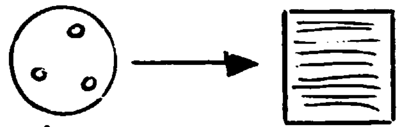
$$Ct = Cu_1 + 2$$

If the transfer of liquid metal is involved then the complexities of the two units are added together :

$$Ct = Cu_1 + Cu_2$$

Figure 17 : THE COMPLEXITY OF THREE STEELWORKS

A) One simple steelmaking line.



Electric arc furnace complexity 4

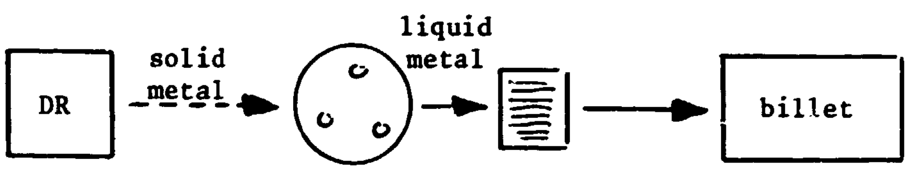
Continuous casting, 4 billet lines complexity 3

whence 4 + 3 = Complexity 7

Mini-steelworks, and with a bar rolling mill of complexity 3

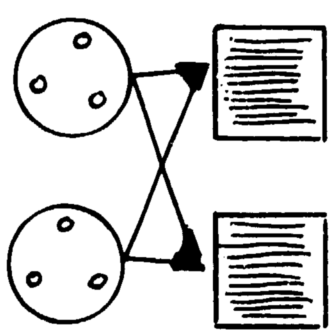
+ 1 = Complexity 8

B) Integration of this mini-steelworks with direct reduction (i.e. a unit of complexity 3, but practically independent)



1 + 4 + 3 + 1 = Complexity 9

C) Steelworks with two electric arc furnaces + two continuous casting lines

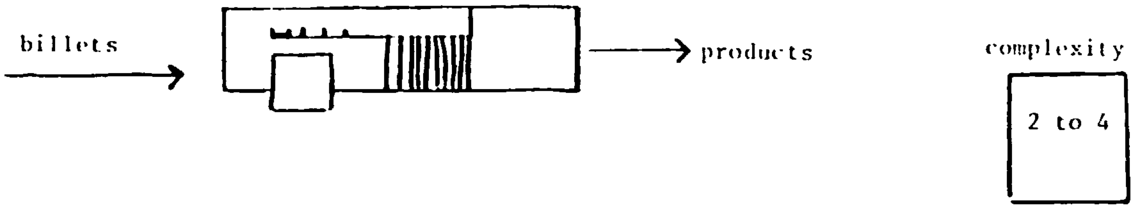


The complexity increases with the deliveries and the scheduling problems, so :

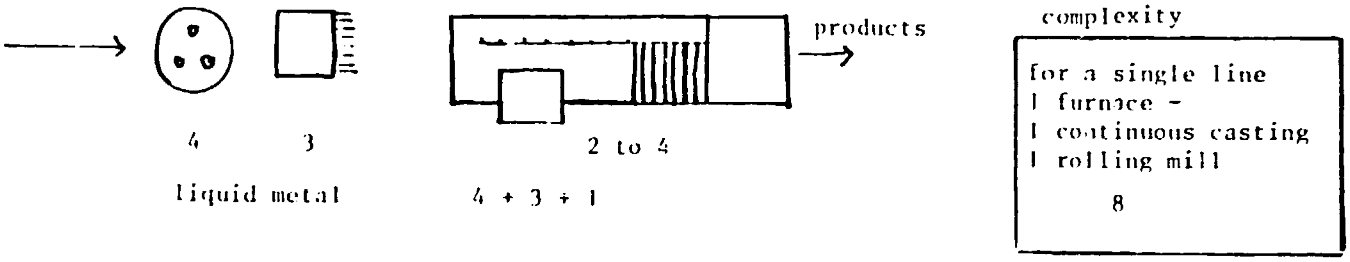
4 + 4 + 3 + 3 = Complexity 14

Figure 18 : COMPLEXITY WITH THE INCREASING INTEGRATION OF A MINI-STEELWORKS

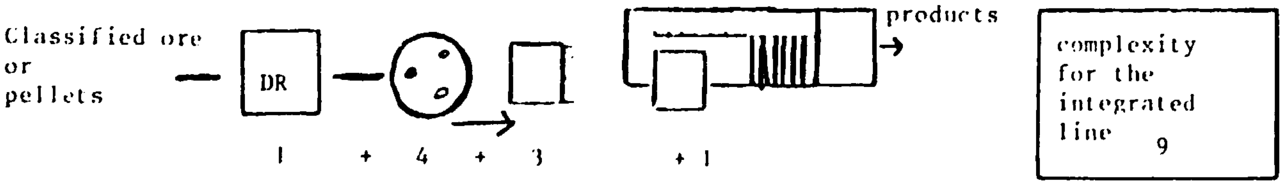
A) A bar rolling mill or, possibly, small merchant goods



B) Semi-integration with an electric arc furnace, using scrap iron



C) Integration with direct reduction



D) Integration with blast furnace + oxygen steelmaking

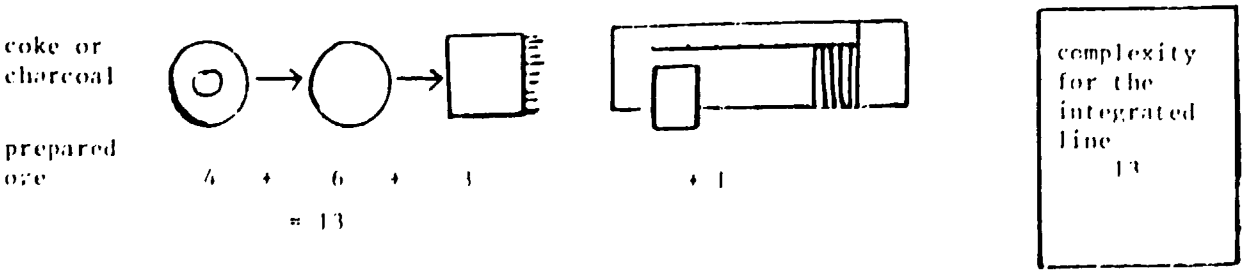
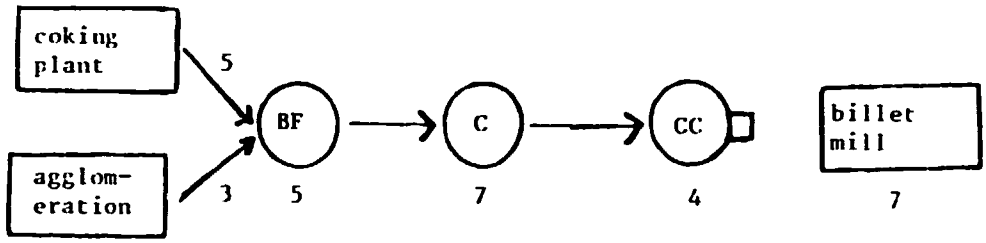


Figure 19 : THE COMPLEXITY OF CLASSICAL STEELWORKS

A) The case of an integrated classical steelworks



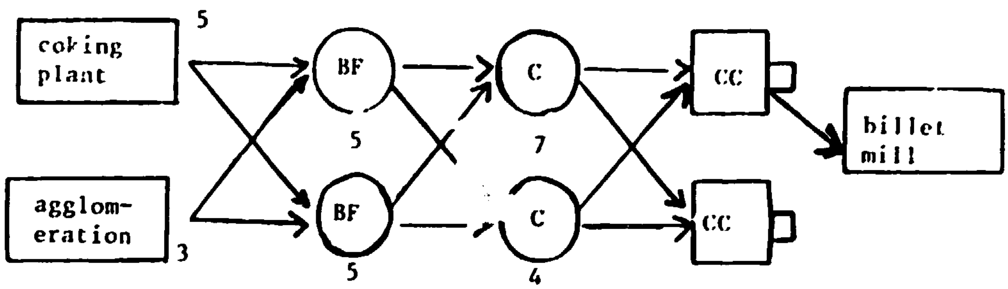
Complexity for transfer of liquid metal :

5 + 7 + 4 = 16

Complexity for transfer of gases with coking plant + agglomeration + billet mill :

2 + 2 + 2 = 6 TOTAL **22**

B) The case of two integrated and connected classical steelworks



Complexity for transfer of liquid metal :

5 + 5 + 7 + 7 + 4 + 4 = 32

Complexity for transfer of gases :

2 + 2 + 2 = 6 TOTAL **38**

CHAPTER VII

DESCRIPTION OF A MODEL STEELWORKS

This is a simple and semi-integrated mini-steelworks (that is to say not producing prepared raw materials, in this case not equipped for direct reduction).

It consists essentially of :

- an electric arc furnace,
- a 4-line continuous casting machine,
- a rolling mill for bars and small merchant goods.

On the scale for the quantification of technical complexities (see Chapter 2) this steelworks is characterised by a value of 8.

In order to locate more precisely the complexity problems of such a steelworks we will examine two aspects which seem to us to be important :

- the environment and the infrastructures,
- the personnel requirements.

PART THREE

THEORETICAL STUDY OF THE COMPLEXITY OF INDUSTRIAL RELATIONSHIPS IN THE IRON AND STEEL INDUSTRY

CONDITIONS FOR ACCESS TO TECHNOLOGICAL MASTERY :

CHAPTER I

GENERAL PLAN OF THE THEORETICAL STUDY OF THE MODEL

1. THE POPULATION OF KEY FUNCTIONS

Reference should be made to paragraph 1.2. of Chapter 4 in the first part and to the diagram which accompanies it. We have identified, in the plant itself, some twenty key functions which form a necessary and sufficient group of varied and interdependent tasks if the plant, viewed from the continuous casting shop as the chosen point of observation, can be constantly supplied and maintained in a state of nominal production at the quality required by the market: we are quite clearly on one of the lines of fragility for the functioning of the plant.

1.1. A necessary and sufficient group of tasks :

- necessary :
  if one of these functions is not carried out, or is carried out incorrectly, the probability of a shut-down, of reduced production or even the rejection of the production, increases dangerously:
- sufficient :
  if these key functions are carried out correctly the others will also be correctly carried out by "induction". As far as these are concerned our model plant is of small capacity, of compact layout and with a simple production programme; everything should take place within a restricted team with a high standard of competence and behavioural patterns.

1.2. Varied and interdependent tasks :

These key functions are to be found in upper and lower management, amongst the team leaders and some at skilled or unskilled operative level, amongst the managers and buyers, etc. The range of competences and levels of responsibility involved is very wide, but the group behaves as a chain where every link counts; none of the holders of these working posts can be successful without a greater or lesser level of support from the others, and each conditions the success of the others. In other words each has the power to frustrate the common objective.

This interdependence therefore requires of all those holding these posts a clear understanding of their solidarity, and this is to be reflected in a high standard of behaviour in each link of the chain.

1.3. The works to be constantly supplied and maintained in a state of nominal production at the quality required by the market:

This is the tangible result of technological mastery. Every step taken towards achieving this mastery is to be measured in terms of regularity and quality; it is not a matter of achieving, by profiting from exceptional circumstances or conditions, isolated records without thought of the morrow. This would prove nothing, and there is the risk that a high price will be paid for it; the plant has been built to create wealth and not to provide sport.

2. ANALYSIS OF THE KEY FUNCTIONS

That being said our population of twenty key functions, as listed in Table X and divided between the Production, Maintenance, Engineering and Supplies (Buying and Stock Control) departments, will be the subject of case by case examination by means of the evaluation sheets

Each of these evaluation sheets, consisting of ten pages, includes the following headings :

1). Objective :

this provides, in a few words, the "why" of the function (page 1).

2). Summary of the function :

this provides, in a few lines, the "how" of the function (page 1).

3). A diagram of relationships :

this is the schematic representation (page 2) of the location of the function in relation to other functions, whether -

- in the hierarchy (or vertical), and
- functionally (or horizontal).

4). Details of the function :

four pages (pages 3 to 6) are reserved, but not necessarily used in their totality, for recording the details of the function.

5). Tables of the ratings of the requirement levels (see explanations in paragraph 1.3.4., Chapter 5) :

- page 7 : know-how criteria (5 criteria),
- page 8 : behavioural criteria (3 criteria),
- page 9 : responsibility/power criteria (6 criteria),
- page 10 : summary table of the requirement ratings.

3. PROCESSING THE RESULTS OF THE EVALUATION OF EXIGENCES

3.1. The results of the quantified analysis are examined from two aspects :

- the exigency levels in absolute values, each raw rating for the criteria being converted into a percentage: for example, if for a given function the total of the five ratings for know-how (each being rated between 1 and 5) give a total of 15 out of a possible maximum of 5 x 5 = 25 then 15 out of 25 gives a figure of 60%.

- the relative importance of the ratings for know-how, behaviour and responsibilities/powers: this characterises the equilibrium between the three components of a function, out of a total of 100.

Let us assume, for example, that a function is characterised by the following absolute values :

- know-how :	KH =	72(%)
- behaviour :	BH =	53(%)
- responsibilities/powers :	RP =	57(%)
	TOTAL :	182
	Mean :	60.7

The equilibrium between the three components is evaluated as :

- KH	: 72/182	=	39.6
- BH	: 53/182	=	29.1
- RP	: 57/182	=	31.3
			100.0

<u>Note</u> : In the present state of the study it is assumed that the three components are of equal weight, there being no a priori reason why this should not be so. Only practical tests in the plant could lead to this hypothesis being revised.

3.2. Research into correlation and an examination of triangular diagrams for the equilibrium values of KH + BH + RP will enable us to formulate more precise approaches to the mechanisms of complexity, on the conditions necessary for technological mastery, on the probable causes of failure to achieve this and on what must be understood in regard to programmes for the transfer of mastery, which will obviously be more complete than the customary training programmes.

The practical consequences on the reality of planning will be the subject of the fourth part.

Table I : LIST OF THE KEY FUNCTIONS WITH THEIR CODE NUMBERS

DEPARTMENT		TITLE OF THE FUNCTION	CODE No.
SUPPLIES (staff)		Spares buyer	1
		Raw materials buyer	2
		Stores manager, customs' clearance, etc.	3
		Stock control manager	4
ENGINEERING		Technical librarian	5
MAINTENANCE SECTOR	shift	Shift storeman, CC	6
		Shift pump mechanic, CC	7
		Shift foreman, CC maintenance	8
	staff	Head storeman/Plant inspector, CC	9
		Maintenance supervisor, CC	10
		Maintenance foreman, CC	11
CONTINUOUS CASTING PRODUCTION (shift workers)		Foreman, CC refractories shop	12
		Tundish preparer, CC	13
		Supervisor, CC billet store	14
		Supervisor, CC utilities & auxiliaries	15
		Grade adjuster, CC	16
		Caster, CC	17
		Foreman, CC machine	18
		Cabin operator, CC	19
		Shift foreman, CC	20

(CC = continuous casting)

CHAPTER II

EVALUATION SHEETS FOR THE KEY FUNCTIONS

There are thus twenty of these, as listed in Table I of the previous chapter. To reduce the overall size of the study and to facilitate reading it we have collected these evaluation sheets together in an annex.

We feel however that it is essential for the reader to take note of these before starting on the processing and interpretation of the results or that, at the very least, he familiarises himself with the content of a sample of them.

To this end the evaluation sheet for the Head shop foreman for the Continuous Casting shop (Code No.20) is set out in the following pages.

All these sheets have been drawn up on the basis of practical exigences in a high-performance French steelworks which holds world records for both productivity and economy in operation. They therefore represent, in regard to the line of fragility which is under examination, the state of mastery which we will now analyse.

Position - SHIFT FOREMAN, CONTINUOUS CASTING

Code 20

PRODUCTION

1) Objective :

To ensure that the production as laid down in the programmes is achieved by coordinating the activities of his subordinates, providing them with technical and/or physical support according to the nature of the incident.

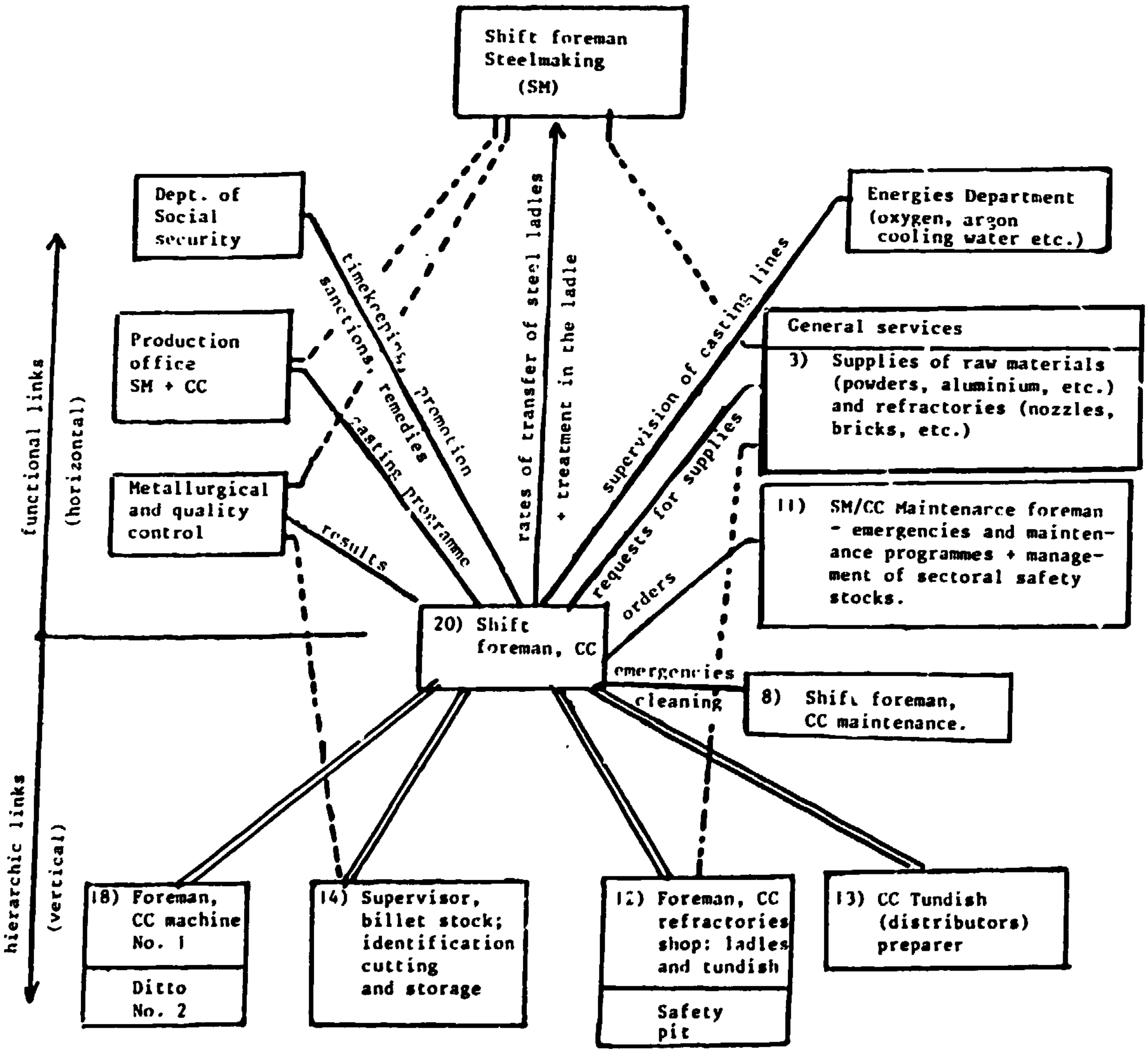
2) Summary of the functions

a) To initiate and to follow-up the operations involved in the production, identification and storage of the billets produced from the ladles of liquid steel (direct responsibility).

b) Administrative work and personnel management (direct responsibility).

c) Ensure the continuity of the continuous casting operations from one post to another and also upstream (steelmaking) and downstream (rolling) : indirect responsibility.

3) Diagram of the relationships



4) Details of the functions

4.1. To initiate and to follow-up the billet manufacturing operations from the ladles of liquid steel, and to identify and store the billets.

4.1.1. Obtaining information

- to note the information, observation and incidents during the previous shifts, as notes in the shift log. To discuss these with the outgoing shift foreman.

- to obtain information on the forecast castings for the shift. Programme drawn up by the head of production, specifying the grade of steel, the number of castings and the format and length of the slabs.

- to request his subordinates to warn him of any anomalies noted on the line or of a breakdown in supplies (powders, aluminium, scrap, nozzles, etc.). If there is any doubt as to the state of the lines the foreman is to arrange for simulated casting (all phases being complied with : introduction, speed, cooling).

- to ensure that the refractories department has a sufficient number of distributors and ladles (in the case where continuous casting does not have priority).

- to verify the presence of stand-by ingot moulds (conventional type).

4.1.2. Initiating the activities

- indicate to the operator the castings to be carried out (according to HP programme). The latter will then start up the manufacturing process and the preliminary operations :
  - . requesting ladles from the steelmaking section
  - . introducing the leading heads after heating
  - . transferring the ladles
  - . treating the steel in the ladles
  - . casting.

The foreman will assist with and check all these operations and will intervene in the event of incidents or in resolving a technical difficulty.

Example of the problems encountered at work station levels :

Operator :

The charge approaches the limits of the ranges, temperature, composition of the bath.
Return of a ladle to the steelmaking section or to the stand-by casting, after treatment in the ladle (temperature too low ... Adaptation of casting speeds to the technical problems encountered or to incidents).

Treatment in the ladle :

Difficulty in the introduction of aluminium or stirring with argon.

Ladle caster :

Rotation of pivoter defective, fixing of nozzles to the drawer difficult, closing of the nozzle drawer impossible, etc.

Caster distributor :

Difficulty in maintaining a constant level. Overflowing, piercing, evacuation of distributor during incident.

Line surveillance :

Lack of pressure on a stand (shut-down of installation or casting), lack of cooling of rollers, etc.

Preparation of head :

Difficulties in preparation (inserting - drying).

Oxidation :

In the case of blowtorch incident, slow down the line with possible manual cut-off. Control of lengths (annotated programme).

Billet stock :

Stock area overloaded. Difficulties in clearing the billets.

N.B. : in the case of sequential casting, necessitating the use of two distributors successively, the foreman will specify and order the procedures.

- in the event of piercing of a line to organise the operations for releasing the slabs, changing the ingot moulds and zone I if necessary.

- changes in format are placed under his responsibility: alignment and conicity, which implies rigorous control on his part.

- verifying the presence of the materials necessary for the castings, and ensuring supplies.

- carrying out the operations of cleaning the workshops.

- reporting to his superiors any incidents encountered and, where necessary, submitting proposals for modifications, either technical or relating to work stations.

4.2. Administrative work and personnel management

4.2.1. Functions relating to personnel management

- responsible for personnel time-keeping
- planning holidays in his team

- granting compensatory time off in such a way as not to create disruptions in the department
- training personnel for work stations. Informing them as to the technological rudiments and training them in safety.
- notifying them of the safety rules, and supervising their application.
- suggesting possible promotions to their superiors, with plans for supplementary training.
- proposing sanctions.

4.2.2. - Functions relating to administrative work

- drawing up the shift report : reports on activities with observations.
- reporting in the "ladles logbook" the numbers and the reasons why these ladles were returned to the steelmaking section.
- noting any requests for information made by the management services during their interventions.
- drawing up :
  a) the reports on incidents (piercing, overflowing, etc.)
  b) statements on physical accidents (specifying the circumstances after a preliminary enquiry)
  c) "withdrawals from stock" notes (general services)
  d) "personnel leaving" notes
  e) requests for interventions by the maintenance services (repairs or modifications to the equipment) and from the transport services (orders for trucks)
  reporting, in the log, the orders in hand (follow-up by Foreman).

4 3. Ensuring the continuity of the continuous casting operations from one shift to another and also between upstream (steelmaking sections) and downstream (rolling mills) as indirect responsibility.

4.3.1. Awareness of being the meeting point between the production activities (steel production and the metal converting activities (steel forming), operating according to different rates and programming norms.

4.3.2. Anticipating, by means of exchanging information with the Shift Foreman in charge of steelmaking and the Shift Foreman in charge of rolling, the possibilities of push-pull operation, and making provision for suitable measures for avoiding this.

4.3.3. Analysing the progress of previous shift(s) and indicating, for the following shift(s), the scenarios for possible incidents, with the proposed remedies.

4.3.4. Requesting, where necessary, decisions from the Head of department engineer(s) by giving succinct, but precise and exact, indications, correctly evaluated in regard to their importance.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SHIFT FOREMAN, CONTINUOUS CASTING			Code 20 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 7/10
Position : SHIFT FOREMAN, CONTINUOUS CASTING							Code 20 PRODUCTION
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.1. Know-how							
5.1.1. Basic general and technical knowledge	a) HND* in metallurgy. b) Iron and steel training of the FAMECK type, steelmaking speciality.				X		
5.1.2. Supplementary vocational knowledge	Experience in a steelmaking post desirable. Experience in any continuous casting post and more particularly an operational function. Experience spread over several years. Elements of accounting.						X
5.1.3. Diversity of the techniques utilised	Specific technique of continuous casting, calling at the same time on knowledge of steel casting, rolling (slab extraction), engineering (oxy-acetylene cutting, ingot regulation), stock management and control and personnel management. Control and intervention in various technical posts (ladle treatment, casting, line supervision, oxy-acetylene cutting, slab store). Varied situations during incidents and an essential understanding of steelmaking problems.					X	
5.1.4. Type and complexity of intellectual processing	Must organise, as a function of the production programme, the work of the team whilst taking into account the personnel present, the availability of distributors and ladles, the steelmaking possibilities and the temperature and quality of the bath. Must coordinate the various actions as a function of incidents and the general operation of the lines.						X
5.1.5. Type and complexity of the physical activities	Administrative work. Intervenes temporarily in the event of an incident, in all the functions, in all the operations, but more particularly in the control of the lines (control panels)				X		

SUB-TOTAL : Know-how

* HND = Higher National Diploma
- original text has :
BTS = Brevet de Technicien Supérieur.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : SHIFT FOREMAN, CONTINUOUS CASTING			Code 20 PRODUCTION

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	To intervene in the event of an incident, in all work stations on the line, and particularly at the ladle and the casting distributor position (risks of piercing, of overflowing).				X	
5.2.2. Degree of contrast of the useful information	Has the same difficulties in perception as his subordinates, but in an episodic manner (slag discrimination, steel discrimination, levels in the ingot moulds, etc.).			X		
5.2.3. Response time	Must decide rapidly on the actions to be undertaken in order to avoid : prolonging shutting down of production - dangerous situation (risk of piercing).					X

SUB-TOTAL : Behaviour

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : SHIFT FOREMAN, CONTINUOUS CASTING			Code 20 PRODUCTION

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Checks and intervenes in the various technical posts (treatment in the ladle, casting, supervising the lines, oxy-acetylene cutting, slab store). Various situations during incidents with understanding essential to the steelmaking problems. Management and training of the production personnel.				X	
5.3.2. Type of pilot information for others	Coordinates the activity of subordinates as a function of the work programme on incidents, informing the posts concerned as to the modifications made to the process: cooling - pressure - speed of casting and removal - stand-by casting etc. After analysis ordering ladles from the steelmaking section. Ordering materials from general services. Informing regarding modifications made to the programme. Drawing up reports describing the incidents and suggesting solutions.				X	
5.3.3. Diversity of functions piloted	12 subordinate posts. 1 higher post (engineer) and 3 equal posts. Relationships with steelmaking, metallurgical control and quality control, sectoral and general maintenance, supplies, social affairs and safety, rolling mills.				X	
5.3.4. Position of the external controls	Modification of the instructions integrated into the process. The results obtained by the agent and his team can only be compared with the objectives established in the medium term (some months).					X
5.3.5. Precision of imputation of consequences	Function as foreman in various posts located in the same process but which depend closely on different departments for their realisation (steelmaking - refractories).				X	
5.3.6 Precision of directives	Must realise the manufacturing forecasts. To do this must adapt his actions to the situations regarding incidents, whether in the process of manufacture or at steelmaking level: non-conforming ladles, shortage of metal, pierced ladles or ingot moulds. Defective pressure or cooling, etc.				X	

SUB-TOTAL Responsibilities/Powers

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SHIFT FOREMAN, CONTINUOUS CASTING			Code 20 PRODUCTION

6. Summary of the requirement ratings

	Points	%
SUB-TOTAL : Know-how	20/25	80
SUB-TOTAL : Behaviour	12/15	80
SUB-TOTAL : Responsibilities/Powers	25/30	83
T O T A L		243

CHAPTER III

PROCESSING AND INTERPRETATION OF THE RESULTS

For our analysis we will start from the appended Table II which sets out the quantified results of the ratings for the requirements and their initial processing, as indicated above in Chapter I.

1. INITIAL COMMENTS ON EXAMINING TABLE II

1.1. In the case of the values of the crude results (left-hand side of the table) the totals for the evaluations range widely from a minimum of 110 to a maximum of 254.

1.2. By contrast grouping the results by departments gives mean values of the totals which show little dispersion from on department to another : 182. 189, 198 and 203.

1.3. This is clearly reflected in the means: from 61 tc 66 from one department to another, whereas the range is from 37 to 85 between the functions. The individual ratings for the requirements also show a high degree of dispersion, whereas the means by departments are much more closely grouped.

1.4. One is led to conclude that, within a chain of relationships along a line of fragility, there is certainly a need for the intervention of key functions which are highly diversified in terms of level and profile, but also that grouping these key functions into units within their respective departments leads to the establishment of teams "of the same weight".

1.5. Nevertheless it can be seen that whilst the weight of the teams shows a greater similarity than that of the individual weightings they are still far from being comparable in terms of their composition, made up from the three groups of requirement ratings KH, BH and RP.

One is thus led to analyse, in greater detail, all these values so as to reveal the secrets of a "line of fragility which holds firm" since it is in this way that we have constructed it, on the basis of existing and satisfactory models.

1.6. The central part of Table II visualises the profiles by means of an arbitrary division by tranches of values. Examination of this synoptic picture leads to the comments on the right-hand side of the table, to which the following may also be added :

- Whilst there exist few functions which exhibit low levels of requirement ratings (although there are some, since they are indispensable) there is no function falling within the lowest values of behavioural ratings; high behavioural ratings are involved in 13 out of the 20 functions.
- High know-how ratings are involved in only 4 functions out of 20, with low ratings in 6 out of 20. Half the functions demand average but solid levels of know-how: for the majority of these this know-how is mainly based on long experience in a variety of various functions (see the rating sheets in Annex 1).
- The breakdown of the responsibility/powers ratings (at the bottom of Table II) differ little from those for know-how when the total population is considered; they are however very different from the ratings for know-how as we move from one Department to another.

1.7. The functions are <u>differently balanced between</u> the requirements in regard to know-how (KH), behaviour (BH) and responsibilities/powers (RP).

The group of three columns on the right, next to the comments, shows this. The utilisation of triangular diagrams will make it possible for us to characterise more fully several populations of functions, outside a grouping by departments, and makes clear the mechanisms of their interdependence.

These initial comments having been made, and these first orientations of the study having been sketched out, the results may now be analysed in greater depth.

2. Investigation into the initial correlations and verification of the coherence of the evaluation system

2.1. Histograms of the distribution of the requirements ratings

These may be seen in Figure 1. Ignoring any groupings by departments and anticipating the information obtained from the triangular diagram (see below) we set out here the histograms for three sub-populations.

These confirm what may be seen from Table II. They show more clearly the jumps on the know-how and responsibility/powers ratings from one population to another, in contrast to the distribution of the behavioural ratings, for which there is a universal minimum threshold.

Conclusions :

1. The responsibilities and powers are, and must be, exercised in proportion to the know-how required, provided always that the minimal behavioural requirements are met.
2. In the case of the key ctions along a line of fragility there are minimum requireme esholds below which no reliability can be expected. The eshold requirement for behaviour is the same for all the functions.

2.2. The only role of organigrams and operational procedures in a plant are to distribute responsibilities and powers in such a way that all the necessary and sufficient functions are exercised, withour redundancy or gaps.

How is the RP requirement rating linked with the other KH and BH ratings ?

Figure 2 shows that exercising responsibilities and powers demands principally the presence of the corresponding know-how, but that the requirement for appropriate behaviour is not nil. It is even important if one considers the upper responsibility range of the population (the four points at the base of the cloud of points relate to the functions of confidence but of low know-how skills). The correlation is then effected with a significant coefficient (0.6 instead of 0.27).

2.3. Up to this point the primary processing of the results only tells us what we already knew, or which we had regarded as self-evident. From this point of view it constitutes rather a verification of the satisfactory basis of our evaluation system, and hence some assurance that the analysis can be continued without any danger of straying towards utopian conclusions.

3. THE IMPORTANCE OF THE CONCEPT OF EQUILIBRIUM BETWEEN THE THREE COMPONENTS KH, BH AND RP and its representation

3.1. Basic considerations

We have established the fundamental hypothesis (see Chapter V on the methodology) that each key function is characterised by the exercise of responsibilities and powers based on know-how and the necessary and sufficient behaviours.

Expressed in another way our basic axiom states that the situation of mastery is characterised by the fact that all the responsibilities are exercised, with the corresponding powers, and that they are carefully distributed between the minimum of the key functions, each carrying its necessary and sufficient means of response in terms of know-how and of behaviour.

One may already sense, intuitively, that all mastery, in the exercise of a vocation at individual level, includes the concept of equilibrium between what one must do (RP), what one knows how to do (KH) and how one is to do it (BH) in order to adapt oneself to changing situations.

When it involves a chain of functions directed towards a certain overall objective, which it is difficult to achieve, it may be conceived that all the functions forming a vocational body must comply with the same equilibrium, without it being necessary for the individual functions being balanced identically (if not they would be in competition rather than in organisation): this is a matter of the organisation of the individual imbalances with a view to an equilibrated resultant which would characterise the mastery of the group.

3.2. Representation of a function by its three components KH, BH and RP.

In Chapter I of this part, and then from the examination of Table II, we have already seen the emergence of the factors for calculating the values in equilibrium, the requirement ratings being adjusted so that KH + BH + RP = 100.

NOTE : It is no longer the absolute values of the requirement ratings which are being taken into account here but the relative values. This should always be borne in mind.

Figure 3 explains the method for representing the functions on a triangular diagram.

3.3. Representation of the population of the key functions on a triangular diagram.

3.3.1. Figure 4 shows the total extent of the triangular diagram and the spread of the twenty representative points.

- In its upper part it contains the point of perfect theoretical equilibrium between the three components, where KH = BH = RP = 33.3.
- To a large extent it is orientated towards the higher values for behaviour, but also shows a slight peak towards higher know-how values.
- Very few functions show a trend towards high RP values.
- One has the impression that the spread consists of several sub-populations that an enlargement of the useful zone of the diagram would distinguish.

- One can represent a function as a magnetic body attracted by the three points of the diagram, and hence subject to three forces in star form, acting at 120 degrees, which fix its mean position, but which is also stressed by forces of varying strengths and directions representing the interactions of the functions between themselves (hierarchic and functional relationships) which result in relative displacements from their mean positions in the constellation.

It may be assumed that, since these interactions are principally of a relational nature, the "play" which is left to the system, once the values of KH, BH and RP have been fixed, develops in the direction of greater behavioural requirements, and this explains the general orientation of the constellation.

3.3.2. To make any further discoveries it is necessary to enlarge the field and examine Figure 5 which covers the values of KH, BH and RP between 20% and 60%. On this diagram each function is represented by a cicle bearing its code number as given in Table II. It is possible to distinguish four sub-populations :

A) Five functions are closely grouped in a small triangle around the theoretical ideal equilibrium point. Their total absolute requirement ratings are the highest found.

Functions	Code	Total of ratings	Mean
Chief spares buyer	1	254	
Chief raw materials buyer	2	198	
Stores manager	3	176	224
Maintenance foreman, CC	11	250	
Shift foreman, CC	20	243	

These are the managers. Their field on the diagram is an equilateral triangle.

B) Six functions are grouped in a larger equilateral triangle, slightly below the management triangle. Their total absolute requirement ratings are very similar to those for management :

Functions	Code	Total of ratings	Mean
Shift maintenance foreman	8	228	
Head storeman/inspector	9	217	
Foreman, CC refractories	12	157	205
Billet store supervisor	14	199	
Foreman, CC machine	18	222	
Cabin operator, CC	19	210	

This is the operational control group: in this group actions are organised, ordered and controlled. In the KH - BH - RP equilibrium priority is given to behaviour (vigilance, anticipation of events, rapid reactions).

C) Six functions are located within an even larger triangle, further to the right and to the bottom of the diagram but overlapping the previous triangle.

Functions	Code	Total of ratings	Mean
Shift foreman, CC	6	110	
Shift pump mechanic, CC	7	188	
Tundish preparer, CC	13	135	162
Supervisor, CC utilities	15	176	
Grade adjuster, CC	16	156	
Caster, CC	17	209	

There are operators of higher or lower levels of skill. It is possible to make further distinctions between :

- functions of team leaders and skilled operatives such as codes 6 and 17,
- functions of trusted personnel with lower skill requirements, such as codes 7, 13, 15 and 16.

D) Finally three functions can be fairly clearly distinguished :

Functions	Code	Total of ratings	Mean
Stock control manager	4	163	
Technical librarian	5	182	190
Maintenance supervisor, CC	10	226	

The mean of the total of ratings is located in the region of the forem , with one of them at management level.

These are the functions where know-how has greater weight, whilst the responsibilities/power level is not as high as that of management.

We can designate these as functions providing technical aid to the management. Within the chain of responsibilities along the line of fragility they guarantee the permanence of a power to collect and process data which allows the management to make decisions, to act and to control (system of management). The functions 4 (stock control = working on documents) and 5 (technical librarian = design office work on documents) are relatively distanced from the zone where the functions of operational control are located.

Function 10 (Chief preparer of the maintenance programmes) is much nearer to these and, in particular, to the two operational control functions which most closely approximate to aid to management: code 9 (Head CC storeman, but also inspector of the CC installations to provide information for the preventive maintenance programmes) and code 19 (Cabin operator who, during the production activities, not only acts as operator but also as interpreter of the display panel). One may therefore assume legitimately that there is a logical interference between zone D and zone B.

3.4. INTERPRETATION OF THE TRIANGULAR DIAGRAM

3.4.1. The cloud in Figure 4 appears, therefore, on Figure 5 as organised, no longer as departments, but as a category of functions, all departments being included, and characterised by their type of KH - BH - RP equilibrium.

Its very organisation leads one to think that the large empty spaces in the diagram also have their significance: there are no man's lands and zones which are certainly open to useful functions but to those which are not key functions. We will now look at these in greater detail and attempt to arrive at some conclusions, taking advantage of some interesting correlations.

3.4.2. EXAMINATION OF THE USEFUL ZONE OF THE DIAGRAM

3.4.2.1. The chain of key functions can be clearly seen, with its four links A,B,C and D, and also the manner in which these functions hold together, mutually safeguarding each other.

It may be assumed that when one of these zones does not exist, or is shifted in such a way that there is no longer interference nor even continuous contact, then the chain is broken.

It will be seen that the cohesion of this chain depends not solely on the personal value of those who fulfil the functions (KH, BH) but also on the distribution and the content of the roles (RP).

3.4.2.2. Furthermore note should be taken of the particularly important role of zone D which serves as the linkage rod between the operational functions and the management functions.

If this category D of the key functions is set aside or is inoperative then management is deprived of its coherent system for the collection and processing of data, deprived of its display panel: the management group (A) operates in a vacuum, is no longer understood and many acrobatics are performed; much labour is expended on producing little, or many rejects, and the habit develops of believing that managing resembles swimming against the tide.

From their side the operational functions, who can no longer operate except by means of expedients (hence the well-known cannibalism which uses duplicate installations as a source of spares, etc.) lose their behavioural values whilst the responsibility/powers values are redistributed erratically, as determined by individual temperaments: one no longer has a plant but rather a conglomerate of more or less competitive shops, with neither satisfactory nor regular products coming from them.

3.4.2.3. It is of interest to analyse quantitatively the <u>equilibrium between the three components, KH, BH and RP, of a function</u>.

a) It is firstly seen than the <u>median point</u> of our population of twenty key functions is situated, in the triangular diagram, at the link between zones B and D, as if to mark the <u>hinge between the semi-chain of management, with its piloting systems, and the semi-chain of operations</u>.

This median point (KH = 30, BH = 40, RP = 30) is at a relative distance from the equilateral management triangle where the three values of KH, BH and RP are balanced.

Why are there so few "balanced" functions ? How, and on the basis of what criteria, are responsibilities and powers distributed ?

b) <u>Equilibrium characteristics</u>

We identify this characteristic by the value of the relationship

$$\frac{RP}{\frac{1}{2}\ (KH + BH)}$$

The significance of this is shown by the diagram of the breakdown of the forces, given at the foot of <u>Figure 6</u>. We start, in effect, from the principle that in the exercise of any function the holder of that post brings KH and BH, which he has acquired through his training, and that RP is defined by the rules of the game, based on the procedures in force, and which result from the system of organisation which has been chosen.

Firstly one can obviously see that the occupier of a function desires to accept more and more responsibility and to acquire more powers for action over the events which hold together the life of the plant, but that he is not necessarily capable, either in terms of his know-how or in terms of his behaviour, to do more than ensure that his actions form a harmonious part of the whole: the limits of the rules of the game must be given to him.

Secondly one can obviously see t[illegible]he occupier of a function can, under certain circumstances, be afra[illegible]ccepting responsibilities and/or of exercising powers, since he does no[illegible] enough confidence in his own know-how and behavioural capabilities: [illegible] is therefore necessary that the rules of the game indicate just what space for freedom is allocated to him, the area in which he has the "right to be wrong".

On what parameters does the attribution of responsibilities and powers depend, and how does this vary within the chain of functions which are under consideration ?

<u>Figure 6</u> provides evidence that, if one takes the means of the values for the groups of functions A,B,C and D, the equilibrium relationship RP/½(KH + BH) depends very significantly on the total requirement ratings of the function, (KH + BH + RP), with a correlation of 95%.

The situation is very different in the case of the individual values: the cloud is highly dispersed (correlation only 44%) and the slope of the correlation line is less than half that of the previous line. It is clear that the tendancy remains the same, but the influence of other parameters needs to be investigated.

In passing it will be noted, in Figure 6, that the RP only rarely exceeds, and then by only a small margin, the equilibrium value $\frac{1}{2}$(KH + BH), as is shown more explicitly in Figure 7.

c) Figure 8 examines the influence of the ratio KH/BH, which characterises the technicity of the function. This figure shows that it is possible to distinguish not four but five sub-populations: our population C (the executants) becomes divided into C_1, which we designate by the term "sub-foremen" (code 6 = shift storeman and code 17 = caster, CC), and into C_2 which we designate by the term "trusted personnel of lower skills".

The search for an overall correlation produced no results (coefficient of correlation 35%). However the orientation and the shape of the cloud suggest the image of a logical chain which develops in a funnel-shaped space between two "no-man's lands" or, rather, two "no functions" lands. Furthermore operational foremen appear to play the role of hinges between two function spaces where the rules governing the distribution of powers and responsibilities are very different :

- For low technicity functions the attribution of responsibilities and powers is very limited, but the leaps towards higher RP values are very considerable, by the simultaneous increasing of the know-how and behaviour values, the latter characteristic being of primary importance.
- As soon as one approaches the sub-foremen functions the passage to responsibilities and powers demands that a considerable advance in technicity be acquired.
- Between foremen and management + aid to management the technicity gap becomes very considerable for only a limited gain in powers and responsibilities.
- Certain management aid functions demand high technicity values, if not being attributed the highest values for responsibilities and powers (the extreme case is the documentation function, code 5).
- From the low technicity functions to those of highest technicity the usable zone where the chain of functions develops becomes increasingly narrow, as we have also seen from the triangular diagram.

The interpretation of those zones not occupied by the chain of functions can be seen later in the same chapter. But for the moment, and to understand more fully the significance of these non-occupied zones, we will examine how the zones which are occupied in the diagram function.

4. THE NERVOUS SYSTEM : Hierarchic and functional links

4.1. To show Figure 8 in another way it is of interest to return to the triangular diagram for the following reason: it showed us, in Figure 5, how the differentiated functions of the chain being examined were located, and which complementary zones they occupy: this is the anatomy of the system.

The triangular diagram will allow us to visualise the functioning of the chain as a result of the circulation of information and of commands.

4.2. To this effect Figure 9 shows, on a larger scale, the zone occupied by the key functions and the links between these functions :

- The hierarchic, vertical or departmental links constitute the motor nervous system, where the action and control flows circulate;
- The functional, horizontal or inter-Departmental links, by a group of functions or from one group to another: this is the sensory nervous system, in which useful information circulates, making it possible for the whole to collect and to process reliable data, and to orientate its action at the lowest level of synthesis, whilst compying with the instructions given by the hierarchic links.

4.3. What can be seen from this diagram ?

4.3.1. First of all it is presented as a real nervous system, with its networks radiating out to the most discrete activities, with its processing centre and its control centre.

4.3.2. The dotted lines indicate the bridges between the responsible Departments: they are shown at the levels where synthesis is possible (reference may advantageously be made to the details in the evaluation sheets in the Annex).

4.3.3. The levels in zone C are "verticalised", since there is not sufficient KH here to constitute a sufficient synthesis level, and not sufficient KH + BH in absolute values for the exercise of responsibilities and powers other than those within the restricted circle of the team (gang leading).

4.3.4. The code 5 function (Technical documentation and coding) belongs to the Engineering Department and represents it. Here only functional links can be seen. In the whole system it represents the reference data centre, the permanent treasury of exhaustive coding and documentation, acting as a kind of gyroscope or, to return to our medical similes, the inner ear which provides balance.

4.4. What conclusions are to be drawn from it ?

4.4.1. The harmonious architecture of the functions.

To repeat, this involves :

- a control centre, supplied with processed information, having a high level of know-how and high motivation, conscious of its responsibilities, endowed with considerable powers for action and issuing coherent orders.

- a processing centre, supplied with raw information which is formulated with a high level of reliability, controlling the archives and the data processing systems.
- continuous and hierarchic networks for the transmission of information and for the execution of orders, with each post, even the most elementary, being at the same time the sensor and the relay for information and an actor in its own vocational domain.

4.4.2. The continuity of the information and action networks.

- No "hole" in each of these networks which runs from the elementary reality to the most complex levels of strategic and tactical activity. Everything is "under control".
- No distortion in the interlacing of these networks: they are placed one on another, even interlaced, and each level of function in one department finds its equivalent in another department at a short distance in the diagram; at each stage one is in contact with professionals of the same level.

4.4.3. The general orientation of the networks links a management, well balanced in terms of KH, BH and RP, with requirement levels where behaviour, that is to say the motivation to serve a system, has priority over the other components. Any other orientation would deprive the nervous system of its efficacy: its reliability is above all a function of a universal and widespread desire to succeed together, shared by men who have confidence in each other.

Considering the imperatives for training these may be formulated in the following manner: the team is more than the sum of its abilities; when each reaches his optimum level of know-how the team has still not been formed, the most important part of the work still has to be done.

4.4.4. It may be conceived that any "gap" or any distortion in this nervous system can generate imbalances, problems and even catastrophes: unchecked information, wrong decisions, uncoordinated actions, "push-pull" operations, a permanent state of crisis, etc.

In effect, and inasfar as a complex system of human relationships may be compared with a complex automation system, any absence of an organ, any error in the selection of the characteristics of an organ at its input and output terminals or any error in the cabling will result in disruptions such as "pumping", foreign "noise" or shrinkage of the usable range of operation or even, in the limiting case, the failure of the system to provide an on-line response. But men are more complex than electronic components, and however they are linked by the cabling of the procedures, they always retain their freedom of action: hence the importance of their behavioural characteristics.

Naturally, and depending on the greater or lesser complexity of the plant, the failings of the nervous system of the team will have more or less serious consequences; when one speaks of technological mastery it must never be forgotten that the first plants established in a country are, in this respect, effectively schools where hopes of achieving technological mastery can be created or, on the other hand, destroyed for a long while to come.

It is thus a parameter of the highest importance, even if of an irrational character, which it is necessary to introduce into the feasability studies before taking any decision on a new iron and steel unit. We will be developing this theme later.

5. THE KEY FUNCTIONS OF MASTERY, THE OTHER FUNCTIONS AND THE "NO FUNCTION LANDS".

5.1. In paragraph 3.4.2. of Chapter III we advanced the hypothesis of the no-man's lands (or rather of the no function lands) on the triangular diagram. We found some similar zones when carrying out investigations into correlations.

From this point of view and with these findings we can look again at the complete triangular diagram (Figure 10), replacing on it the zones A, B, C and D within which lies our chain of key functions.

5.2. The zones of non-mastery

5.2.1. Firstly we can see that there is, to the north of the figure, a zone where any function for which the organisation wished to make provision could be the cause of serious disorders, if not of catastrophes since there would be too high a level of responsibilities and powers for too low a requirement in know-how and behaviour (see also Figures 7 and 8).

This could be the result either of an over-evaluation of the function in regard to responsibilities and powers or, as is more often the case in new iron and steel industries, by placing in that function someone whose personal standard falls below the values demanded by the function, either in terms of know-how, of behaviour or of both know-how and behaviour.

In any case if it is desired that the plant should operate according to the proposed programme and should fulfil the economic role assigned to it it is necessary that the key functions are exercised reliably as from the time of commissioning, and it is necessary that the chain of key functions should be established and interlinked within the compact configuration A, B, C and D, the whole ABCD area always being located under the line where RP = 34.

If all or part of this group of functions is displaced outside the general condition :

$$\frac{RP}{KH + BH + RP} \approx 34$$

it will be necessary to compensate for this by means of external assistance.

Such assistance brings essentially know-how and is less concerned with behaviour, apart from some exceptions. We will consider this in greater detail later. For the moment we will accept the concept that there are limits to its intervention, that the efficiency of transfer is never 100% and that it can never compensate for all gaps in the training of local personnel, in particular those gaps concerned with industrial behaviour (except, obviously, in the case of a plant under a complete management contract, a case where one must talk not of assistance but rather of taking over, which is a very different matter).

Whatever the position, and continuing our geographical examination of the triangular diagram, we will assign a sector for the transfer of know-how in the bottom left-hand corner in the region of the highest values of the know-how component.

5.2.2. To the right of zone C in the diagram there is a zone of useless functions (in the sense of key functions), or we might say rather a zone of non-necessary functions.

6. WHERE ARE THE FUNCTIONS OF THE MANAGERIAL STAFF LOCATED ?

6.1. THE PRINCIPLES

In the description of the methodology for this study we deliberately chose to concentrate our examination on the population which is directly involved in the daily struggle for technological mastery: it is, in effect, at this level that the battle is won or lost.

The combatants in the field have neither the time nor the competence to organise the battle, to make long-term forecasts or to take decisions of a strategic type. It is the specific function of the managerial staff to organise, to forecast, to promote the morale and well-being of the executants and to decide on a coherent strategy; it should be added that this function is exercised in two directions :

- firstly within the plant: they form a part of the chain of key functions, firmly linked with the functions A and D, and have to ensure the solidity and permanence of these links;
- secondly outside the plant: there they are responsible, at all the interfaces of the environment at the same level as themselves, for the coherence of the totality of the multiple exchanges with the outside world, and these are carried out daily, in detail, with the functions A, B and D.

Finally they themselves form a diversified and hierarchic elite corps, coherent in behavioural terms, which has to provide by its example an attractive image of continuous development.

6.2. The requirement ratings of the managerial functions

6.2.1. It is necessary to distinguish at least two categories of managerial functions :

- those which are directly linked with the life of the departments of the plant: heads of divisions or departments, engineers or administrative executives;
- those which are directly linked with the general directorate: chairman, general directorate, technical directorate, sales directorate, administrative and financial directorate and the social services directorate.

It is true that in a mini-steelworks, and particularly when it is a case of the first graft of an iron and steel industry in a developing economy, the cohesion of the managerial corps requires that it should be as small as possible and that it should all be resident in the same place, that is to say the plant.

The distinction between the two categories is nevertheless illuminating even if, at individual level, the situation arises where one person participates in both of these functions.

6.2.2. The managerial function directly operational in a Department of the plant

In the example under study this could be :

- The Chief Engineer in the Production Department: regularity and quality of the production.
- The Chief Engineer of the Maintenance Department: the maintanance and ongoing regeneration of the productive apparatus and of its technical auxiliaries.
- The Chief Engineer of the Energy and General Services Department: logistics, technical auxiliaries and support to production.
- The Chief Engineer of the Design and Works Department: the reliability of updated documentation and research into the better matching of the plant to its evolving environment.
- The Head of the Supplies Department, covering the Purchasing of materials and parts and Stock management: meeting the material needs of the plant at the lowest cost.

Along other lines of fragility one would find, for example :

- The Head of the Sales Department: understanding and controlling the markets, the distribution circuits for the production and reliable data for establishing development projects.
- The Head of Social Services: meeting the needs of the plant in terms of human capital at the levels demanded by the functions, and satisfying the developmental needs of the personnel.

These managerial functions are, in effect, functions of type A (management), requiring additional KH and BH qualities to match the additional responsibilities and powers given to them :

- the additional KH in their respective fields is not linked solely to knowledge and experience of greater extent or depth (which is, however, necessary) but above all to a capacity for logical analysis and clear synthesis when faced with the data and the situations resulting from complex phenomena.
- the additional BH may be conceived of in two ways :
  - in regard to their subordinate functions A,B,C and D in the hierarchic line the managerial functions must constitute educational models in respect of behaviour; nothing can replace them in this role;
  - within the corps of managerial executives of their own level of RP and of the higher RP level, these functions involve, each in their own speciality, the organs for the collection and processing of a multi-faceted reality, on the basis of which good or bad decisions will be taken (in this respect their responsibilities and powers may be greater in respect of their KH and BH). The behavioural requirements, at this level, whilst their definition may be more subtle, are no less determinant for the overall performance of a managerial group where equilibrium is not easily established between the necessary cohesion and the no less necessary confrontation: the personal

talents of the Chairman and/or the Director-General will certainly not be strangers to the training of this behaviour.

In total therefore one may reasonably establish the requirement ratings for the managerial posts directly linked to the operational Departments as follows :

. Absolute ratings :

KH = between 80 and 100 Mean = 90

BH = between 80 and 100 Mean = 90

RP = between 90 and 100 Mean = 95

T = between 250 and 300 Mean = 275

. Relative ratings in the triangular diagram :

KH/T = between 32 and 33.3

BH/T = between 32 and 33.3

RP/T = between 36 and 33.3

It can be seen that, on the triangular diagram, these managerial functions occupy the upper part of the domain of the A functions, that is to say with a net predominance of the Responsibilities/Powers factor, and with a total value of the requirements standard T which is clearly higher. They remain, in fact, an integral part of the configuration A + B + C + D, that is to say of the team of the plant.

This is the category of superintendents' functions, which we will designate by the letter S.

6.2.3. <u>The managerial functions directly linked with the General Directorate</u>

These are the higher management functions, where the decisions taken have serious consequences in the medium and long term, and cannot be taken without the intervention of agreements with the highest public and private authorities in the environment.

At this level strategy and public relations at high levels are the essential functions; there is direct participation in development policy and this is the more so in a developing country where the highest political power is so close to the senior executives in the economy, the public administration screen being less dense in such countries.

This involves an important feature for the continuation of our analysis, namely that this category of functions in fact belongs to <u>two</u> triangular diagrams :

- the triangular diagram for the plant, where they exercise responsibility at the highest levels of authority;

- the triangular diagram of the administration of the country, where they carry out one of the most important operational functions in a developing economy.

These are therefore bridge-functions. In the diagram for the plant they are at the limit of the no-functions land towards the (excessively ?) high values of RP. These we will designate by the letters GM (General Management). In the diagram for the administration of the country they occupy places of the A,B,C type if in fact the mastery of the administration of a country has some analogies with technological mastery: the following paragraph will attempt to elucidate this question.

7. THE REPRESENTATIVENESS OF THE MODEL BEYOND THE POPULATION STUDIED

7.1. Before going any further, and before daring to draw any general conclusions of a normative character, it is necessary to verify that the model which has been established takes account of the complexity of any other line of fragility within the interior of the plant and within its environment.

7.2. Within the plant

7.2.1. The line of fragility which has been studied has its origin in the continuous casting workshop.

It could just as well start from the steelmaking workshop. or the rolling mill section. What would have changed? It will first of all be noted that the origin of this line is in the production function, and that this is because production is the end purpose of the plant: everything moves forward to that end.

The origin on the floor of the continuous casting section has been chosen deliberately: within the continuous flow of production this is the linking point between those sections producing the liquid metal and those which produce the metal in its final form.

These two groups of processes have end purposes, rates of production, reference values and risks which are all different. The greatest risk of disruptions in the conduct of the plant is to be found at this interface, that is of continuous casting. The largest stocks of materials are to be found upstream of the steelmaking section, the largest "lungs" which despatch the products are downstream of the rolling mill. Between the steelmaking section and continuous casting the link is a rigid one; the ladle of liquid metal is either accepted or not. Between the continuous casting unit and the rolling mill the buffer stock is one of the smallest.

Casting cannot be conceived without steelmaking, which provides the liquid metal, and reciprocally the steelmaking section cannot be conceived without a casting unit which produces not a final product but a semi-product. However the combination of a Steelmaking section and a Continuous Casting unit may form an independent plant, a plant which produces semi-products.

The rolling mill may be conceived as an independent unit, converting a solid semi-product into a solid finished product, without any intermediate fusion.

In one or the other of these configurations the degrees of flexibility the degrees of flexibility are greater than when the two units are combined together. The levels of reliability required may also be less, since the consequences of a failure are less heavy financially.

One may therefore advance the concept that, in a complete assembly, it is <u>the line of fragility which passes through the continuous casting section which gives the best picture of the demands of mastery, but that all these images must be taken together</u>.

If the "supplies" line of fragility is made to pass through the steelmaking section or through the rolling mills then the production functions would result in the evaluation sheets showing some change in the know-how details but no change in the behaviour details.

The maintenance functions would also be revised in the same sense.

The Buying and Stock Management functions, since they are general services, would remain the same, as would also Engineering.

In other words if one develops more completely the "Supplies" line of fragility by integrating all the production functions one simply multiplies the number of points on the triangular diagram without changing its architecture.

The same applies to the technical utilities services; for example the water treatment and distribution sub-assembly is in itself a plant producing products (the various qualities, temperatures and flowrates of water) and subcontracting to production which makes requests to them and then returns the water and effluents for regeneration. This sub-assembly must operate reliably, according to the programme and the modifications to the programme, using its supplies of materials (raw or industrial water, the chemical additives needed for treatment, etc.) whilst maintaining the installations in good working order (sectoral or general maintenance) starting from stocks and purchases of parts and services and complying with the requirements of the waste disposal plants.

7.2.2. Other lines of fragility, of greater or lesser importance, also exist; in particular we may cite :

- the distribution and sale of the products,
- the supply of labour and the maintenance of the individual levels of performance required for each work station: recruitment, initial or subsequent training and the active management of the shift towards an appropriate industrial life.

Does our method of analysis apply to these domains which apparently involve pure software ?

First of all it must be pointed out that one finds a diversified and ranked universe on these lines of fragility :

- the sales function is responsible for filling the order book, but not independently of the forecast scheduling of manufacture which integrate all the technical and administrative parameters whether internal or external to the plant. The sales function is responsible not only for recognising the market for the products but also of developing it, organising the promotion, distribution and sale of the products.

If the term plant cannot be used of this activity then the term enterprise certainly can.

What is an enterprise if it is not a grouping of persons with complementary know-how, inspired by a homogeneous behaviour, who accept between themselves a certain distribution of responsibilities and powers in order that they may arrive, in a stable manner, at a beneficial situation ?

The tools, concepts and methods are different here from those involved in manufacture, but one always finds the same catagories: A of managers, B and C of operatives on organised teams and D of the management aides (customers' files, statistics, forecasting systems, liaison with production scheduling, etc.).

7.2.3. All the lines of fragility intersect each other: they are not independent:

- no manager of category A is isolated on a single line of fragility; at one moment or another he will be implicated in a problem linked with a line of fragility other than that on which he is normally located;
- those in category D, each on their own line of fragility, form a body of systems, the coherence of which must be constantly maintained so that the managers and the executives can understand the situation and make lucid decisions, each at their own level;
- meetings arranged according to a immutable calendar and agenda link together, at level A and also at the level of the executives S and C_1, all the lines of fragility: the rigorousness of the reports, the clearness of the forecasts and the coherence of the decisions taken at these meetings are the mark of industrial mastery; the decisons are put into effect and their results presented to the next meeting, etc.

Success at a complex industrial level is achieved at the price of simultaneous mastery of all the lines of fragility. We will see that this image of the interior of the plant may also be utilised at its peripheries.

7.3. At the periphery of the plant

7.3.1. The technical infrastructures and bodies in the environment of the plant are also "plants". more or less complex and with more or less numerous lines of fragility.

Viewed from the iron and steel plant this category includes all the customers and suppliers of materials, good and services and whose occupation requires the utilisation of industrial equipment and materials: these are the producers, converters, carriers and consumers or the distributors.

They all have in common the fact that they need to maintain, in a state of reliable operation, a logistical hardware adapted to the needs of their clientele :

- quarry or mining working,
- generator or converter of energy, chemical products, etc.,
- static network for the distribution of energy, water, fuels or telecommunications,
- fleets of vessels, aircraft and road and rail transport,
- port handling installations or depots,
- maintenance and development of road and rail networks,
- metal converting industries,
- building and public works enterprises.

The primary concern in all these activities is a desire for the systematic maintenance of the operational equipment, and hence for the supply of spares leading to a system for the collection, processing and control of all the reliability parameters, with at the same time a capacity for anticipating the problems posed by development: one finds, other things being equal, the same lines of fragility as those found in an iron and steel plant, with the same key functions with similar details of requirements and complexity.

One finds the same A, B, C and D functions with different absolute requirements values, as a function of the complexity, but always arranged according to the configuration of our triangular diagram, with a high behavioural requirement. One will also find, and in the same place, the executives.

In other words there is no difference in nature between the iron and steel plant and its technical peripherals, but only differences of complexity

7.3.2. Non-technical infrastructures and bodies : software "plants"?

The approach to the lines of fragility of purely service bodies, practically denuded of hardware, is more delicate: these are the public or private administrations such as ministries, banks, the customs, commercial agencies, educational or cultural establishments, corporate or trade institutions, etc. They do not, apparently, merit any analogy with the plant, and yet nevertheless....

If their desire for maintenance of their equipment is very greatly reduced (typewriters, telex machines, computers, etc.) and if the search for suppliers or clients does not contitute a major concern and their operational routine makes them relatively sheltered from internal crises this by no means implies that they are free from lines of fragility nor that they cannot represent, for the whole of their environment, "the" line of fragility of the country.

In fact the vast majority of these public or private bodies are not subject to the stress imposed by the mastery of materials or equipment: the adverse consequences of non-mastery are not seen immediately, the results of the action being seen neither in terms of operation or a halting of operation, nor in terms of clear causalities.

To confirm this statement it is only necessary to ask a question of the type of "Why has it not been possible to arrange customs' clearance of the box of spares No. BX 381/10762/WM/94348 ?".

Any "seizing" in the complex administrative mechanism necessitates an enquiry which is often lengthy and difficult if the cause of the blockage is to be identified, involving going through all those circuits through which the accompaning documents could have passed, often without leaving any trace behind them.

If one looks a little closer one has here a plant which is processing raw materials (information) so as to produce semi-products or products which can be utilised in quantity and quality (decisions, authorisations, clearing orders, payments, etc.) by means of an organised machinery (the departments and their processing circuits) which must be constantly maintained at the required level of reliability (control of methods and procedures, reinforcement at peak periods) by means of constant investments in improving know-how and behaviour (maintenance of the human machinery).

<u>These are plants where key functions operate and which maintain complex machines practically entirely composed of human components</u>.

It may be noted in passing that since many developing countries are former colonies they generally have administrative "machines" and the corresponding "notices for use and maintenance" which come directly from the nineteenth century, whereas they are investing in an industry at the end of the twentieth century.

Viewed from this angle the software plants which are peripherals of the administrative type are more complex than the iron and steel industry, since their primary machinery does not have the innocence of material machinery. <u>It is here that the "engineering of behaviour" counts even more than in industry</u>; it is concerned with the irrational parameters of complexity rather than the "engineering of know-how" which resolves the rational problems of methods and means.

Since the machinery itself, and not only the operators, contains a behavioural component, since one is here far from the brutal confrontation with equipment, the mastery of a coherent administration of development involves three major lines of fragility :

- supplies of reliable information at the real front of development, where the result is achieved,
- maintenance of the human machinery in regard to know-how and, above all, in dynamic behaviour,
- supplies of "human machinery" and methods for the constant renovation of the software plant.

It follows from this that, in order to organise, direct, maintain and supply these components of the human machinery, to progress and to "sell" the products to the satisfaction of the clientele, functions of the A, B, C and D types must exist as a reliable chain in the system along each line of fragility. At each level, however, there will be a need for a higher requirement in terms of behaviour as compared with the standards needed in a technical plant; this is demanded by the continuous regeneration and comprehension of the human machinery.

At the level of the executive functions there is also a need for a higher behaviour requirement at the interfaces with the exterior: in effect most software plants are in contact with all the other bodies, being either accelerators or retarders of their development.

The existence of certain administrative bottle-necks is well known, since they can be immediately detected. Other bottle-necks are less immediately identifiable, even though they exist, since their "products" cannot for the moment be tested. This is the case with educational or cultural establishments, which may be considered as "software plants producing the components of the human machinery". This is probably the location of the weakest line of fragility in a developing society which is seeking technological mastery. We will return to this point in the fourth part of this study.

8. THE CLOSED CITADEL OF TECHNOLOGICAL MASTERY

8.1. Everything that we have analysed in the previous pages will be found summarised in Figure 11. Up until now we have dealt with the problems by separating the variables. Starting from the raw requirement ratings for KH, BH and RP by key functions and their total T = KH + BH + RP, which gives a measure of the absolute standard of requirements, we have sought the correlations and then plotted on a triangular diagram the relative equilibrium positions between KH, BH and RP by using the relative values KH/T, BH/T and RP/T which then replace the concept of an absolute standard.

We can now proceed to a synthesis for our iron and steel plant, knowing also that this has value as an analogy for the bodies at its periphery.

8.2. The citadel of technological mastery

The three-dimensional diagram in Figure 11 has the advantage of representing, in perspective and in relief, the useful "landscape" of the triangular diagram by attributing to the zones A, B, C, D, S and G heights which are proportional to the absolute standards T.

The logical group of six key function zones no longer appears here as a chain on the same plane but as a citadel of technological mastery, formed from a number of buildings of different heights and shapes. The heights of the blocks are the mean heights for the categories A, B, D, S and G. Block C (the operational functions) show a sloping roofline from the smaller standard values (sub-group C_2 = trusted functions, requiring few skills) up to the highest standard values (sub-group C_1 = shift foreman functions) and slopes up towards the left (operational functions requiring higher technical skills).

8.3. The surroundings of the citadel of technological mastery.

This citadel is bounded :

- to the north by the wide desert of dangerous functions (too much responsibility and power, etc.),
- to the east by the smaller desert of the unnecessary functions - seen, naturally, from the point of view of technological mastery,
- to the west by that zone which does not belong to the functions of technological mastery within the plant but is occupied by all the external functions which are sources of increased know-how: for a young plant this may be technical assistance whilst for a plant which has achieved maturity it may be any type of contact with external homologues (technical cooperation agreements, published literature, professional congresses, relationships with research bodies, etc.).

We have shown in this zone a reservoir for the transfer of know-how, outside the confines of the plant, so as to mark the foreign character of this function, its limits of intervention and the fact that it cannot replace a lack of know-how on the part of the operatives.

- to the south-east there is an analogous reservoir, based on teaching and a source of improved industrial behaviour for the population of the plant. We have deliberately indicated that it is fed exclusively by the citadel of technological mastery, and not from outside; these goods cannot be bought.

- in the centre, from the recruitment funnel, is the field of training.

8.4. The fourth part of this study will illuminate and examine in depth this zone of training, fixing the general rules for the most efficient access to technological mastery in the iron and steel industry.

For the moment we will simply bear in mind the strict contours of the citadel of iron and steel technology, and will observe how it works in conjunction with the other citadels at its periphery.

CHAPTER IV

INTER-RELATIONSHIPS BETWEEN THE IRON AND STEEL INDUSTRY AND ITS ENVIRONMENT

I. THE INTER-RELATIONSHIP CIRCUITS, THEIR LEVELS AND THEIR CONTENTS

Messages and products are exchanged between the iron and steel plant and the technical or non-technical peripheral bodies which condition the reliability of its functions, at various functional levels and at various levels of significance for the mastery of development.

Mastery of these exchanges is one of the unavoidable conditions for technological mastery, in the iron and steel industry as elsewhere: however satisfactory its performance at any given moment it is always seriously threatened, to a greater or lesser extent, by failures due to the fragility of the environment.

The lines of fragility within the plant always have extensions which run deep into the environment, never passing through just one single body but following tortuous and often ramified paths through several and sometimes many bodies, marking out the diversity of the structures and the hierarchies.

2. By way of a simple example the table on the following page shows, in the form of a logical sequence of the initiation of activities, one of the possible prolongations of the Supplies line of fragility in the iron and steel plant we have studied.

The history here starts from an order to buy a batch of spares. The starting interface is the Spares Buyer (key function No.1 in the previous theoretical study) who knows that the parts are not available on the local market and hence must be imported. He knows this, but before he can obtain an import licence it is necessary to prove the fact and also to prove that it is not possible to use local components which could be adapted by means of some modifications.

The history ends with the arrival of the batch of parts at the plant. It is assumed that all goes according to plan.

In the column on the right of the table are indicated those bodies which intervene on behalf of the buyer of the plant who, within the plant, requests action from the financial and accounting department at the banking interface.

The table does not take into account the despatch and return of files from one body to another and the necessary feedback or the convening of committees to examine the files, involving administrations such as the Ministry for Finance, the Ministry for Overseas Trade, the Ministry responsible for the iron and steel plant and the bank, so as to process the file, to decide on the import regime and to fix the choice of mode of international payment.

Nor does the table take into account the necessary interventions at all levels to "keep the file moving", nor any of the detailed difficulties which could hold back the progress of each activity, such as :

- Step 1 : overloading of the telecommunications system,
- Step 2 : the customs' tariffs have not necessarily been updated so as to identify complex or new generation industrial parts,
- Step 3 : overloading of the banking services, methods poorly adapted to the complexity of business affairs,
- Step 4 : errors in transcription between the files and the packing lists (translations!) which will subsequently hinder customs' clearance,
- Step 5 : bottle-necks at the ports, breakdowns of cranes due to a lack of spares there, also,
- Step 6 : overloading, sometimes seasonal, of the customs' services.

All this forms an integral part of the Supplies line of fragility, starting with a machine in the plant and extending and becoming diversified outside the plant into a complex network of functions, in series and in parallel and with feedback loops which can also become blockages.

SEQUENCE OF OPERATIONS FOR OBTAINING SUPPLIES OF SPARES

Step	ACTIVITIES	MEANS	PLANT AND ENVIRONMENT INVOLVED
1	On the basis of the order to purchase - identify the possible sellers	Catalogues + communications (telephone, telex, letter)	Plant Buyer + Telecommunications + Sellers
	Send out calls for tenders. Negotiate prices, delivery etc., draft definitive order.	Telephone, telex, letters, visits abroad	Sellers + Telecommunications + Airport, visas, hotels
2	Obtain import licence	Customs' tariff (according to country of origin of the parts) Import regime (free or contingency) Levels of duties	Customs' Administration
3	If necessary request derogations	- file covering specifications, prices, delivery - prove that the parts cannot be found locally	Ministry for Finance Ministry for Industry Ministry for Overseas Trade via Bank
4	Implement the instruments for international payments, according to exchange regime and import restrictions	- complete order file - modes of payment : . documentary credit, . documentary transfer, . simple transfer ? - Forwarding agent, Insurers - seller's quality control	Bank with Ministry for Finance Ministry for Overseas Trade in conjunction with the seller and the seller's bank
5	Making available fob Sea or air transport	Verify from the seller : - packing list - packaging - bill of lading or air waybill	Seller + quality control body + seller's Bank + Forwarding agent
6	Unloading and storage in Customs	Checking the packages (damage or not)	Forwarding agent + Insurer
7	Customs' clearance	Complete file + Compliance with the packing lists	Forwarding agent + Customs
8	Transport to the plant and entry into store	Railway, roads	Local carrier + Supplies department
9	If necessary instruction and negotiation on damages	Finding of damage or anomalies	Expert + Insurers + Lawyer - against the seller or the carrier.

In this complex network all levels of RP in all the bodies involved are actors, more or less, each on his own chain of reliability: one weak link results in the breaking of the chain.

It is necessary to appreciate that the existence of an iron and steel industry exerts a very heavy load on the whole of this chain: this is the consequence of the very specific character of the iron and steel industry to be, as pointed out in the first part of this study, "self-consuming". The files covering supplies of imported parts are reckoned in thousands a year, since it is only exceptionally that the orders can be grouped with a single seller, and it is in the interests of the plant to encourage competition.

If the young iron and steel industry is not to be stifled by the bottle-necks of the environment it is therefore necessary, at the moment of deciding to implement the project, to launch an upgrading of the entire environment, not only in terms of material infrastructures but equally in terms of the software and organisation of the whole environment, considered in all its fields :

- activity flows,
- the means,
- the organisations, and
- adequate training in know-how and behaviour.

3. THE COHERENCE OF THE INTER-RELATIONSHIPS BETWEEN THE IRON AND STEEL INDUSTRY AND THE ENVIRONMENT

3.1. We have seen that for each technical or administrative body at the periphery of the iron and steel industry the chain of key functions must always present itself in the configuration shown in Figure 10.

By way of an example we will see how relationships between bodies develop at several RP levels, since the smallest stresses on the environment, imposed by the iron and steel plant, can trigger off a process of imbalancing which sometimes calls for decisions at the highest levels of Responsibilites/Powers.

This is already true in an industrialised country, and so is probably even more true in a developing country where the equilibria are more fragile and more threatened by the crisis of growth due to development.

In a developing country, as in other places, the social body has not generally produced what is called a middle class in sufficient quality; the high-level RP functions are, more than ever, associated with everyday decisions whereas their vocation should be more strategic.

3.2. What we may define as the criteria of coherence for the plant/environment inter-relationships do not lack importance since, in our triangular diagram, the middle classes A and D form the link, in the chain of reliability in a body, between the base B + C and the summit S + G :

- B + C : the corps of operatives in direct contact with reality, operating with partial and complementary KH, with a high BH content but relatively little RP;
- A + D : the corps of managers of the action, well balanced in respect of KH, BH and RP;
- S + G : the corps of executives, endowed above all with RP and BH, supplementing their own KH with that of the group A + D.

3.3. This duly posited the "iron and steel universe", as we defined it in the first part of the study, the plant and its environment, may be represented as a stack of triangular diagrams, all of the same configuration but differing simply in the nature of their know-how :

- the know-how of the iron and steel industry;
- the know-how of the technical environment (energy, telecommunications, transport, the converting of metals, etc.);
- the know-how of the administrative world (ministries, banks, customs, insurers, etc.)
- the know-how of the fields of teaching, education, information, the world of culture, etc.

This is what is shown in Figure 12.

This universe is traversed by links at all levels, links which may be either informative (the transmission of information for execution by others) or operational (orders, instructions, acceptances or rejections, litigation, negotiation of contracts or concerted actions).

These formal or informal links, programmed or improvised, are made material in writing, by oral communications at a distance or by meetings of persons or groups of persons: it is a very complex system where the initiatives from any point may have no effective result but merely to produce interference in the form of noise, disrupting the system if coherence is not mastered, firstly at the level of each body and then at the level of the assembly of bodies.

In other terms development causes complexity; growing complexity favours development by increasing exchanges but it may also hold it back or even kill it if the circuits are not "cabled" together as demanded by the energy of the system.

3.4. The factors for coherence

3.4.1. Each category of key functions has its place

When we look at the stack of triangular diagrams from the top downwards each key function which enters into dialogue outside its own body must find the equivalent function on another diagram, having its own KH and endowed with the same KH/BH/RP equilibrium.

This is necessary if there is to be understanding, if matters are to be handled between equivalents and, above all, if the operations which result from these exchanges are to remain under control on both sides, if one is to have the best chances of arriving at the lowest overall cost.

There must therefore not be too much distortion between those zones in the diagrams which are occupied by the chains of key functions.

3.4.2. No "holes" in any chain of key functions :

This is to say that all the linkages must be ensured, and that if one of the diagrams suffers from a weakness in its chain a regulating mechanism must speedily overcome this fragility. What is this regulating mechanism ?

The diagnosis of weakness comes in general from observations made by the equivalents in other diagrams, who are well placed to detect it.

It is the responsibility of the executive functions, by concerted actions between bodies at their level, to implement the suitable measures, firstly in the short term (for example by assistance) and then in the long term.

It is at this point that the intrusion of the iron and steel industry, a major consumer of goods and services, may lead to envisaging a mutation in the surrounding systems if they are not able to absorb the sudden increase in exchanges.

3.4.3. Everywhere, and at all levels, homogeneous behavioural patterns

This is essential: without homogeneous behaviour the messages will neither be understood nor processed correctly; it will be a Tower of Babel with actions becoming bogged down and files moving about at random with no end results.

The "adjustment" of behavioural patterns is the No.1 task of the executive functions up to the highest levels of power. But it must be fully appreciated that behaviour is not conditioning: development is not achieved by mass-programmed individuals but through persons who are educated and sufficiently free to devote all their energies and all their initiative to the service of their function, fully defined in a fully understood system, and one which functions. In brief, therefore, it is achieved by citizens and not by automatons.

It is not possible to go beyond this strict enunciation of a criterion of operation without adventuring into the domain of political options on development, and this is obviously outside the scope of this study.

4. BY WAY OF CONCLUSION TO THE THIRD PART

This third part has been entirely devoted to a study of the mechanisms of the complexity of relationships between human functions within the iron and steel plant and in its environment.

The parameters of complexity, within each function and in relation to the other functions, have been the subject of an essay in quantification: in terms of the absolute values for each parameter and in terms of the relative equilibrium values between parameters.

The interplay of functions within a very complex system which we have termed "the iron and steel universe" (the plant and the peripheral bodies affected by its activity) has shown the interdependencies and the criteria for operation.

All the observations made on model systems, all the so far known laws of industrial mastery must be translated into terms of directing lines, of major practical rules and the initiation of actions to train a population capable of acceding to this industrial mastery: this will be the subject of the fourth part.

Figure 1 : HISTOGRAM SHOWING THE DISTRIBUTION OF THE REQUIREMENT RATINGS FOR THE THREE POPULATIONS APPEARING ON THE TRIANGULAR DIAGRAM

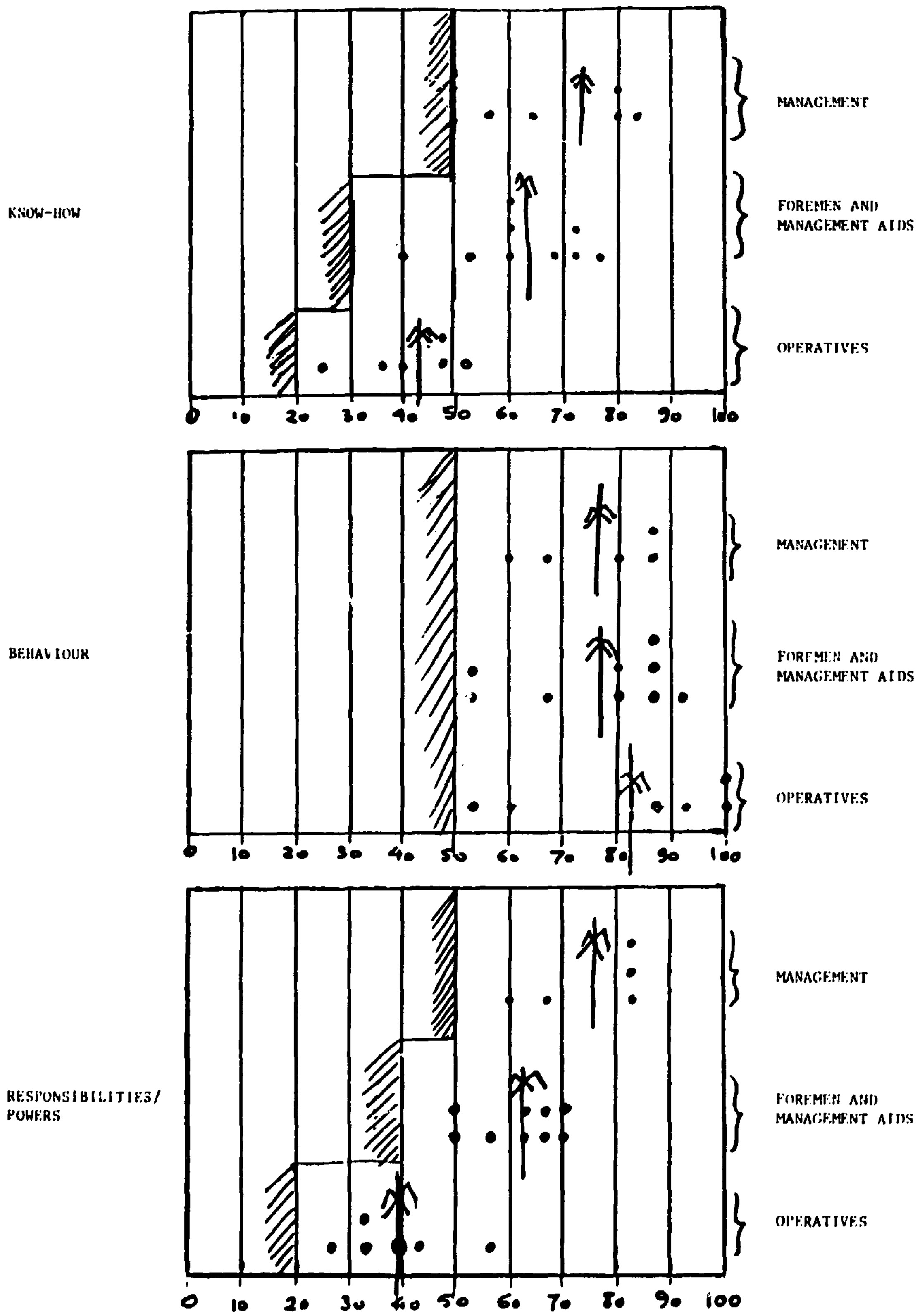
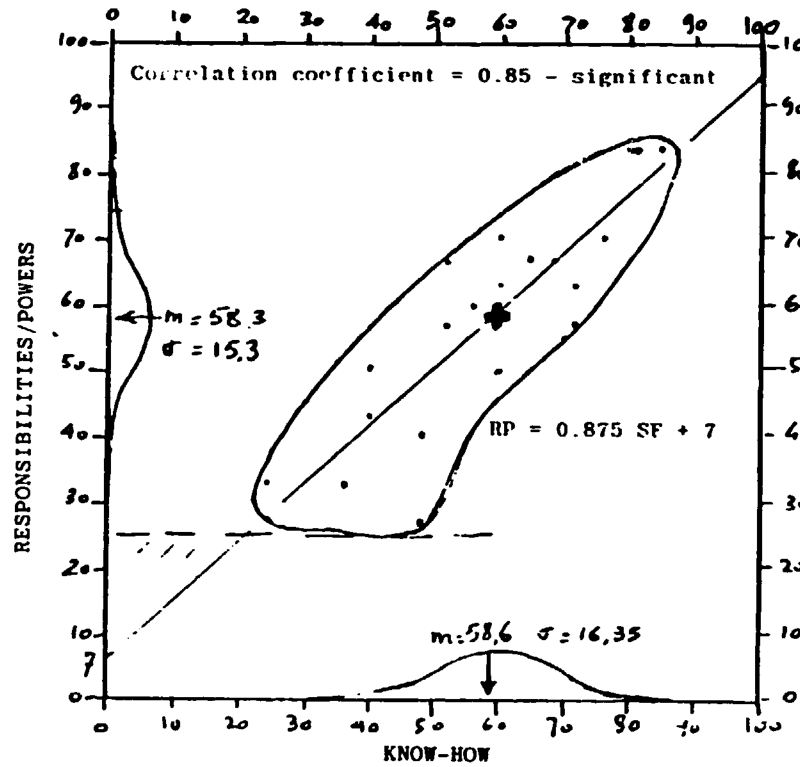


Figure 2 : RELATIONSHIPS BETWEEN THE REQUIREMENT RATINGS

Within a given function the know-how requirement rating is significantly linked to the presence of responsibilities and powers, but does not of itself explain the latter.



Within a given function the behaviour requirement rating is weakly linked to the presence of responsibilities and powers, but its influence does exist.

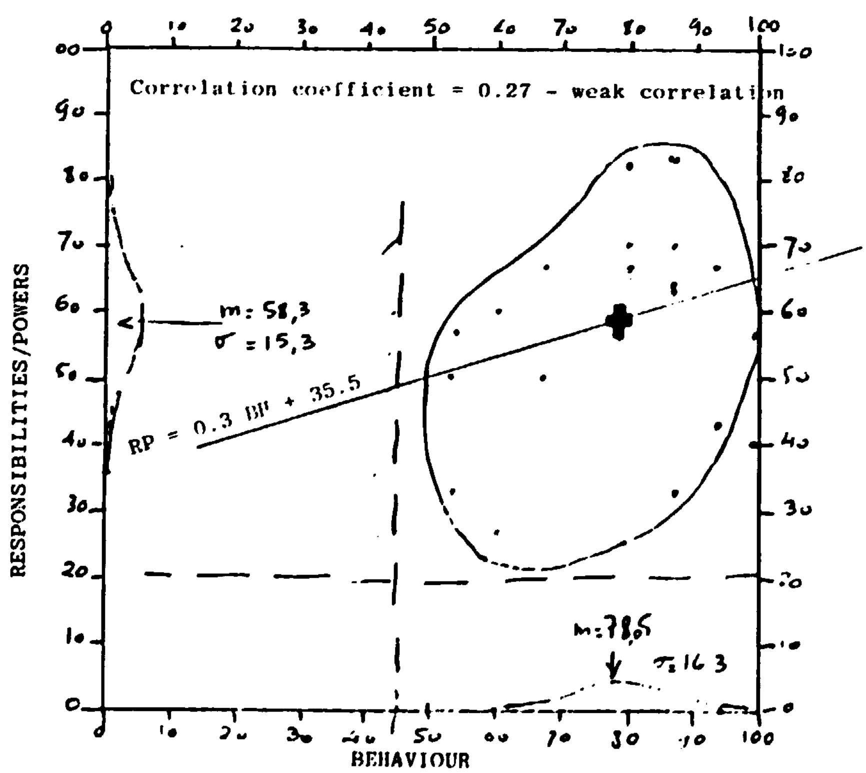
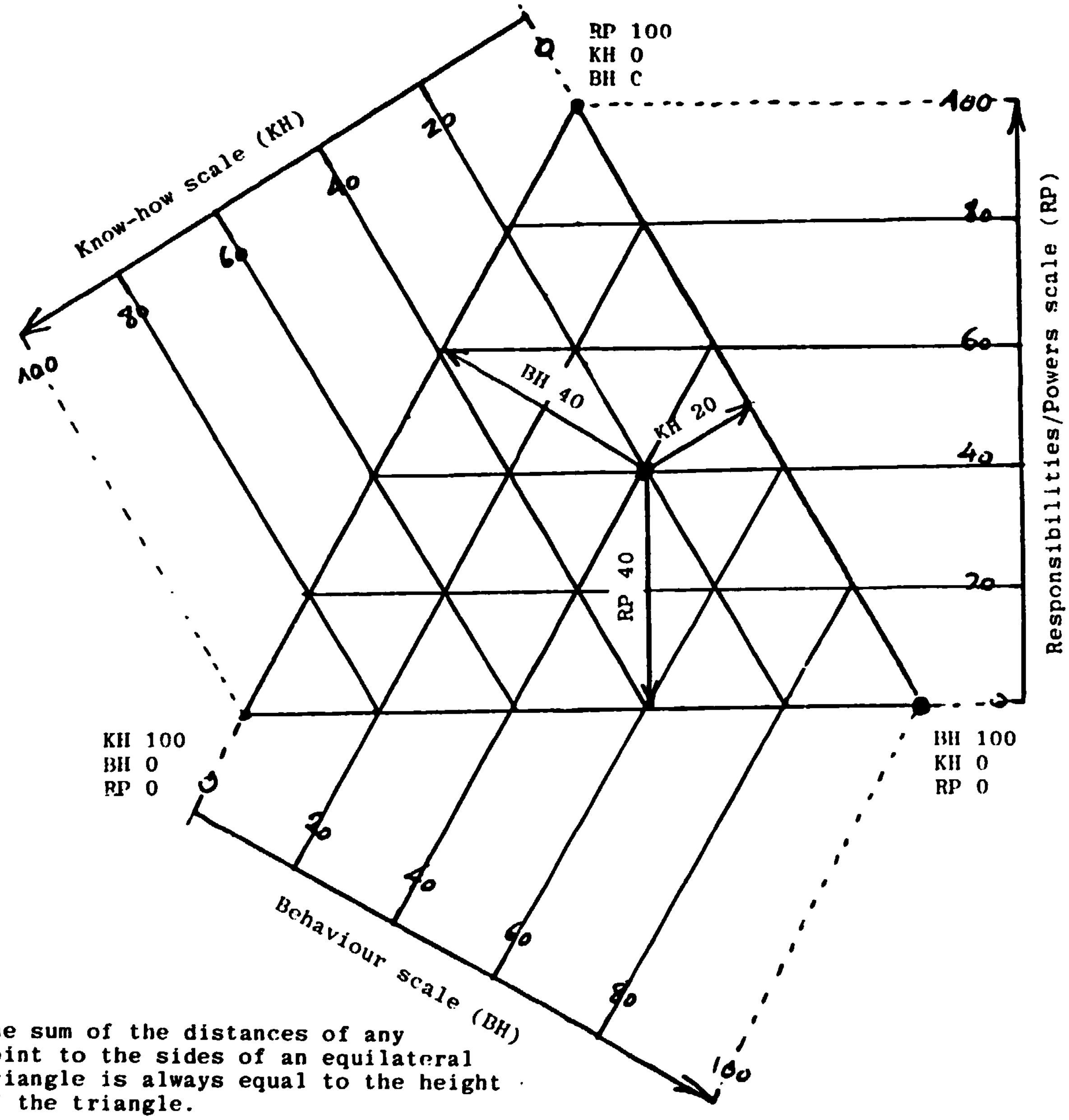


Figure 3 : PRINCIPLE OF THE LOCATION OF A FUNCTION BY MEANS OF ITS THREE COMPONENTS ON A TRIANGULAR DIAGRAM



The sum of the distances of any point to the sides of an equilateral triangle is always equal to the height of the triangle.

Figure 4 : CHAIN OF KEY FUNCTIONS ON THE TRIANGULAR DIAGRAM

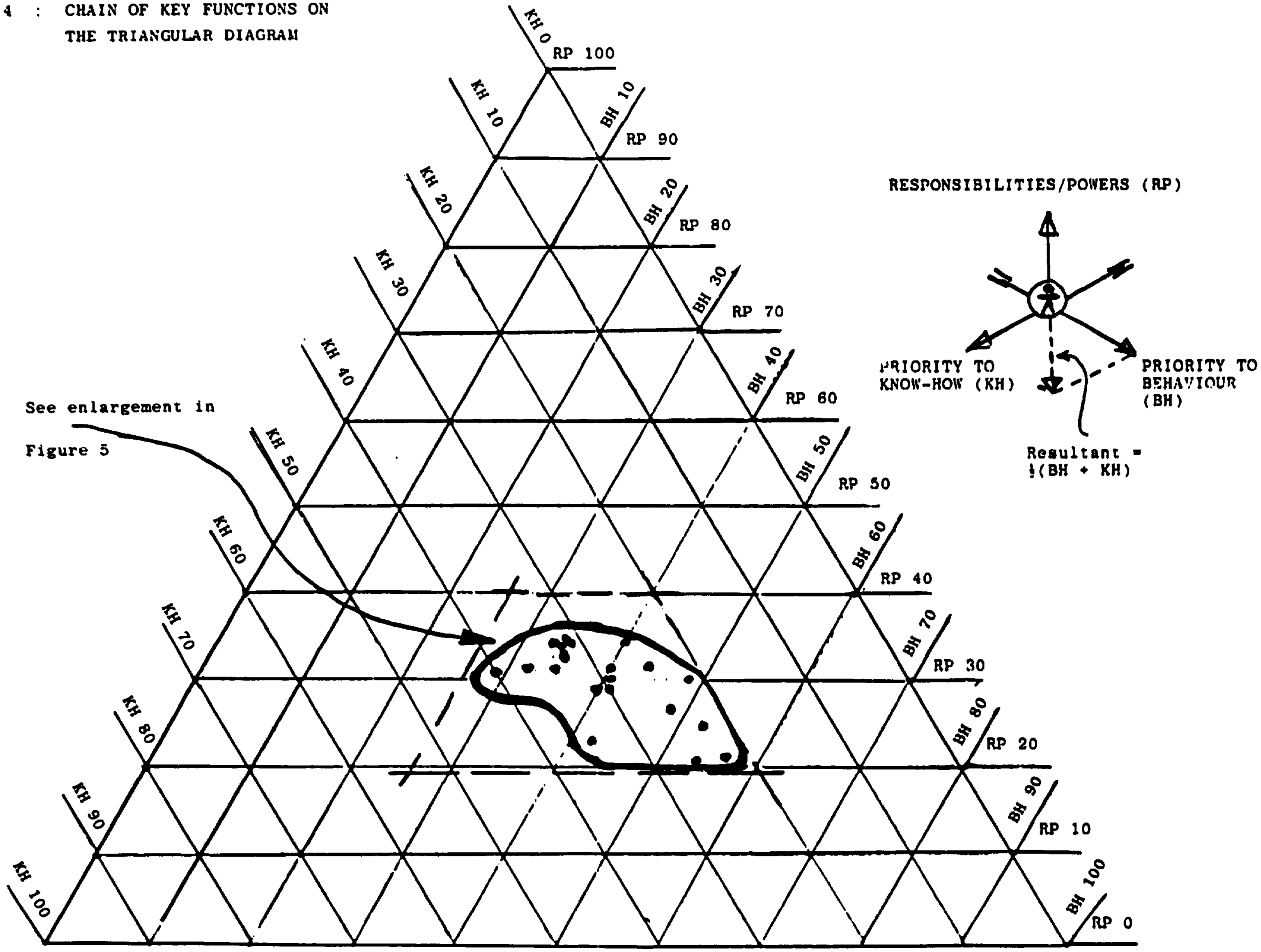


Figure 5 : USEFUL AREA OF THE TRIANGULAR DIAGRAM

The asterisk in zone A marks the theoretical equilibrium point where KH = BH = RP.

The symbol ● on the boundary between zones B and D marks the position of the mean equilibrium of the 20 points.

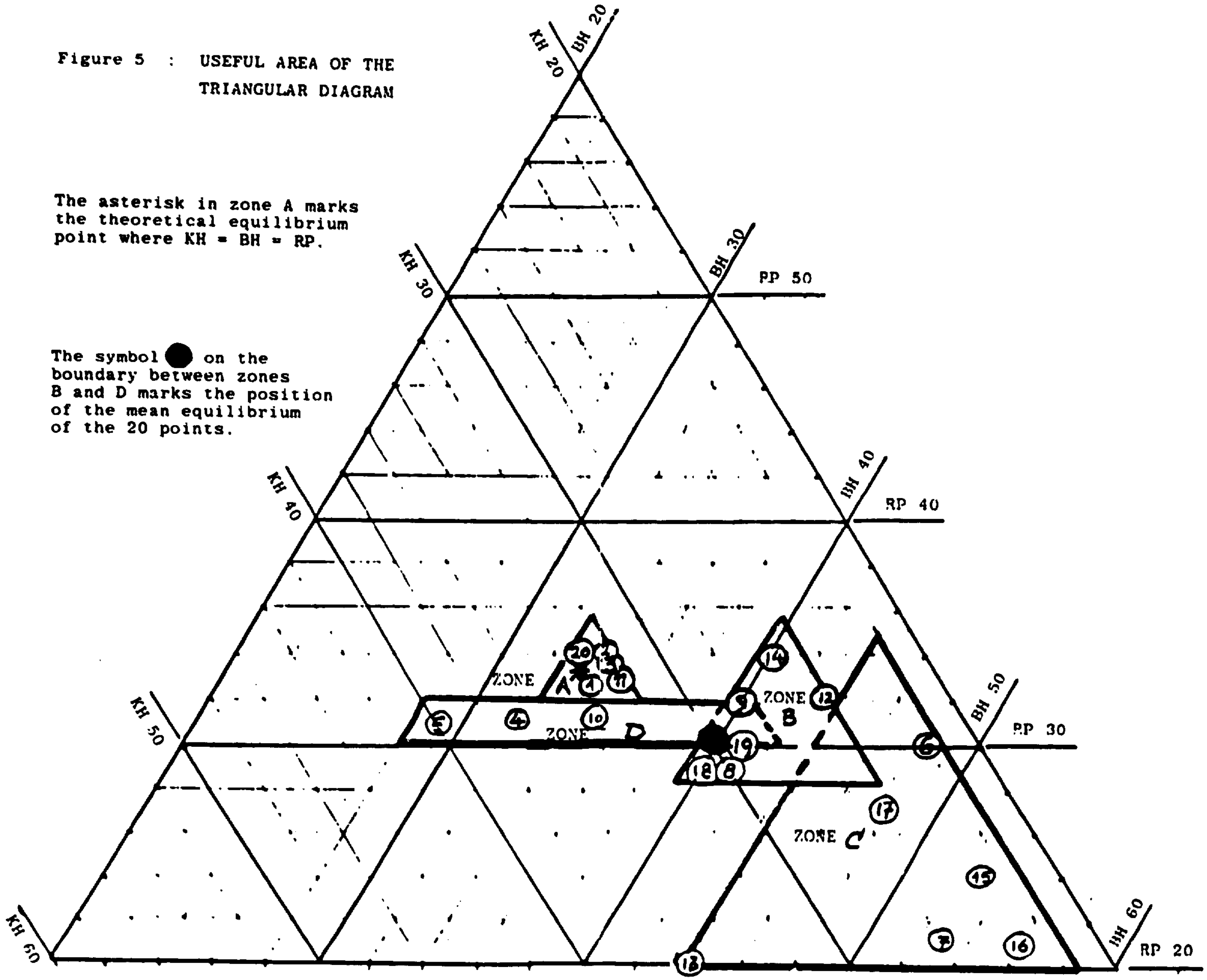
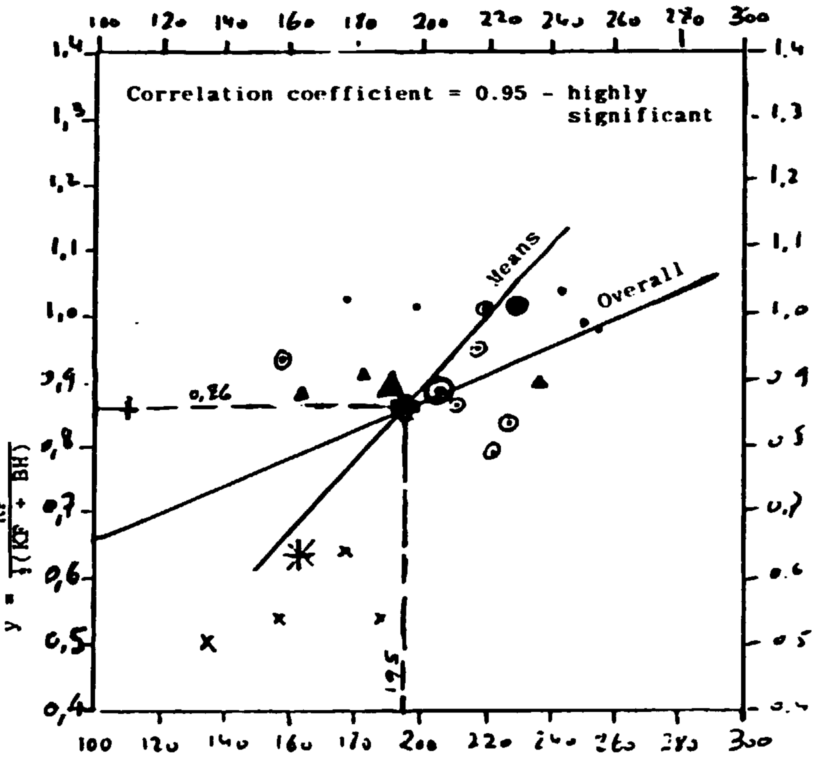


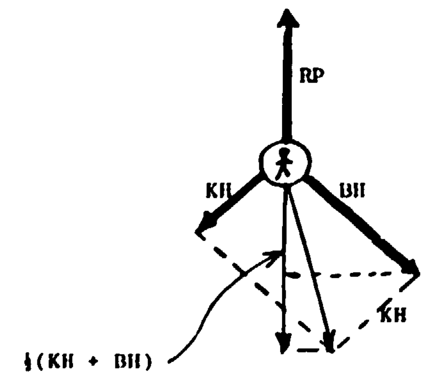
Figure 6

Calculated from the absolute requirement ratings.

	Function code	KH+BH+RP	RP/½(KH+BH)
•	1	254	0,97
•	2	198	1,02
•	3	176	1,03
▲	4	163	0,88
▲	5	182	0,91
+	6	110	0,86
×	7	188	0,54
⊙	8	228	0,83
⊙	9	217	0,95
▲	10	226	0,90
•	11	250	0,99
⊙	12	157	0,93
×	13	135	0,50
⊙	14	159	1,01
×	15	176	0,64
×	16	156	0,54
+	17	209	0,75
⊙	18	222	0,79
⊙	19	210	0,86
•	20	243	1,04
Mean A ●		224	1,01
Mean B ⊙		205	0,89
Mean C + ×		162	0,64
Mean D ▲		190	0,90



- For the four mean points :
  correlation coefficient = 0.95
  Straight line :
  $y = 0.57 \frac{x}{100} - 0.25$

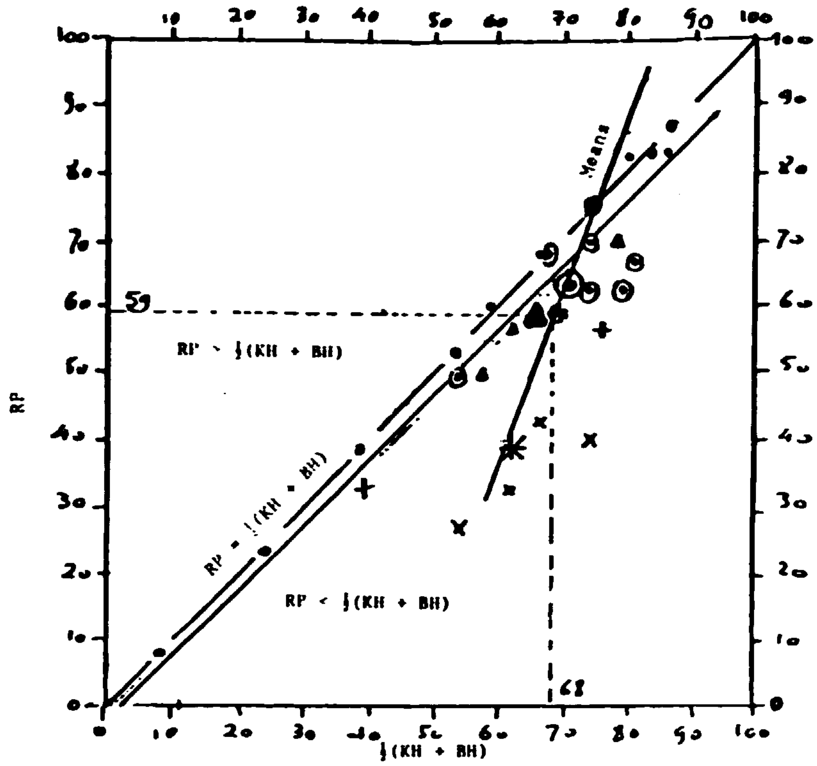


- For all the 20 points :
  correlation coefficient = 0.44
  Straight line :
  $y = 0.2 \frac{x}{100} + 0.46$

Figure 7

Calculated from the absolute requirement ratings

	Function code	½(KH + BH)	RP
•	1	85.5	83
•	2	65.5	67
•	3	58	60
▲	4	56.5	50
▲	5	62.5	57
+	6	33.5	33
×	7	74	40
⊙	8	60.5	67
⊙	9	73.5	70
▲	10	78	70
•	11	83.5	83
⊙	12	53.5	50
×	13	54	27
⊙	14	66	67
×	15	66.5	43
×	16	61.5	33
+	17	76	57
⊙	18	74.5	63
⊙	19	73.5	63
•	20	80	83
Mean A : • (Management)		74.5	75,2
Mean B : ⊙ (Operational foremen)		71	63
Mean C : + × (Operatives)		62	39
Mean D : ▲ (Aid to management)		66	59



1) For the mean points

Correlation coefficient = 0.96 – highly significant

Straight line : RP = 2.6{½(KH + BH)} – 120

2) For all the points excluding X (Trusted personnel with low levels of skill)

Correlation coefficient = 0.87 – significant

Straight line : RP = 0.9{½(KH + BH)} + 1.9

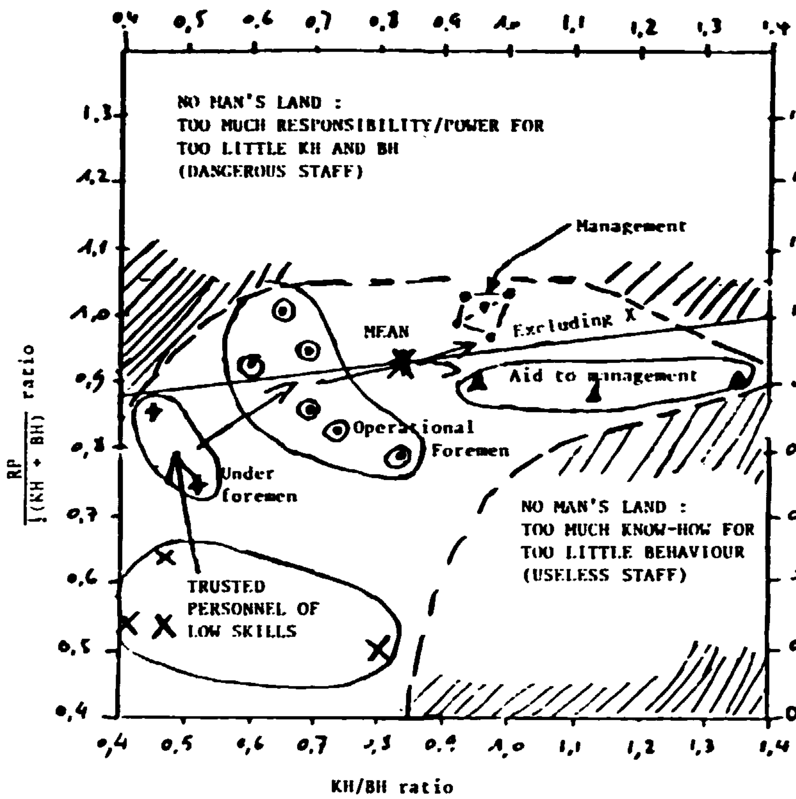
3) For all the individual points

Correlation coefficient = 0.74

Straight line : RP = 1.02{½(KH + BH)} – 11.7

Figure 8

	Function code	KH/BH	$\frac{RP}{\frac{1}{2}(KH+BH)}$
•	1	0,97	0,97
•	2	0,96	1,02
•	3	0,93	1,03
▲	4	1,13	0,88
▲	5	1,35	0,91
+	6	0,45	0,86
×	7	0,48	0,54
⊙	8	0,73	0,83
⊙	9	0,69	0,95
▲	10	0,95	0,90
•	11	0,92	0,99
⊙	12	0,60	0,93
×	13	0,80	0,50
⊙	14	0,65	1,01
×	15	0,43	0,64
×	16	0,41	0,54
+	17	0,52	0,75
⊙	18	0,83	0,79
⊙	19	0,69	0,86
•	20	1,00	1,04



By removing the posts coded X from the population the latter is then characterised by :

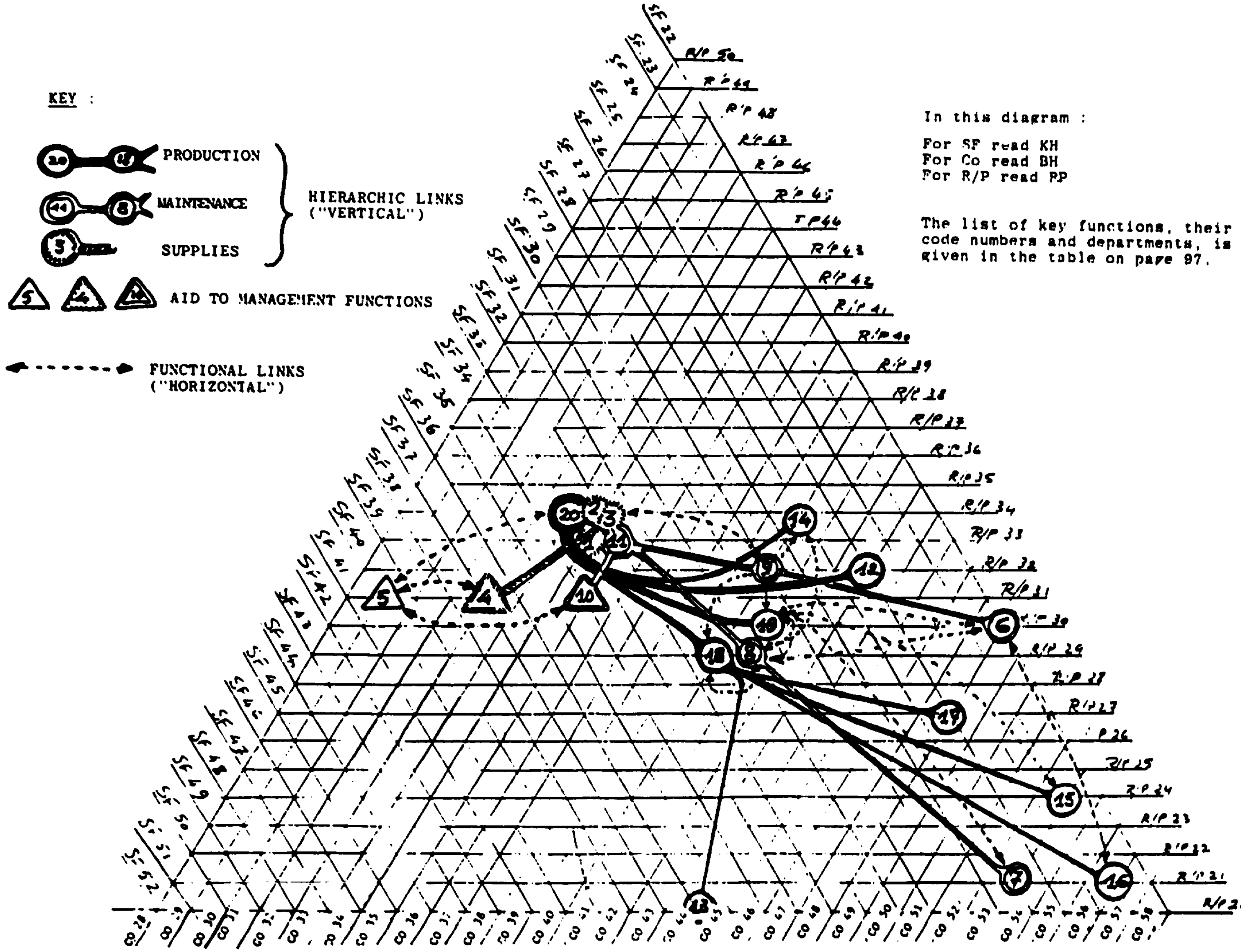
Mean $\frac{KH}{BH}$: 0.835 0.23

Mean RP / ½(KH + BH) : 0.92 0.085

The correlation coefficient of 0.35 is of low significance.

$$\text{Straight line } \frac{RP}{\frac{1}{2}(KH + BH)} = 0.81 + 0.13 \frac{KH}{BH}$$

The categories of key functions identified on the triangular diagram are clearly seen here, together with those zones in which any function becomes either useless or dangerous. The "corridor" in which the chain of responsibilities on a "line of fragility" develops is a narrow one.



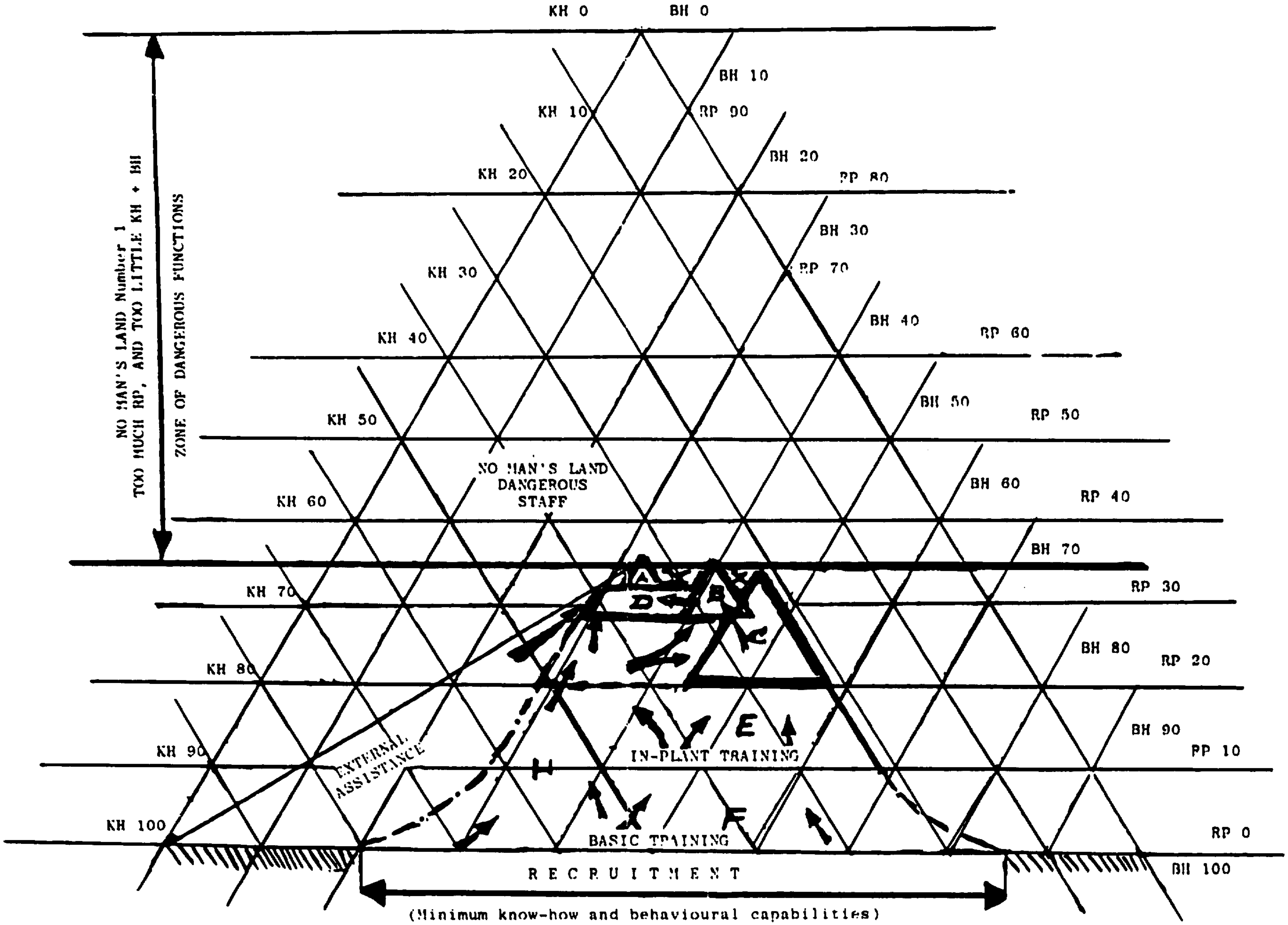
In this diagram :

For SF read KH
For Co read BH
For R/P read PP

The list of key functions, their code numbers and departments, is given in the table on page 97.

Figure 9

Figure 10



KH 0
BH 0
KH 10
BH 10
RP 90
KH 20
BH 20
RP 80
KH 30
BH 30
RP 70
KH 40
BH 40
RP 60
KH 50
BH 50
RP 50
KH 60
BH 60
RP 40
KH 70
BH 70
RP 30
KH 80
BH 80
RP 20
KH 90
BH 90
RP 10
KH 100
RP 0
BH 100
NO MAN'S LAND Number 1
TOO MUCH RP, AND TOO LITTLE KH + BH
ZONE OF DANGEROUS FUNCTIONS
NO MAN'S LAND
DANGEROUS
STAFF
A
B
C
D
E
F
H
X
EXTERNAL ASSISTANCE
IN-PLANT TRAINING
BASIC TRAINING
RECRUITMENT
(Minimum know-how and behavioural capabilities)

Figure 11 : THE CITADEL OF TECHNOLOGICAL MASTERY

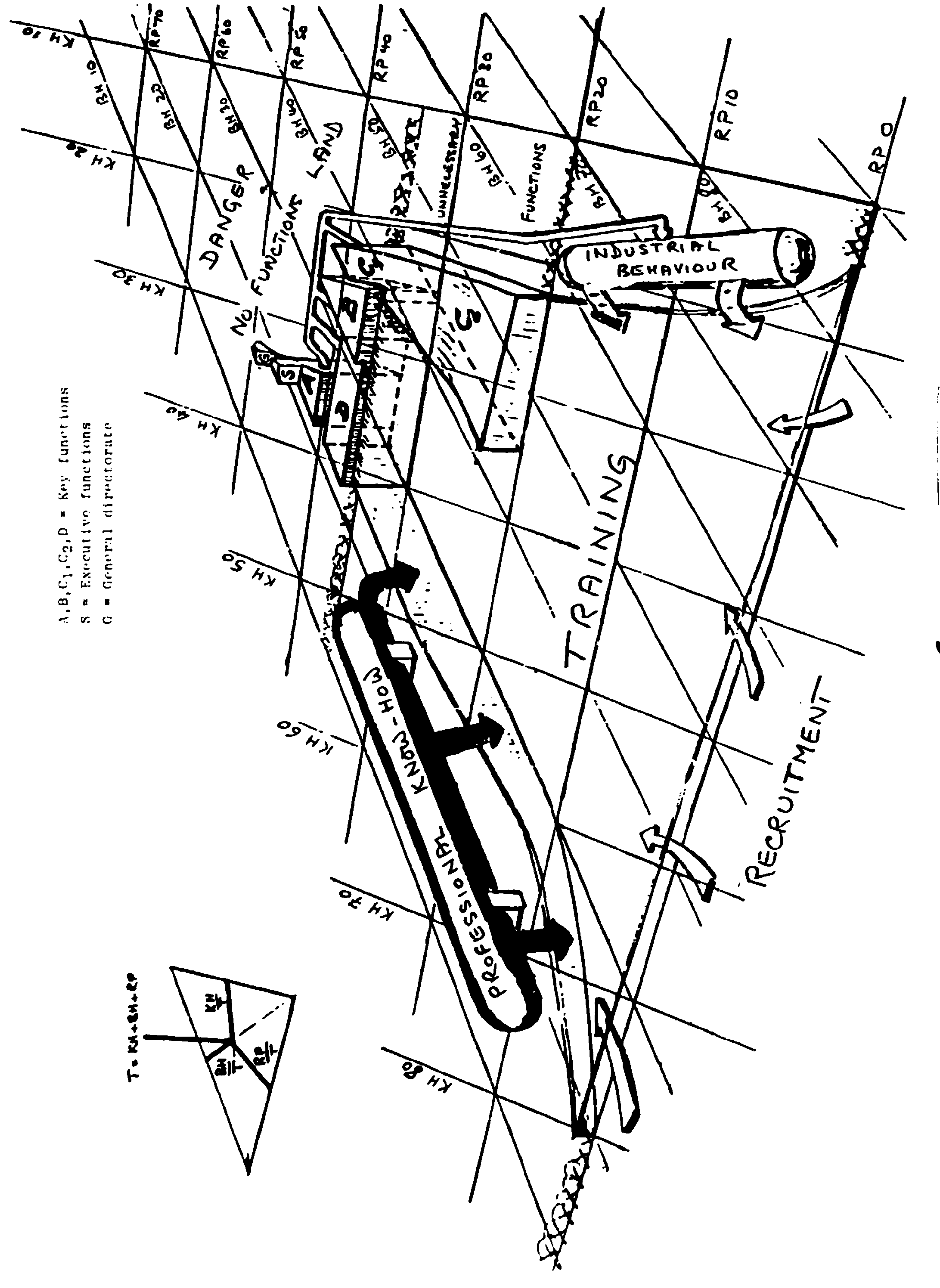
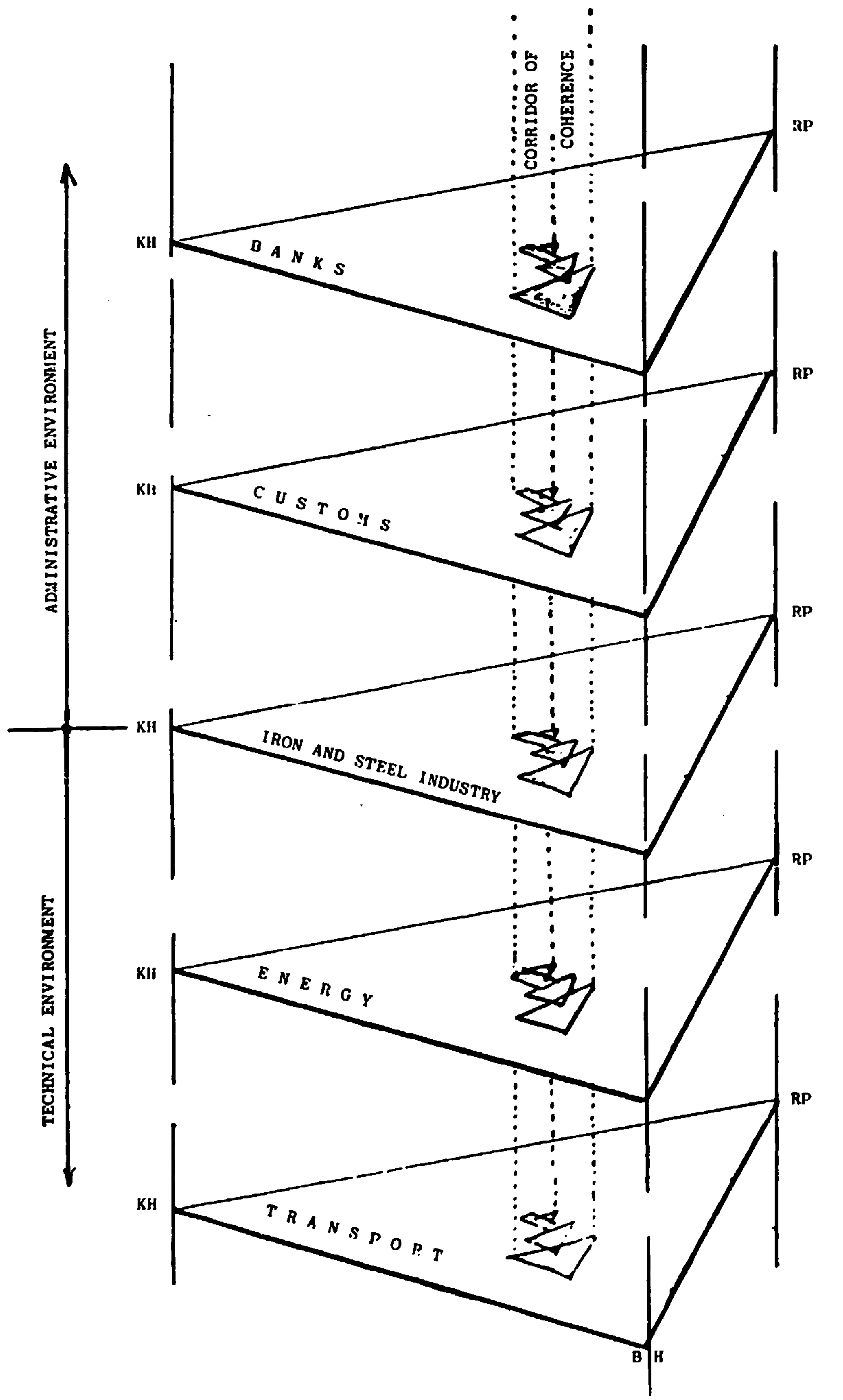


Figure 12 : Inter-relationships between the iron and steel industry and its environment



PART FOUR

THE CONDITIONS AND THE ROUTES FOR ACCESS TO TECHNOLOGICAL MASTERY IN THE IRON AND STEEL INDUSTRY AND IN ITS ENVIRONMENT : GUIDELINES FOR TRAINING

I N T R O D U C T I O N

BETWEEN AMBITIOUS CHOICES AND THE ART OF THE POSSIBLE : the guidelines.

Moving from the model of industrial mastery which was studied under the microscope in the third part to the reality of planning development, which exists in the world of contingencies, there is at least as great a distance as there is between genetic studies in the laboratory and the art of producing and acclimatising a mutant cereal variety.

From the narrow and controlled field in which one observes an aggregate of cells up to the natural field, subject to the random effects of climate and ecology and where the mass effect is considerable, lies an adventurous route where prudence is as necessary as hardiness.

However it is necessary to succeed, and before moving ahead it is necessary to reflect, to acquire the operational ·ules and means if false manoeuvres and their irremediable consequences are to be avoided.

When it involves grafting a first iron and steel activity on a developing or even mutating socio-cultural environment and economy it is possible to find many reasons favouring the choice of an ambitious plant and a commissioning schedule which is as short as possible. But it is adventurous to neglect the elementary laws which condition access to industrial mastery, and which are the laws of maturing.

From what level of maturation is it possible to launch production according to a schedule which gives good assurance of success, and how is one to achieve rapid and effective maturation ?

The hardware project (the installations) and the software project (the work team) need to mature at the same rate: do they, and how does the one depend on the other ? Are some scenarios better than others ? What are their principles and their r· What are the risks involved in disobeying certain laws of maturi what accompanying measures are needed in the environment ... kle the complete maturing of the hardware + software gra ... l steel industry ?

These are the essential q... re posed.

The operating rules of the ... industrial mastery, established in the third part of this study, will help us to formulate the answers. They have, primarily, the form "a study of the risks if ...". These provide the boundary marks indicating danger. It will ... only at the conclusion of this fourth part that we will dare to formulate the rules - or rather the guidelines for selecting the best possible route.

CHAPTER I

A FRESH LOOK AT TRAINING : THE CONTENT, THE STAGES AND DURATIONS, THE INTERDEPENDENCIES AND TECHNOLOGICAL COMPLEXITY

1. TRAINING : FROM RECRUITMENT TO THE "CITADEL" OF TECHNOLOGICAL MASTERY

1.1. The principal stages of training on the triangular diagram

1.1.1. On the triangular diagram shown in Figure 10 (Chapter III of the third part) we identified a zone in the shape of a funnel which linked the base of the "citadel of technological mastery" at the bottom of the diagram to the "line of recruitment" defined by the characteristic that RP = 0.

This space, which is shown in three dimensions on the triangul... diagram of Figure 11 (also in the third part), can now be arranged in stages, as is shown in the appended Figure 1.

1.1.2. This zone of the acquisition of competences and of apprenticeship organised towards responsibilities and powers also has the form of a funnel :

- the base for recruitment is largely open along the line RP = 0, but does not extend along its full length, since recruitment to the plant itself is not open to those with absolutely no know-how or to those completely devoid of behavioural values.
- it is connected in plan and in level to the limited volumes occupied by the citadel of technological mastery, zones which may be nearer or further from the recruitment base.

This means that the objective of recruitment and training is :

a) - to impart more know-how to those recruits who have a little (this is obvious) but also to impart more industrial behaviour to those who, already possessed of a store of know-how, and proud of their capabilities, are tempted to believe that the ascent to the higher levels of responsibility/powers depends exclusively on this know-how.

b) - to narrow the original disparities so as to form a homogeneous and coherent team in the service of an end-purpose (balancing of KH, BH and RP).

c) - to give to each individual the levels of T = KH + BH + RP which correspond to the requirements of the organised functions and to his capacity to advance forwards.

1.1.3. Once understood and accepted this representation of training prevents any simplification of the problem: it is not the transfer of individual know-how which counts; a collection of specialised persons does not as yet form a society, and the distance and the obstacles between recruitment and technological mastery are more impressive than might have been thought. What is this distance, and what are the obstacles ?

1.1.4. Before looking at the distance let us examine the major stages and the biggest obstacles.

On this same Figure 1 the space reserved for training has been divided into compartments :

- in terms of levels towards taking up functions
  - . basic training } for all the recruits.
  - . specialised training }
  - . "in-plant" training }
  - . for the highest levels of responsibilities/powers a stage of acquiring operational experience.
- in terms of routes, either towards operational functions or towards management functions.

Between these two routes there are possibilities for switching from one to the other, but these opportunities are limited to the first stages of training: after this the programmes for the two routes differ too much for this to be envisaged.

There are, naturally, screens: examinations, gradings by those in charge of training or by the superiors on the job, checking of the KH, BH and RP levels achieved and which make it possible to pass, or not, on to the next stage of training and to be directed into one or other speciality.

The "training" volume on the diagram may therefore be seen, starting from recruitment, as a series of interdependent basins, as a "breeding ground" where a population is modelled increasingly into the image of the citadel of technological mastery and where it is simultaneously and progressively nourished from three sources :

- know-how
- industrial behaviour
- the exercise of responsibilities and powers.

As one progresses towards technological mastery so the total level, T = KH + BH + RP, rises and the equilibrium between KH, BH and RP is established.

Training conceived in this manner is more than teaching, it is an overall education, not solely of the individual but of the team, the group, the operational department and the company.

1.2. Where are the sources of this additional KH, BH and RP to be found ?

1.2.1. Know-how :

In the case of the first iron and steel industry installed in a country it is clear that the know-how must be supplied from outside, even if some basic know-how exists locally. For example a given country could be able to train excellent mechanics by its own efforts, but the mechanical engineering involved in the iron and steel industry deals with parts of dimensions so far outside the normal limits, coupled with tolerances as close as those involved in watchmaking, so a new apprenticeship is necessary.

Similarly there may be good masons available locally, but the laying of refractory bricks in the furnaces or steel ladles is a very different matter.

However necessary it may be to give a good basic training locally to all recruits, irrespective of the levels involved, the essential know-how of the iron and steel industry demands support from outside.

This is shown, in Figure 1, by the reservoir on the left, marked "Professional Know-how" which can pour out its teaching resources at all the levels of training.

1.2.2. Industrial behaviour :

We have already seen that it is the quality and the distribution of BH throughout all the key functions which will ensure coherence.

We have also seen that it is largely a function of the socio-cultural heritage and of the distribution of the resultant RP, even if it is largely conditioned by the specific nature of the working tools.

It is therefore by self-training that this component will be largely imparted: it cannot be supplied by persons other than the local and definitive hierarchy of the plant.

This is why Figure 1 shows a reservoir of "Industrial behaviour" on the right, at the higher values of BH, solely supplied from the local citadel of technological mastery which has developed it from the full assimilation of know-how learnt from others: it is this reservoir which provides the resources for all levels of basic and in-plant training.

It may be understood, therefore, that the route by which a team climbs up to the technological citadel is not a simple one. The entire team does not make the ascent as a single unit; it is necessary to send out a preliminary group to carry out reconnaissance and to assimilate the knowledge gained, and this group will then give confidence and moral support to the rest of the party. The route involves a process of iteration, a succession of successful feed-backs.

2. THE TIME NEEDED FOR MATURING : More time is needed for a team to mature than is needed for building a plant

2.1. The time needed to achieve technological mastery

It is true that the path is narrow, difficult and long.... Let us try, therefore, to establish a timescale for this path between the process of recruitment and of entering the citadel of mastery.

Let us assume, for the purposes of our first approach to the problem, that the material facilities for training exist (operational buildings for recruitment and testing, with work-places and workshops), that the first staff have been appointed and that procedures have made it possible to draw up the job profile sheets and hence the recruitment sheets, and also that the basic training programmes have been developed and that suitable teachers and training staff have been found (amongst these there must be an adequate number of representatives of the future operational supervisors who have either been trained if the plant is still in the project stage or who are already working if the plant is actually in operation).

With everything in place how long will it take to start from the situation of recruitment and to arrive at the full exercise of technological mastery ? The table on the following page, which reflects the requirements in an industrialised country, gives the blunt answer: too long, and even longer than the table shows if one adds the additional and major constraint that it is those with the already high absolute standards who participate in the training of those of lower levels of KH, BH and RP, as is always the case in an industrialised environment.

As it stands the reply is a discouraging one: is it necessary to act so far in advance if a team for technological mastery is to be trained ?

The partly consoling answer is that it is possible to start up an iron and steel operation with a team which is still far from technological mastery but one which has a high probability of achieving it one day, but always provided that certain conditions are met. The figure on page 164 helps in identifying these conditions.

2.2. The conditions for arriving at technological mastery

2.2.1. The figure on page 164 is, first of all, an illustration of the table: along the x-axis is the time-scale, along the y-axis the absolute standard required (T) for each type of function, A, B, C and D. This gives the curve on the left.

The curve on the right shows, on these hypotheses, the theoretical commencement of ideal self-training; this is necessary if mastery is to be achieved, in particular by the adaptation of the BH and RP values to the local socio-cultural and economic context.

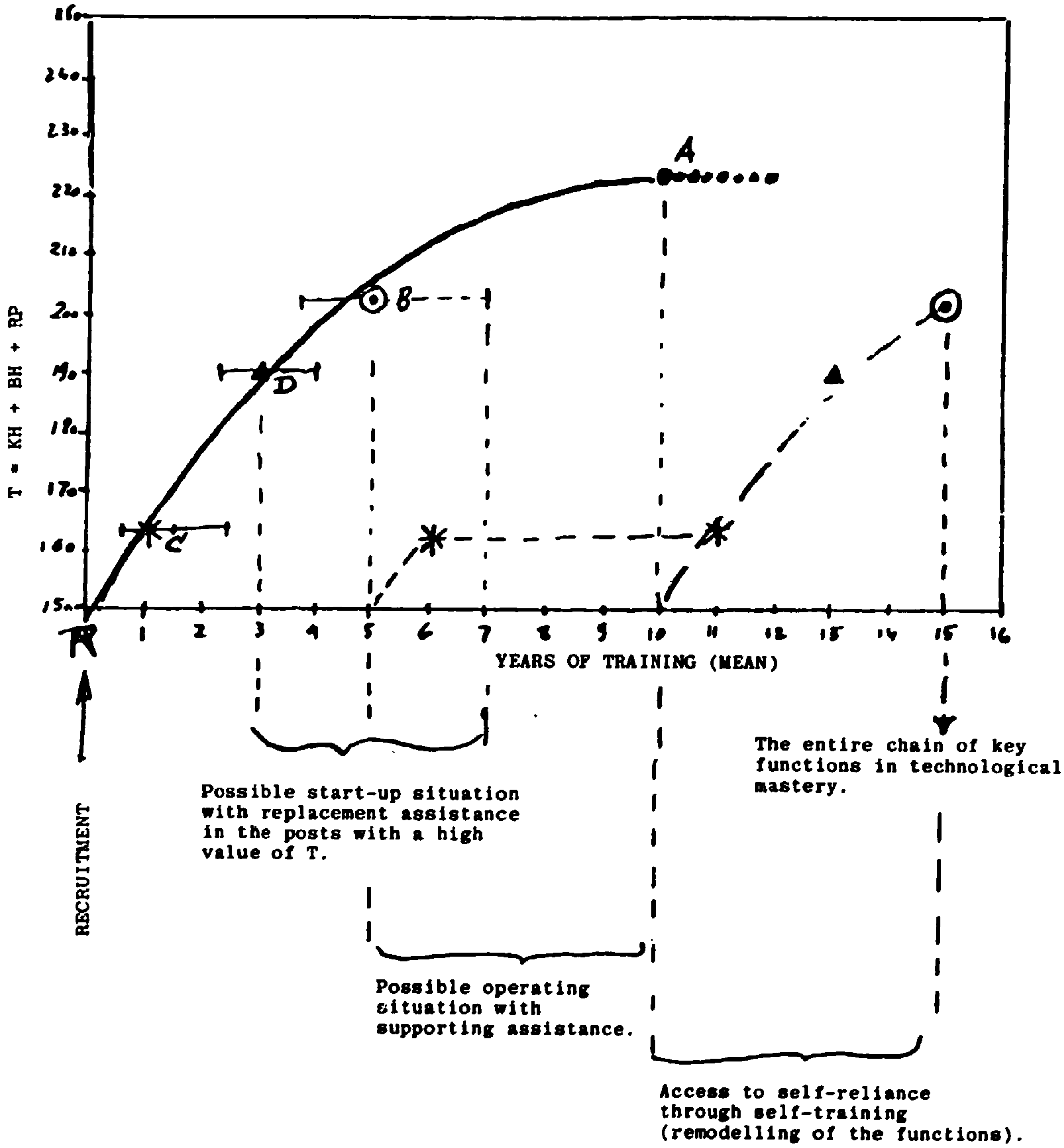
We will now examine these conditions in greater detail whilst continuing to retain the optimistic hypotheses set out at the beginning of paragraph 2.1. above.

DURATION OF TRAINING IN MONTHS IN ORDER TO FILL A KEY FUNCTION

Key functions / Stages	C_1 min.	C_1 max.	C_2 min.	C_2 max.	D min.	D max.	B min.	B max.	A min.	A max.
Selection at recruitment	1	2	1	2	2	3	2	3		
Basic training	3	6	3	6	6	9	6	9		
In-plant training	3	9	6	12	6	12	12	24		
Operational experience			12 (in a C_1 function)	24 (in a C_1 function)	12	24	24	48		
T O T A L	7	17	22	44	28	48	44	84	Access through B and D	
B then D or D then B					24	36	+ 24	36		
T O T A L min.					52		68		120	
T O T A L max.						84		120		204

Summarising : C_1 mean 1 year
C_2 mean 2½ years
D mean 3 years
B mean 5 years
A mean 10 to 12 years.

THE ROUTE TO TECHNOLOGICAL MASTERY AND SELF-RELIANCE



2.2.2. The transfer of know-how

By definition this is a pure teaching operation intended to give to each person, and according to their ultimate function, the theoretical knowledge, the practical experience and the mental and behavioural reflexes which are needed in carrying out his individual task.

This transfer of know-how is most generally entrusted to foreign bodies, linked or not with the contracts for supplying the equipment.

As in all teaching the teacher needs to implement a suitable form of pedagogy. Such teaching is addressed primarily to the intelligence, to the memory, to physical coordination and to the reasoned control of personal action.

However, since the teacher utilises the pedagogy and the progressive methods inherited from his own cultural background the transfer of know-how can never be effected without some modification of the behavioural patterns of the pupil: if the latter is adaptable there will be a transfer of industrial behaviour at the same time as the transfer of know-how. If the subject is not adaptable there will be a slowing-down of the transfer of know-how, or even a crisis of rejection. Statelessness is not solely geographical.

It will be understood, therefore, that where the identical know-how training programme is concerned, the choice of the socio-cultural environment within which it is to be carried out is not without its influence on the efficacy of the transfer of know-how, nor on the modelling of behaviour.

What is one to think, therefore, of certain pseudo-teams in the so-called "patchwork" plants, where the members have been trained either as individuals or as small groups in a wide variety of places, determined by the allocation of units of the plant to suppliers on the basis simply of the operation of international competition ?

It can be said that all programmes for the transfer of know-how are good - at least for the nationals of the industrial environment which gave rise to the programme and which has proved its efficacy. But are these programmes equally effective when applied to other persons ?

It is necessary to think, therefore, in terms of a certain "yield" from this transfer of know-how; this yield is always lower than that found in an industrialised environment.

2.2.3. Education in industrial behaviour and in balancing responsibilities and powers.

Here, unlike the position with the transfer of know-how, one is less concerned with pure intelligence, with memory or the control of actions, but much more with imagination, sensitivity and the art of living in a community developed by tradition on a given soil and in a given environment.

Certainly intelligence and reason are not absent: it is a matter of understanding the system of new relationships which are implemented and of appreciating the essential traits dictated firstly by the end-purpose and secondly by the rigidities of the operational process. Obviously the acquisition of know-how assists this understanding; one cannot exist without the other and vice versa, but with the equipment and the lines imposed by the operational process it is necessary to become the architect of a system in which one feels culturally at ease whilst still remaining efficient.

Everyone needs to contribute to the building of this edifice; failing this there is the risk that it will become a foreign and disruptive body.

It is necessary to understand that the ambiance of an efficient iron and steel plant is something special; it can be seen that, in the industrialised countries where the iron and steel industry was born, to work in mining or in steel (fields which have been traditionally linked) is seen as a worthy occupation: there is a pride in working in these industries, and this shared pride develops into a community of interest which stretches beyond national frontiers; all steel workers throughout the world share a kind of impersonal passion.

Within the plant the "chiefs" are much nearer to the operatives than in other industries.

This ambiance probably finds its origin in the acute consciousness, at all levels, of exercising a dangerous vocation; it is continually necessary to dominate the considerable forces which are called into play and which can often be adverse. It is therefore necessary to depend more on each other than in other industries, to form a part of an elite body, welded together and where no-one has the right to make a mistake.

Everything depends, therefore, on mutual confidence, born from being able to rely on the complementarity of know-how and behaviour in the service of a rigorous system of responsibilities and powers adapted to local mentalities.

If this ambiance is not created, and maintained by ongoing progress, technological mastery will never be attained.

There must be no mistake about this: it is here that the iron and steel project will succeed or founder, it is here that every planning body comes up against one problem which largely escapes from its means of analysis because it contains a highly irrational component. To deal correctly with it calls for a high level of desire to succeed in the cultural mutation "from inside".

Once this is understood it will also be understood that :

a) - Responsibility for this part of the training cannot be sub-contracted, although some partial sub-contracting may be envisaged.

b) - The maturation of the team should be entrusted to an indigenous, and preferably already mature, core team.

c) - The project to form a team must certainly come before the installation project.

d) - The "levelling-up" of the teams to the environment forms a part of the iron and steel project.

2.2.4. The interlinking of training activities

The time needed to achieve access to technological mastery has to be measured in terms of years; the number of these will depend :

- on the quality and quantity of the human resources which are identified and selected;
- on drawing-up a lucid programme for overall KH + BH + RP training upstream of the programme for material investment, and with interlinked stages;
- on the manner in which these interlinkages are carried out and controlled;
- on the choice of sub-contractors in the matter of training and of the capacity to master them;
- on the degree of maturity achieved by the start-up team of the plant at the time when the erection of the plant is started (the moment when the team and the plant meet);
- on the degree of maturity of the teams and the environment infrastructures at the moment when the iron and steel plant starts operating;
- on the technological and administrative complexity of the installations to be operated (see the second part of this study).

In the search for technological mastery - which, we would repeat, is a matter of maturation - it is necessary to consider time and, as a consequence of this, to schedule the time.

Time is most effectively dominated when it is seen in advance as an ally; it is difficult to form an alliance with time in the middle of a fight against time, that is to say when the contracts for the material investments are already in force, with all their financial corollaries.

It will be later, in Chapter III, that we will describe the norms for the interlinkages which are specific if the normal ascent towards technological mastery is to be achieved.

For the moment we will examine an important factor, namely the technological complexity of the plant which is to be operated.

2.2.5. The influence of technological complexity on training

We will be looking back to the second part of this study which surveyed the various routes for producing steel and the various types of iron and steel plants or enterprises according to the routes, the manufacturing programmes and the matching of the plant to a national or very localised market.

An initial series of comments must be made :

a) - as the plant become larger so the number of employees rises and there are more people to be trained;

b) - as the plant approximates to the "integrated" type so its management becomes more complex whilst the number of key functions at the interfaces, with higher standards of requirements, also increases;

c) - the more the plant operates on a continuous flow-sheet the more rigorous becomes the management and the higher the requirement standards for all the functions;

d) - diversification of the production programme (increasing the complexity of the product mix) amplifies the complexity of management and so operates in the same direction as parameters a), b) and c) above.

Summarising :

Every factor of complexity in the hardware (size, flow-sheet, diversity of production) results in an increase in the complexity of the software (in quantity, quality or "cabling") and, as a further consequence, in the "software plant" which is training, and also in the longer duration of the apprenticeship in technological mastery.

Furthermore every factor for complexity in the hardware (plant and environment) is reflected, at the financial level, by increasing charges not due solely to the investment costs but also to the longer running-in period for the installations due to more serious incidents during the commissioning period.

Without being able to establish it rationally one obviously feels - and this is confirmed by experience - that the factors for complexity in the hardware and the factors for complexity in the software are not so much additive but in fact are multiplicative when obtaining the factor of overall complexity when seeking technological mastery: the risk of failing to achieve this increases according to the same laws and, with it, the financial risks.

2.2.6. By way of conclusion to this new look at training we may retain the following principles where the conditions for achieving technological mastery are concerned :

- Principle 1 : The team-forming project must not be reduced to a transfer of know-how; this forms only a relatively minor part of it.

- Principle 2 : Responsibility for the programme for training the team must not be sub-contracted, and any sub-contracting which is necessary must be mastered.

- Principle 3 : The team, formed under the best of conditions, needs much more time to mature than is needed to decide on the installation and to build it.

- Principle 4 : The complexity of the installation increases the complexity and the duration of the programme for training the team.

- Principle 5 : The marriage between the team and its plant will only be a success if the state of maturity of both has been conceived as an overall project, where all the risks have been mastered.

The above principles also contradict the usual practice of "calling on technical aid" when it is already too late and when, even using these supplementary and costly rockets, any chance of getting into orbit may have disappeared for ever.

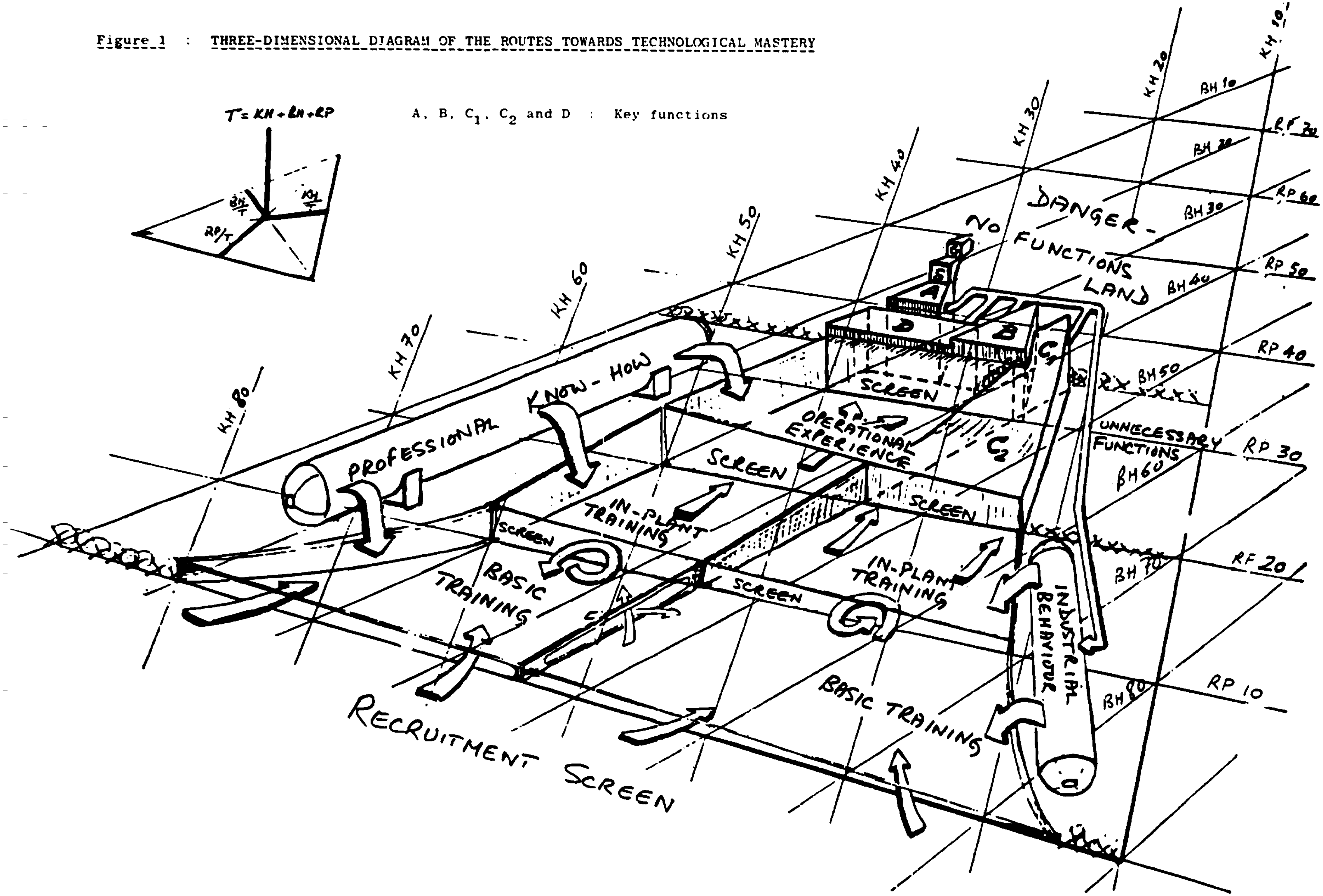
Let us be clearly understood: it may be necessary but it is not sufficient to entrust the training tasks to the suppliers of the installation; it is necessary but it is not sufficient to lump together all kinds of assistance made outside the contracts for supplies.

Such sub-contracting is at the service of a much vaster programme to which it may lead, a programme which must be drawn up, carried out and controlled by a small indigenous and multidisciplinary team, able to form a bridge between the reality of the human resources and the content of the technological mastery in and around the iron and steel industry.

It is this small core of mutants which must be created: it forms the embryo of "self-reliance".

Figure 1 : THREE-DIMENSIONAL DIAGRAM OF THE ROUTES TOWARDS TECHNOLOGICAL MASTERY

A, B, C_1, C_2 and D : Key functions



CHAPTER II

THE TRAINERS

1. THE UNIVERSE OF TRAINERS

1.1. The industrial advance of the developing countries, and the technological mutations in the industrialised countries, have encouraged the growth of vocations in the training field, together with that of methods for the so-called accelerated training.

Another aspect of training is assistance, generally termed technical assistance, which is concerned with accompanying, advising and possibly consolidating a young team during the first years of operation; its intervention may be requested during the first stages of designing the project.

A large number of companies have been formed and are prospering on the training or assistance markets. There are also a large number of individuals who offer their services for integration into young teams where they occupy a position which is not so far filled by an indigenous person who is still undergoing training.

Finally there have been created in most developing countries Training Centres as essential complements to the national educational establishments. These training centres are either orientated towards the specialisations necessary for a particular industry or are intended to impart basic know-how, which can be used in any industrial activity, to comparatively unskilled labour. These centres also train indigenous trainers, and this is surely one of their most "profitable" long-term aspects for a country.

1.2. This picture of the universe of trainers, drawn in broad strokes, provides a list of the means which can be used in an overall programme of recruitment and training; this is sub-contracting. But we have already seen that such training, good as it may be, but imparted by these means, is not sufficient to lead to technological mastery and, ultimately, to self-reliance.

In other terms such training may train the members of a team, but does not necessarily train a team.

1.3. We have also established the fact that, for a programme for training a team with a view to technological mastery, it is necessary that the drawing up and the supervision of this programme should be indigenous.

Drawing up and supervising the programme obviously assumes a high level of competence, a high level of motivation and a high level of awareness of responsibilities.

Before examining the forms and limits of sub-contracting we will define the managers of the programme.

2. THE MANAGERS OF THE PROGRAMME

2.1. We have deliberately used the plural here. Even if we are limited here to a single programme for the training of a team for an iron and steel plant, and away from its environment, no one person can claim to know all the particular features of the technical and administrative functions of an iron and steel plant.

This is even more true if one includes in the programme, as is highly desirable, the "upgrading" of teams in the environment so that the newly created industry finds, at the time of commissioning, peripheral links which are of comparable performance. What is required, therefore, is a supervisory team with a person in charge.

The size of this multi-disciplinary core will depend on the size and complexity of the plant.

What concerns us here is to list the functions which must be carried out in it, to define the profiles and the backgrounds of the corresponding managers and to sketch out the conditions for their own prior training.

2.2. The functions of the Training programme management team

2.2.1. The recruitment and selection function : This is already the level at which, for good or ill, the marathon towards technological mastery starts off. To return to our image of the triangular diagram: this is the base, as wide as possible, of the training funnel; it is also the first screen and the first switching point.

To achieve what is needed :

a) The recruitment/selection function must supply to the Training unit, in the order and categories as required by the interlinking and durations of the programme, raw material of the quality or potential quality compatible with the various categories of functions in the programme.

This is to say that the recruitment/selection function cannot be validly exercised unless one already has, within a serious organisation framework, descriptions of the functions and profiles which are required, of the type of the sheets to be found in the annex to the third part of our study.

NOTE :- We have established that the team will start to be recruited before the investment project has materialised in the form of contracts for supplies and work: the project management team will have needed, even before this point, to have constructed its organisational plan for the plant with the essential procedures, the key function sheets, the logical sequences and the durations of the Training programme.

- Recruitment and selection require, if they are to be effectively carried out, time after a serious study has been made of the human resources.

- The scheduling of these tasks will be set out later in Chapter III.

b) The recruitment/selection function must have adequate installations, methods and equipment in order to select the recruits, to establish for each of them their KH and BH profiles, to compare these with the required profiles, to evaluate any divergencies, to propose those training "menus" which can be envisaged (in terms of stages, durations and costs), to propose engagement (or rejection) to the programme Directorate and to carry out the decision.

If a considerable part of the test equipment and methods can be the subject of sub-contracting the same does not apply to the final judgment, inasfar as this involves an in-depth knowledge of the socio-cultural environment (for this it is essential to be a member of the environment) and also experience of the realities of development in the country (for this it is also necessary to live "inside").

For these reasons the manager of the recruitment/selection unit must be a national of the country. Is it also necessary to add that he has participated in drawing up of the organisation programme and that he has measured the requirements of the latter ?

As far as the candidates are concerned he must be an attractive model of the KH/BH/RP equilibrium to be achieved. He must be a future executive in the upper hierarchy of the plant: he is closely concerned with the challenge of technological mastery.

NOTE :- To collect together the various conditions of installations + methods + equipment is a project in itself and one which is not to be taken lightly; it requires both time and resources. We will be integrating this into the scheduling of activities in Chapter III.

- To find the recruitment/selection manager is not a matter of immediate concern ...

2.2.2. The Training programme supervisory function

This involves managing the programme and having it carried out, from the time of engaging the recruits up to the time of forming a total team which has given sufficient proof of its operational value so that one may be assured that it will achieve technological mastery through self-training (this is the mark of self-reliance).

The stages of the training of individuals and groups (basic training, in-plant training, periods of operational experience) all involve the parall[illegible] :quisition of know-how and industrial behaviour within the propos[illegible] ystem of the distribution of responsibilities and powers.

The supervision of the programme will have to take particular care that the training sub-contracts are coherent with this philosophy, and this will oblige him to take, for his part, all those measures which will guarantee its application.

For example : A continuous casting team should, after its basic training, carry out a training session in a foreign plant similar to the one which is envisaged. The team must not arrive for its training stage either before or at the same time as its future shift foreman: he must have had sufficient time for learning on the job and also to become integrated into the environment of foreign foremen and to effect the marriage, at his own level, between the exigences of his job and his own culture. He will thus be able to impart both know-how and industrial behaviour on his own team, will become their joint teacher with the foreign staff, will model their behavioural patterns and, by acting as their big brother, will be able to give them confidence.
For its part the foreign plant, the training sub-contractor, will need to adapt its usual methods in negotiation with their acting foreman. Nothing of this can be built up if everyone arrives at the same time, far from their own country, unknown and disorganised.

In order to achieve the best quality of training it follows that the supervisors of the programme must have already achieved, within themselves, this marriage between the exigences of working in the iron and steel industry and the socio-cultural background of the recruits who are undergoing the training.

This presupposes the following two essential conditions :

- The supervision of the "team training" programme is indigenous,

- There is sufficient flexibility in the planning and in the budget so that it is never necessary to sacrifice the essential factor, which is quality.

To these are added the following derived conditions :

- The supervision of this programme is carried out by a team, the core of the future directing team of the plant, where the functions of the Production, Sales, Administration and Financial and Social Affairs Directorates are represented and already operational for constructing the software of the plant and for modelling in all these sectors (and not solely in the technical sector!) a highly efficient team serving a system of coherent relationships.

- This directing team will be constantly improving its own training by means of a form of kriegspiel constantly played-out on a model of the plant at the time of its design, in the definition or basic engineering phase and in its development or project engineering stage. In this way it will provide the supervisory team for the plant with valuable thoughts, or even exigences, from the time when this team is already "living" in the plant which it will subsequently have to direct.

- This directing team must not enclose itself in a kriegspiel which is limited solely to the iron and steel plant but must also anticipate those relationships which the plant will have to establish with its environment: by doing this it will prepare for and continuously consolidate the extensions of its own lines of fragility into the environment, so helping the latter to become conscious of the new exigences to which the overall system of inter-relationships will have to conform. In this way it becomes the motive force and the model for the training programmes to be implemented and, in particular, for adapting the teaching systems to the exigences of technological mastery.

3. THE SUPPLIERS OF RECRUITMENT

3.1. These are all the public or private bodies which provide, on the labour market, a population which is more or less "trainable" for the needs of industrial development and, in particular, for the iron and steel industry.

It is clear that, in our proposals which are always directed towards the acquisition of technological mastery, the values of know-how are closely linked with the values of behaviour when it is a matter of training, irrespective of the degree of this.

Teaching must always go hand-in-hand with education in behaviour.

3.2. In a developing country the problem is one of passing rapidly from an economy of the agrarian type, and hence a village society, to an economy of the industrial type, and hence an urban society, without destroying the social fabric, without any irremediable loss of the cohesion on which the unity and equilibrium of a nation is based.

The term nation is generally an anticipation, since a number of developing countries have become states before becoming a nation, and have had to suffer from ethnic and cultural disparities which create tensions which are highly prejudicial to the development of a homogeneous pattern of behaviour of the industrial type.

It is the national educational system which has priority in the difficult task of bonding these disparities together, to ensure a favourable development of mentalities and behaviours in such a way as to enrich knowledge whilst at the same time not losing cultural riches in all their plurality.

3.3. If one wishes to have the best chances of achieving technological mastery it is first of all necessary to be persuaded that factories are generally the most inappropriate and the most costly centres for basic training for industrial life.

The factory is an essential part of the national economy, built to create wealth and not to convert farmers and stock-raisers into industrial teams.

It can - and it must - institute self-training for the improvement of skills, a condition of its progress towards full mastery. By contrast it will commit suicide if the poverty of the human resources (in both quantity and quality) compels it to substitute itself for an ineffective national education system.

3.4. The training of the intermediate classes must be a priority objective of teaching in the developing countries.

Recruitment for an iron and steel plant in these countries always comes up against the absence of this class, from which it is validly possible to train a foreman, team leader, designer or the head of a design group, a stores manager, a principal employee or a buyer, all functions which form the indispensable framework of the management system.

Overtaken by time one is often forced to give the title of Foreman, since it is necessary to have one, to the most "mature" of the workers and, at the same time, to ask those responsible for higher level basic training to turn him more into a foreman than an engineer, which thus completely falsifies the operation of Responsibilities/Powers to the point of destroying the structure of the "citadel of technological mastery" (cf the third part of our study): in this way the plant becomes an anti-training school.

3.5. It is therefore necessary to establish, around and in the proximity of the growing industries, "citadels of educational mastery", independent of the industries but maintaining a dialogue with them, so as to produce a diversified population of the industrial type in all the categories and at such levels of KH and BH as link them with the requirements of the key industrial functions with only the implementation of training limited to specialisation, to the acquisition of operational reliability and of subsequent training directed towards technological mastery.

3.6. How is this educational system to be implemented ?

Here again we must guard against confusing directing lines with recipes: there is certainly no miracle recipe or even laws of development of the type of "if one initiates an action A one will arrive at a result B".

Everything is a matter of contingencies. Everything is subordinate to the quality of the directing political authorities, to the intensity of the truthfulness of their relationships with the population of the country and its future.

To encourage and to raise up future "citizens of the citadel of technological mastery" probably demands much more imagination and realism, daring and patience, than to populate ruinous industrial landscapes with hastily prepared "labour", produced from production moulds bought on the international training market.

What may be said here is that, in every country, the educational system will be better organised and structured when the basic teaching functions have received and understood the message of the industrial recruiters, and when the latter have matured their thoughts more lucidly regarding the conditions of access to technological mastery in a given place and at a given time.

No one can replace the indigenous actors in this evolution: but many can assist them. But they can only assist them, and we will now see how this can be done.

4. Sub-contracting the training programme : the forms and limits of Assistance

4.1. Assistance in training can take many forms: on the satisfactory combination of these means, on the mastery of their implementation in time and space, will depend the success of the programme for training the team.

It will also depend on its lower cost: nothing is more ruinous than delayed assistance, since it is necessarily expatriate and costly.

We will now take a brief look at the various forms of assistance, sketching in the limits of their use.

4.2. Replacement assistance : this term describes all assistance which is designed to fill a gap in a team or in an organisation which should be 100% local by the introduction of a non-indigenous person or group of persons.

Replacement assistance is not without its dangers: it is a solution which is sometimes convenient at a time when one is fighting against the clock, it is always expensive and not necessarily directed towards patient training, and it can lead to a situation where the position is never occupied by an equivalent indigenous person.

It should only be a transitory solution, and it is necessary to ensure that it is just this, irrespective of the excellence of the service provided by the expatriate and his capacity for integration.

It is essential, a fortiori, to ensure that there is no progressive concentration of replacement assistance in the key functions at this or that level, for example at foreman level: the image-objective of the citadel of technological mastery can, in the eyes of the indigenous population, appear to be out of their reach.

Subject to these reservations the utilisation of this form of assistance could be necessary at the very beginning of the launching of a programme, when the supervisory team, still very new and in which certain members have not yet completed their own cycle of training, needs to develop its working methods and where the weight of experience is lacking.

One can also use it, profitably and always in a transitory manner, in the course of the programme, by limiting it to solving this or that clearly defined problem which necessitates a high level of expertise: for example the operational implementation of the methods and equipment for recruitment and selection (but not their design).

4.3. Assistance with training : in the training programme this represents all the means and methods which one has to purchase for the acquisition of kn w-how, means and methods which are arranged around the project for education in behaviour, designed by the programme supervisors.

The use of these means and methods is controlled by the following rule :

With the object of acquiring technological mastery it is necessary to arrange matters in such a way that a constantly increasing part be given to self-training at every hierarchic level and at each stage of the development of the training programme.

Put in other terms at every given level of key function it is always necessary to associate even more actively the higher level (which has already been brought to a sufficient level of maturity) in the action of transferring know-how.

As each person advances towards the end of their training it is increasingly necessary that they should feel the formative influence of their future superior, and also that the latter should feel himself increasingly responsible for the training of his subordinates.

In this way, and not in any other way, it will be possible to weave together even more closely those links which guarantee the cohesion of the team all the way along the pathway which consists of basic training, specialised training, operational experience abroad followed by the regrouping of the specialities on the site of the plant under construction, familiarisation with the equipment and the procedures, the simulation of operations at an increasingly inter-departmental level, the commissioning of the plant, the progress towards normal operation and hence the access to technological mastery.

Various bodies of a variety of types intervene along this pathway :

- Basic and specialised vocational training centres,
- Further training centres,
- Companies selling installations and the corresponding specialised training,
- Iron and steel companies receiving students (one rarely finds an existing plant which is identical to that in the project; it is therefore necessary to divide up the students between several plants. Care needs to be taken, since the organisation in them may be very different one from another),
- Technology transfer companies, possessing pedagogic methods making it possible to "train the trainers",
- Organisation and management consultancy companies (it is necessary to seek advice from them, not the ability to "do it all"),
- Start-up assistance companies, and those helping during the progress towards normal operation,
- Cooperating experts made available by bilateral agreements between States.

It may be said that it is less dangerous to entrust the training of a team to just one of these bodies, designated the General Training Contractor, than to fragment the sub-contracting and to organise it oneself if a valid programme supervision team has not been formed.

<u>In regard to the sub-contracting of training no obligation to produce results can, in fact, be required at a contractual level: the obligation to produce results is that fixed by the supervisor himself, and he cannot transfer this to any other person</u>.

4.4. <u>Supporting assistance</u> : This covers the methods and means made available to a sufficiently operational team, already capable of self-training and so of self-progress, but which still lacks the latest "tricks" needed to achieve full technological mastery.

Such assistance can take place either in the plant itself (or at its head office) or at some distance in its environment. Light-weight but very "advanced" in its specialisation, this assistance may be either transitory or of long duration. Given the level of performance achieved by the team it is reflected more in the form of contracts for cooperation than in the form of contracts for assistance.

This type of service is frequently used in the industrialised countries.

The following is a non-exhaustive list of examples of this :

- Temporary missions of expert consultants to solve quality problems,
- High-level missions to the General Directorate for strategic development studies,
- Contract buying agent for spares from abroad,
- Contracts for research work or surveys,
- Contracts for marketing studies to enlarge the market,
- Participation in International Trade Associations and their activities (congresses, publications, exchanges of experts and experiences, etc.) and in their research programmes*.

5. <u>Self-training : the last and necessary step towards technological mastery</u>

5.1. It is too often forgotten that the so-called industrialised countries are developing countries, at least in regard to their regions. One finds, in the industrialised countries, subsidiary greenfield plants formed by the major iron and steel companies and located in areas of a lower level of industrial development, and which have experienced commissioning and progress to full production without any problems, using experienced personnel seconded from other plants belonging to the company.

These new plants are then increasingly <u>staffed</u> with local personnel, inheritors of a regional culture without any great industrial tradition and, a priori, with little of the industrial behaviour as practised in those regions with a history of an iron and steel tradition, and who have then been trained for this work.

(*) <u>NOTE</u> : In this respect it is interesting to point out how the creation of an Iron and Steel Institute (or similar) has been of benefit in the Latin American and Arab countries.

What do we see ? These new plants have, progressively or by mutation and sometimes with convulsion, changed procedures and behaviour patterns under the impulse of a new population which has invaded all the key functions, at all levels, ten years after start-up. And all this has taken place without losing technological mastery but rather by perfecting it to international levels of performance (energy economies and man-hours per tonne) and become an astonishing model for their trainers ....

And all this within the same industrialised country where the cultural differences from one region to another are slight.

This means that if the acquisition of technological mastery is sensitive to the social behaviour patterns of the environment it is important to pay attention to them.

It also shows at what point these last steps towards technological mastery demand remodelling by self-training in such a way that everyone forgets that the iron and steel industry has been imported: <u>the graft is successful when the scar has disappeared</u>.

5.2. Transposing this to a developing country let us assume that we are at the end of the best possible scenario (some scenarios will be described later, at the end of this study).

Some of the functions of the directors (S) and some of the A functions are not yet being carried out by local personnel with the necessary mastery, but the team is complete, the know-how and behaviour are 90% reliable and the distribution of Responsibilities/Powers has reached an equilibrium which, given a few small failings, appears to be stable. Replacement assistance has ceased some time ago; training assistance has been reduced in quantity and intervenes less and less, having now only a morale-aiding role by its comforting presence. This is the time to "sever the umbilical cord" - but to do this prudently and progressively.

It is necessary to watch very carefully the first independent steps of the managers in class A in particular and, during such time as is necessary, not to withdraw the safety net entirely. This moment is the beginning of a relatively short period of grace during which the team, possessing the necessary know-how, must progressively and in unison pass from one BH + RP combination to another which will be its equilibrium configuration for self-reliance.

At this point in time training assistance has disappeared, the team being capable of improving itself by self-training and of taking complete charge. All that remains, as in other places, is the supporting assistance which is only manifest in occasional missions at longer and longer intervals of time.

Soon its interventions will no longer be motivated by operational problems but only by the problems of the fine tuning of equipment or of installations to bring them into line with the changing conditions of the environment (it is necessary to understand and to accept that the "hardware" of a plant is never finalised, however farsighted and careful those who designed the installations have been).

On the software side this is the moment, if the team is to become independent and self-reliant, for it to proceed gradually, and by itself, to the fine tuning of its organisation: every plant in the world, and especially those with the highest performance, carry out these remodellings from time to time either to adapt better to the environment or to take greater advantage of the qualities of the team, as from the moment when it becomes better known.

5.3. We can cite some examples of remodelling of the organisation :

5.3.1. For climatic reasons.

5.3.1.1 In certain climates greasing become more than a routine activity. The frequency and quantity of greasing must ensure the protection of the mechanical equipment from the aggressive effects of fine sand, from the ambient salinity and/or an exceptionally high atmospheric humidity.

The stocks of grease have to be protected against any physical, chemical or organic degradation due to the climate.

The role of the greaser therefore becomes so important that it may be necessary to create a post of "Chief greaser" for the sole purpose of giving priority to this concern, and it will be his responsibility to supervise not only the greasing operations but also the satisfactory conservation of the stocks of grease in the stores.

One could also, if it would contribute towards promoting greater cohesion in the team, organise a weekly tour of duty amongst the existing foremen in which they would exercise the function of the chief greaser,

5.3.1.2 In an arid or desert climate water is very precious and a symbol of life. Any function related to water must therefore receive priority since this involves a very special "line of fragility" which is generally unknown in an industrialised country.

5.3.1.3 The same may apply to any function related to air conditioning in a hot country or to electrical energy if the plant, being isolated, produces its own power, etc.

5.3.1.4 Plants in the developing countries unfortunately possess more "lines of fragility" than plant in the industrialised countries, and the means implemented for achieving technological mastery must take this into account.

It follows from this that promotions to functions of which we have spoken must be accompanied by a corresponding increase in know-how and behaviour: a "Chief" (RP) of maintenance of air conditioning in an isolated environment will have a higher professional qualification (KH) and a more marked behavioural requirement (BH) than in an industrialised region.

To summarise the above one can say that that the standard requirements (T = KH + BH + RP) will be higher, whilst the equilibrium point of the function on the triangular diagram remains unchanged.

5.3.2. Because of general behavioural patterns in the socio-cultural environment

5.3.2.1 This type of remodelling is more subtle, inasfar as the service imperatives of the installation are incompatible, or in conflict, with the socio-cultural patterns of behaviour (too great a divergence between the model of a technological mastery society and the model of the prevalent society in the country).

The conflict may be more or less serious, according to whether it is located at the level of normal habits and conventions or to whether it questions a form of social organisation, linked to a sacred or even institutionalised heritage.

5.3.2.2 Less serious, and more easily overcome with perseverence and rigorousness, are the behavioural distortions due to current traditions and habits, such for example as :

- "Tomorrow" in some countries means sometime or never;
- Age may be a symbol of knowledge and wisdom: a young executive will have difficulties in having his authority accepted, even when he himself does not feel inhibited in this way;
- "There isn't any" says the storekeeper to the bearer of a part withdrawal request: this may be just the general expression of resignation which is accepted by everyone in a cultural environment which is accustomed to shortages and where men have always rejected the role of introducing order into the world of things.

This basic behaviour may lead to not wanting to force the pace, to refuse to think ahead and to put off until later, until "tomorrow", an event which is programmed but which has been thwarted by an unexpected incident, even if only a minor one.

- The "Chief" diminishes his image as a leader if he arrives at a working meeting bringing his papers with him, or if he asks questions so as to obtain information;
- Social status is seen in terms of the degree of elevation or of physical comfort: the operative on the gantry crane believes himself to be the chief whilst the cabin operator does not always feel that he is subordinate to the foreman who spends all his time walking around the installation, etc.
- The anthropomcrphic reaction : the machine "doesn't want" to work ....
- Ethnic groups or families who are historically enemies, and whose antagonism persists within the plant;
- Habits of reading other than from left to right may result, as a reflex, in false interpretations of single-wire diagrams, isometric drawings or curves shown on a VDU screen. It may be necessary to re-write certain documents in common use, if only to facilitate classification in files which open "backwards". It is necessary to check twice the code numbers typed on documents relating to calls for tenders, to customs' clearance, etc.

Such types of reflexes can be corrected by ongoing psychological actions; it may not therefore be without value to create and maintain a post of psycho-educationist responsible for improving behavioural patterns.

5.3.2.3 More serious are the fundamental conflicts which may arise from institutions in the social organisation and which are incompatible with the simplest necessities of technological mastery.

This touches on a very delicate field where every compromise solution, even the best, leaves little hope of achieving complete technological mastery before the long term, that is to say for as long as it takes for the social form to evolve, in its entirety and through its institutions and until adequate conditions of individual and collective behaviours have been created.

Within the environment of the plant, where we have identified some infrastructures which are essential for its efficient functioning, the social form is also an infrastructure, but it is not localisable since it acts universally within all the functional bodies of society, including in the plant itself.

Amongst all the possible components of the social form what are those which can constitute factors inhibiting technological mastery in an activity as complex as the iron and steel industry ?

The level of complexity of the relationships between functions can be a concept of primary importance here.

Whilst certain institutionalised behaviours are not inhibiting of artisan-level mastery they can appear as mild poisons for the mastery of a simple and lightweight industry and as a mortal poison for the mastery of a heavy industry such as an integrated or semi-integrated iron and steel industry, inasfar as success in multiple, delicate and interlinked operations owes much to the solidarity of the functions, and hence demands that every member of the team gives continuously and freely, during his working hours, all his capabilities according to the very strict rules of the game.

This means that the personnel must be :

- Freely recruited, free to stay with or to leave the company, with free access to documentation;
- In very good physical and psychological condition, and therefore well remunerated: wage scales in the iron and steel industry should be independent of wage scales in other industries, and account must be taken of this in the profitability studies before deciding to install an iron and steel industry.
- Free of subjection to any hierarchy other than that of the plant: no feudal forms must interfere in the network of responsibilities/ powers in the plant, nor disrupt the interplay of the required behaviour patterns. This is not a denial of the utility of trade unions but is a rejection of the imposition of a single and political trade union, owning the labour force.

More generally this is the rejection of any hold, of an absolute character over the individual's behaviour during the time that they are exercising their function: the plant is both lay and apolitical.

All these conditions are sometimes difficult, if not impossible, to combine together within the evolving context of certain societies; it is necessary however to consider lucidly the fact that whilst one can negotiate with men it is impossible to negotiate with steel, with the apparatus which is used to produce it, or with the automated systems which increasingly govern operations.

5.4. Two questions by way of conclusion to this chapter on the trainers

5.4.1. When it is a question of technological mastery one thinks in terms of an "absolute model" and seeks assistance where this model exists. And where the model is found both the social form and the components of behavioural patterns are very different.

In fact there are a number of models, all of satisfactory performance but founded on very different social forms, resulting from very different histories and cultural backgrounds, and evolving in different ways towards greater mastery.

Between these models the competition is also so intense that, as far as they are individually concerned, the concept of a model does not exist, or is strongly relativised.

If assistance from them is necessary for a young iron and steel industry where and at what moment does their help cease to be beneficial and runs the risk of operating to the detriment of the self-reliance of an iron and steel industry assisted in this way ? Have they not constructed their own mastery with the minimum of external assistance (though with considerable communication between themselves) ?

Is there no longer a place, therefore, for another original model of technological mastery, which one can construct oneself, in one's own context, to grapple with the problem whilst combining to their best effect all the unique mix of potentialities which one possesses, and once the start-up assistance fuse has been ignited ?

Furthermore what absolute character can be attributed to all the conditions for mastery which have been enunciated above, and which operate in other places ?

It is necessary to accept the facts : one can buy assistance, which is a school, but one cannot buy mastery: one either has, or has not, the will to conquer it by efforts towards mutation.

Are not the real trainers found in one's own midst ?

5.4.2. When, how and on the basis of what criteria is the choice of assistance for training and for starting production to be made ?

- Generally it will be financial conditions which guide the choice from amongst the most olympian "models". Cultural community, ease of communications, behavioural similarities and pedagogic value largely occupy a second-class status. Is this not a great pity, knowing that apprenticeship is not dependent on the absorption of know-how, important as this may be ?

- Generally training operations are initiated too late for the principal executives (not just the technicians!) to have matured at the time when assistance should come into operation. One of the conditions of their maturity is that they have become operationally conscious of the variety of models of technological mastery, and that in this respect they have been able to exercise their critical powers, in complete independence, and without having underestimated the difficulty of the tasks. It is necessary therefore that they should have seen a great deal, in many places, and have spent a sufficiently long time in each place. No one can replace them when it is a matter of taking the final steps towards a mastery which will not resemble any other form of mastery. Is this not the most important investment to be made ?

CHAPTER III

THE CHOICE OF A SCENARIO FOR TRAINING TOWARDS TECHNOLOGICAL MASTERY

1. PRESENTATION OF THE POSSIBLE SCENARIOS

Before establishing the rules of conduct and the necessary steps in the surest route towards technological mastery we will describe the worst (and, alas, also the most frequent) scenario, which we will call the "anti-mastery scenario".

In order to explain, step by step, the consequences of the development of these scenarios we will utilise the analytical apparatus constructed in the third part of our study, to which reference should be made for an understanding of the terms and notations.

It would also be of value to refer to the first part which dealt with the parameters leading to success or failure and also with the actors involved in success or failure.

For greater clarity in the explanations the unfolding of these scenarios will be set out on the left-hand side of the sheet, the right-hand side being reserved for observations on the consequences of the various interlinkings of the decisions.

In both scenarios we are concerned with the same country and the same formulation of the political decision.

Time being an important factor it is indicated in months from the origin of the project, that is to say from the official statement of a political decision to introduce an iron and steel industry into the economic fabric of the country.

The time-scale extends over a maximum of ten years, and assumes that no team exists in the country which has sufficient iron and steel experience to master the programme.

Naturally many favourable factors could lead towards accelerating the process. But it is the interlinking of the actions which counts, together with the content of the stages which allows the next step to be taken in total security.

Where the development of an iron and steel industry is concerned it is more than ever necessary to adopt the principle "gently does it" ....

2. The bad scenario : anti-mastery

Month	Stage	Actions	Observations
0	0	In the light of iron and steel imports, and given the increase in the GNP, it is time to provide the country with a mini-steelworks (80,000 t/y ?) for the commoner types of long products. Scrap is available locally.	The analysis is based on the world statistics for the industrialised countries, showing a correlation between the GNP and the consumption of steel. Can this be extrapolated to the bottom end of the scale ?
0+..	1	The Ministry for Industry is asked to supply, as a matter of urgency, a draft plan. No special credit is allocated. It is necessary to contact the sellers who will provide studies free of charge in order to maintain their competitive positions.	The basic philosophy: everything will be purchased, and at the present moment the buyer is in a better position than the seller, and it is necessary to profit from this situation.
	2	An international call for tenders is launched. Two sites are envisaged. The iron and steel import statistics are appended. A profitability study is requested with a turnkey proposal. Replies requested within two months (pressure from planning).	- The definition of the plant is vague, the precise legal part is lengthy. - Use is made of customs' statistics. They include iron and steel imported under contracts for major State works, so that it is not possible to identify the iron and steel consumed by the public.
4 to 10	3	The tenders are examined. They are not technically comparable. There is difficulty in linking together the commercial and financial conditions. Reservations are expressed regarding the "local conditions" for a turnkey plant. Training is dealt with in one table and one page.	A premature entry into a spiral of negotiations in which the essential problems of the "iron and steel graft" are masked. The Ministry for Industry team very much want to see a steelworks. They are made to visit five on the run ... by invitation.
12	4	In order to see matters more clearly one finally releases a small credit for studies entrusted to a foreign "independent" company. Mission : local surveys, choice of the site, profitability limits. Time becomes even more pressing. The sellers also press and fine down their tenders. These include the training of the first occupants of the technical posts up to the time of entry into production.	Pressed for time, stifled by the incessant siege of the sellers in competition, solicited by the local entrepreneurs on the best alliances with the sellers, the decision-makers and their study organisations "forget" the real distance between their human resources and technological mastery.
16	5	The "turnkey" contract is signed. It is a legal masterpiece. Everyone knows where he has introduced his snares. The plant is described carefully: for his money the buyer will have included two years' of spares (no list, but every effort will be made to obtain the maximum). Commissioning and acceptance tests could, if necessary, be carried out by the seller's personnel if the buyer's personnel are unable to do so: the seller knows that he has his bill of discharge, even if he feels it to be rather costly. As far as the quality of the training which he will give is concerned this is contractually protected by the minimal specifications of the personnel who are to be recruited.	It is necessary to make a decision before the final dates of validity of the financial offers. The last day of negotiations has been devoted to training, the cost of which cannot be contained within the financial envelope. The list and duration of the training stages is reduced. Discounts are obtained. Responsibility is accepted for recruitment (it's easy!) and training in the basics of a foreign language. Everyone, knowingly or unknowingly, has overlooked the team.
18	6	The contr t comes into effect. In 25 months : commissioning In 32 months : end of the acceptance tests In 44 months : end of the guarantee year, the date on which 30% of the nominal capacity will have been achieved with one 8-hour shift, and when the second team has been trained. Three years after commissioning one should be in the normal operating regime at the nominal capacity with three shifts.	At the Ministry for Industry the list of "obligations of the buyer" is beginning to be examined with some disquiet : - access infrastructures - supplies of water, energy, etc. - supplies of raw materials - recruitment centre operational by month 3. - despatch of the first students during month 6 - opening of training centre on site in month 12! - construction of the site facilities It is necessary to have the credits, to distribute them and to draw up the programmes. Hurry on with the work (it's already too late).

2. The bad scenario : anti-mastery (contd.)

Month	Stage	Actions	Observations
28	7	The seller has practically completed the engineering work. The despatch of the equipment begins. On the site of the plant the Civil Engineering work is going ahead, the frameworks for the buildings arrive. Success has been achieved in recruiting some labouring personnel and some well qualified technicians, together with some engineers leaving the university or with 2 or 3 years' experience in a local agro-food factory. So far not a single foreman has been located in the country. It may be possible to find one in the neighbouring "friendly" countries which are more industrially developed: they are being sought in this way, whilst accepting that this will not solve the problem in the long term, given the sometimes chauvinistic character of such workers, and the hazards of friendships with neighbouring countries...	The engineering has developed without anyone having been able to participate, the documents are received at the Ministry where they are filed until the plant team is formed and can be informed of this. It is to be expected that the categories B and particularly category A will arrive later for their training courses than categories C and S. It still only involves the technical functions. The technical functions D have been quite simply forgotten in the training, together with all the non-technical functions in all categories.
36	8	The erection of the equipment begins on the site. This would also mark, theoretically, the start of the technical training on the site to be given by the seller to groups of workers and technicians headed by their team leaders and foremen. There are certainly some recruits intended for level C technical functions, but the senior personnel has not yet returned from its training courses abroad: they left late, the seller found them to be of a lower level than that which was agreed, and has accepted to give them basic training, resulting in a delay of 6 months. The population being trained on site feel themselves orphaned, and the seller's erectors have other things to do than teach them the rudiments which they ought to have learnt at school. A poor moral climate.	This is the start of the period which is propitious for buyer-seller litigations. On the site, on the buyer's side, a small group of supervisors for the work has been installed with a contractual mission to manage administratively the trainees on site, awaiting the seniors who are still being trained. Suddenly the buyer starts to be concerned with establishing the non-technical part of the plant management: this is born and develops independently of the technical staff, who are still absent. As far as the management system is concerned this is based on those industries which are operational locally. Is the accommodation camp operational ? No, it is still being built, and the workers are brought into the site from a distance.
42 to 46	10	The erection work is completed, and finishing work and no-load tests have started. The personnel trained abroad arrive on the site and discover a completely installed plant which differs from the units on which they have been trained. They ask for technical documentation and ask for explanations. The seller's personnel are managing the site in the most delicate phase and are in no mood to show themselves cooperative.	The Ministry and the administrative staff of the plant have obtained supplies of scrap, lime, additives, etc. All this is (at least on paper) in line with the seller's specifications. The buyer's technical staff have to be satisfied on this matter when they return from their training abroad. Are the commissioning staff of the seller also satisfied ? Are the minimum logistics now assured for the start-up operations ?
47	11	For a month the commissioning staff of the seller and the technical staff of the buyer write and re-write the check-lists, making the final adjustments. The erectors make the last minute modifications.	Are the modifications made during erection and commissioning shown on the drawings ? Who is, in the plant, the D-category person responsible for documentation - does he exist ? He has not been trained, but hastily nominated from the buyer's staff.
		For a month the seller and the buyer have formed, outside the contract, teams for preparing the scrap which, as supplied, is nothing like the standard qualities supplied in the industrialised countries. It is cut and sorted by three 8-hour shifts...	It takes 5 years to train a scrap foreman in the industrialized countries. Our foreman has had 6 months' training abroad, since he was recruited too late (see stage 7) and has hardly been on the site for a month ....
		The no-load tests have resulted in many hydraulic gaskets being changed. The erectors' spares are all exhausted, and it is necessary to search through the cases of spares, only just cleared through customs and stored in the plant stores, where the stores labourers still await their chief.	The training of a stock control manager has been "forgotten". A senior storeman has been hastily nominated from the stores labourers, and he now finds himself suddenly faced with a list of 20,000 articles distributed throughout 50 cases ... and with empty shelves! How is he to cope?

2. The bad scenario : anti-mastery (contd.)

Month	Stage	Actions	Observations
48 to 50	12	Production has finally started, more than a month late: first castings, first rollings. This is satisfactory, as a rate of one casting and some hours' rolling a day. The difficulty is in linking the operations so as to be able to produce continuously during an 8-hour shift. Each operator knows his individual task, but does not know how to link upstream and downstream. The team leaders and foremen (A and B) do not feel very sure of themselves and of the others, and refuse to accept responsibility. The executives S and G are fighting against the environment: power failures, deliveries of materials, transport of the personnel, supplies for the canteen. New personnel arrive, and have to be integrated into the existing teams ...	It is at this moment in time that the lack of preparation on management and the absence of procedures and their supports (reports, stock withdrawal notes, coding of materials and parts, safety rules, etc.) begins to be cruelly felt. Everyone has learnt, when on training, various different procedures which it is now too late to analyse and to adapt and to play the necessary kriegspiels: the war has already started, and all that can be done is to get matters straight for the period of the guarantee tests. After that one will see ...
53	13	The guarantee tests on the installation are finished, two months late. The seller withdraws his working team and leaves only two observers on the site during the guarantee period of one year. This is contractual. It is proved that the installation conforms. It is also proved that the "training" in know-how of the sample of personnel entrusted to the seller also conforms to the contract. But there is still no "team". The seller leaves the place open for "technical assistance".	The Ministry for Industry has become increasingly aware, over the last four months, that there is a considerable lack of know-how and of much of the necessary organisation of the team; it has therefore released additional credits in order to permit the long-term intervention of technical assistance. The contract is signed: about a dozen foreign engineers and technicians will come. They do not come from the seller's country, where everything is too expensive.
66 to 72	14	The technical assistance has been on site for six months. On arrival the personnel discovered an unknown plant, and has spent six months criticising it, but also introducing order into the technical documentation, in the stores and in the procedures. This has involved mainly the executives G and S, the foremen A and the management aides D, so as to ensure a minimum of logistic coherence. It also acts in regard to the technical environment of the plant, explaining to the interfaces the needs of the plant and the importance of reliability. They have acquired personal influence at the highest responsibilities/powers levels of the environment.	In the light of the state of disorganisation which is found and the urgency of the objectives to be achieved the mission of the technical assistance team has changed: it has increasingly become replacement assistance and less and less training assistance. The local managers and executives (G,S,A) develop the habit of relying on their help and to reign without directing (they "sign the mail"...) whilst the operatives (B and C) look to the assistance for their own security: their only contact with the local hierarchy is on matters of social security, and relationships are falsified. The higher RP levels in the environment secretly hope that the assistance team will remain for a very long time .... It is comforting. The Ministry has however recruited half a dozen dynamic executives who will be sent abroad for two years in the plants from which the assistance team comes.
		The plant is now operating on one 8-hour shift. The team for the second 8-hour shift has reached the end of their training. Their training abroad by the technical assistance group differs from that of the first team.	A new brood is now introduced into the team, probably better armed than the "old guard" : is there a prospect of conflict here?
		Production reaches 25% of the nominal capacity, but quality is not consistent, due in particular to the poor quality of the local lime and scrap and to the irregular arrival of the imported ferro-alloys. It is necessary to obtain new supplies of spares.	One now comes up against the real problems of regularity in supplies, both local and imported, together with the problems of distribution of the products (sales). Educating the environment becomes a very difficult task. The administrative and financial Directorate of the plant begin to face cash-flow problems.

2. The bad scenario : anti-mastery (conclusion)

Month	Stage	Actions	Observations
84	15	The plant is operating with two 8-hour shifts, and the third team is being trained on site. Advantage has been taken of the better training of the second team to redistribute the allocation of the A, B and D level functions. Some of the "old guard" foremen have left the plant and are doing better outside. Some of the local executives have changed. General malaise. The assistance team has been on the site for 18 months: this is very expensive, and whilst production has reached 50% of the nominal capacity in terms of quantity the quality is not often of international standard. The principal customers being foreign works enterprises they reject deliveries or demand discounts. The local "scrub" clientele is difficult to reach or makes sporadic purchases. Stocks are rising, and the lower quality products are recycled through the furnace. Nevertheless it will be necessary to think in terms of importing scrap if one wishes to get out of the impasse.	Far from the reality of the plant the Ministry for Industry draws up its accounts under pressure from the Ministry for Finance. Nothing has happened according to the forecast financing plan. More than 24 months after commissioning the reimbursement of the loans is going badly and the prospects for any rapid improvement in operation are poor. The plant's teams are disparate, lack cohesion, clans are forming, training still has to start up again, the real management is foreign and does what it can. Certain members of the assistance team are repatriated at the end of the repatriation contract and others are sent out It is necessary to make some decisions - Will they be beneficial ?
96 to 120	16	Since the third team started work and the plant has been operating on three shifts the withdrawal of the main technical assistance has been negotiated and only two high-level foreign cooperative executives have been retained to assist, with their know-how and methods, the new local executives, full of dynamism after two years spent abroad in the plants of the technical assistance team (see stage 14 above).	The courageous measures which have been taken indicate that one has started to "cut the umbilical cord" and that the importance of the human investment and the software is now understood. Will the team, which is still disparate but increasingly coherent in terms of KH, BH and RP, be able to hold the line ?
		- The collection and primary preparation of scrap from the entire country is integrated into the plant: this still costs less than importing good quality scrap. - The management of all the concessionary points of sale throughout the country has also been entrusted to the plant.	With the start of integration at the plant (scrap, distribution and sale of the products) of traditionally private services will this not overload an always fragile team ?
		- The shortage of local production of spares and wearing parts, the complicated legislation covering their importation and the damage to the imported refractories under the effect of the weather are major causes of the irregular operation of the plant.	This is far too late an attack on the problems which need long-term action: the development of the serving industries, reforms in the administrative procedures in the public sector, etc. What is the position with the reform of the country's educational apparatus ?
120	17	In month 120 the plant, 5 years after commissioning, produces 65% of its nominal capacity and everyone, finally motivated, makes the best of a bad job. This state of affairs could last for a long time.	Reimbursement of the loans is taken from the national budget, to the detriment of development. The plant is still not profitable. Is it in fact the plant which is not profitable, or is it rather its team and its environment ? The plant (hardware) and the personnel (software) have had totally independent histories, and have been the subject of such unequal care!

END OF THE BAD SCENARIO

3. The good scenario : "Gently does it ..."

Month	Stage	Actions	Observations
0	0	In the light of iron and steel imports, and given the increase in the GNP, it is time to provide the country with a mini-steelworks (50,000 t/y) for the commoner types of long products. Scrap is available locally.	The analysis is based on the world statistics for the industrialised countries, showing a correlation between the GNP and the consumption of steel. Can this be extrapolated to the bottom end of the scale ?
0+..	1	The Ministry for Industry is required to prepare, for the Plan, a project analysing all the risks and all the constraints, short and long term: one does not want to risk false moves in the general development of the country where equilibria are still fragile. A credit is released for this study, to which the other Ministries will be required to contribute.	The political desire for development is tempered by wisdom. The authorities will not make a decision without mature reflection and with documentation. To grant a credit for studies is to demonstrate the importance and the seriousness of the document which is required. To call on the collaboration of the other Ministries is to demonstrate an awareness of its complexity.
2	2	An Interministerial Commission is set up under the aegis of the Ministry for Industry which will decide on and establish a small permanent task force of 5 or 6 persons, representing Industry, Commerce, Energy, Transport and National Education, allocated powers and a study budget. At the end of the second month this is operational. The task force reports every month to the Interministerial Commission.	From the start there has been an awareness of the configuration of the "citadel of mastery" in regard to BH and RP at the highest levels of responsibilities and powers and down to the operational levels. It is still necessary to integrate the KH, which can be at least partly purchased.
5	3	The task force has travelled around for three months and has obtained documentation, from independent sources, concerning possible sellers of plants or training : international organisations (UNIDO), iron and steel plants in neighbouring developing countries, publications on similar experiences, etc. It has drawn up a very imprecise document on a project for the installation of an 80,000 tonnes/year plant, but this document clarifies the needs and the constraints : - upper and lower limits for the material investment costs; - upper and lower limits for the operating costs; - list of the technical and non-technical personnel with their know-how characteristics; - check list of the parameters for success or failure in other countries; - estimate of the financial losses if a good installation cannot be efficiently operated; - recommendations to the Interministerial Commission, which may be summarised as follows: priority to the acquisition and maturation of all the software necessary; the hardware which is suitable for us can then be more safely deduced.	Since the task force is multidisciplinary one has avoided the trap of a prior technical project which would serve as a plaything, with attention concentrated on the details. Since the task force is 100% local there is understanding in the approach to the problems and a consciousness of being co-responsible for the scenario which is to be developed: within the initial Kriegspiel the embryonic relationships between the plant and its environment have every chance of developing normally. The participants will be the bearers of coherent messages to their respective Ministries.

3. The good scenario : "Gently does it ..." (contd.)

Month	Stage	Actions	Observations
6	4	After approving the report from the task force the Interministerial Commission decides on : - the recruitment, and sending abroad for training in a foreign steelworks of the same size (mini-steelworks, 80,000 t/year) of a team of six university graduates : . 4 engineers . 2 technical salesmen for a period of 1½ years.	- These six future executives for the plant should, during their training in the same plant, divide their apprenticeship between the following functions : . steelmaking and rolling mills (2 engineers) . maintenance and plant engineering (1 engineer) . raw materials (1 engineer) . buying (1 technical salesman) . sales and management (1 technical salesman) They should measure the progress of their training, <u>together</u>, every day.
		- the launching of serious studies on : the local market the human resources.	- The results of these studies will form the solid bases of the project, should it come to fruition.
		- the creation of a recruitment, selection and supplementary basic training centre for technical and non-technical personnel intended for the categories A, B and D, and valid for any complex industry.	- It has been appreciated that this was the essential connection between General Teaching and Industry. Irrespective of the ultimate decision on the iron and steel project this centre is a good investment.
		Initial credits are granted whilst awaiting for the detailed budgets and planning to be presented and approved The supervision of this programme is entrusted to :	- The credits for launching, however small they may be, are the concrete evidence of a realistic dynamism and a desire for rigorousness in management.
		The Interministerial Task Force, which becomes a permanent body to which the piloting of the iron and steel project is entrusted in an overall manner.	- This Task Force starts to be taken very seriously by the public Administrations. ("These people have a future"). A magnetic behavioural field is being created.
15	5	- A considerable part of the Recruitment/Selection/Further training Centre begins to be operational : . built well and rapidly, using extendable modules, on the model of an efficient centre visited abroad by the Task Force. . the equipment, now being installed, is not all new. . the recruiting staff and local teachers, supplied by the Ministry for National Education and the Ministry for Industry, are assisted by foreign cooperators who supply the methods (training the trainers).	- It has taken 9 months not to complete (since it is an ongoing project) but to open a recruitment and selection centre. The first observations resulting from the experience are compared with the results of the study into human resources, carried out in parallel.
		- Detailed studies of the markets and human resources have been devised and carried out under the close control of the Task Force. It is realised that the iron and steel imported by foreign enterprises carrying out major works under contract has to be deducted from the customs' statistics. The permanent local market is not 80,000 t/year but 45,000 t/year, and only of the lightest products. The non-urban needs are not small but are difficult to satisfy since they are widely dispersed in areas with poor transport infrastructures. It is also realised that each year the university produces "general" engineers but no specialists, and none have had any training in industry. It is also realised that the country lacks a middle class.	- One can see clearly here that it was right not to dive head-first into the elaboration of projects which had been drawn up before all the data relating to the problem had been seriously examined.
		- Decision : the National Education is considering a cycle of intermediate studies intended to reach the level of Diploma of Higher Technical Studies. Meanwhile the Further Training Centre will have to supply this gap.	- The major problem has not been side-stepped : The real resources are the men. The "citadel of technological mastery" is built on the middle classes.

3. The good scenario : "Gently does it ..." (contd.)

Month	Stage	Actions	Observations
26 to 30	6	- Return to their own country of the team of six student executives (see stage 4). . They report to the Task Force in a joint report. . At the recruitment and basic training centre they inspire the students, monitors and pupils to accept the know-how they have acquired, to transmit their experience and to prepare behavioural patterns with a view to overseas courses for the categories A, B and D. . they take note of all the studies carried out by the Interministerial Task Force and comment on them.	During their training period of 1½ years in the same foreign plant the six executives will have the time : - to become trained, each in his own speciality, - to live in the environment peculiar to the iron and steel industry and to observe it in all its complexity, - to develop amongst themselves a philosophy of adaptation to the socio-cultural context of their own country, - to measure everything that technological mastery in the iron and steel industry owes to the complex environment, - to be in a position to control the sub-contracting of studies and the dialogue with sellers, when the time arrives, - to become the undisputed seniors of the A and D students under training.
		- Summary report from the Task Force to the Interministerial Commission : . Recommends the launching of technico-economic studies for a proposed plant of 45,000 t/year, extendable to 80,000 t/year, with aid from an external Consultancy specialising in this type of plant. The engineering will be orientated towards reducing the imported spares to the minimum. End of the studies and calls for tenders forecast for month 38. Signing of construction contracts in month 48. Commissioning forecast for month 80. . Proposes training in a foreign plant for a dozen persons selected for the A and D functions (technical and non-technical), forecast duration 6 months, accompanied by one engineer and one technical salesman already trained in this foreign plant. . Sets out the budget necessary for this programme.	- <u>This is the point of departure of the hardware project</u> : Sufficiently competent when back home one can claim to be able to guide the studies, for which there still remains the need for supporting know-how. The design staff, trained at the local Training Centre, are sent for a training period with the sub-contracting consultants.
		- The Interministerial Commission gives its approval.	It has been definitively understood that it is better <u>to invest in software before becoming the prisoner of the financial charges on the hardware</u>.

3. The good scenario : "Gently does it ..." (contd.)

Month	Stage	Actions	Observations
38	7	- The hardware project is well "framed", not only for the plant but also for its environment (in particular the accommodation camp). . One knows where and how to find, collect and prepare the scrap and lime; . The interconnections to the infrastructures have been studied and simulated; . One knows how far it is necessary to adapt the equipment to the climatic conditions and to local supplies of spares and wearing parts; . The variations in stock levels of materials and spares have been studied and simulated and the necessary stock levels have been fixed; . Sales promotion and distribution have been studied according to the two possible schemes (integration into the plant or not); . The plant and environment budgets have been established; . The calls for hardware tenders are precise.	- One knows where one is going, one knows why; the whole environment has the elements needed to prepare itself around the complete model which has been established in this way, and which is capable of being improved. - The adventure can be mastered.
		- In regard to the software project : . The four executives who did not accompany the A and D students abroad have drawn up the organisation and procedural projects and have tested them in relation to the environment via the Interministerial Task Force. . The two other executives return to their country with the ten A and D students: these are not yet fully at the A and D level, but have the required EM, BM, RP profile. They can now act as monitors to the B and C personnel at the local training centre, testing the procedures which have been developed and participating in the development of the hardware project.	- From now onwards it is possible to utilise this first organisation model as a simulator in the training classroom, to train and test behavioural patterns and to refine the procedures. - The equipment which will finally be purchased will undoubtedly differ from that in the training plant. However the executives S and the managers A + D, now in control, are sufficiently educated so that their futures courses in the adaptation of the equipment finally purchased will be both short and effective. Insofar as they have been able to make their contributions to the defining of the details of the plant they will feel that they own the plant and are responsible for it. <u>The chain of key functions, on the triangular diagram, begins to be solid even before the plant rises out of the ground</u>.
48 to 50	8	- The contracts for supplies and works have been signed, the financing is organised (plant + environment). Spares are listed, coded and costed.	- From this time onwards the pressures of time and money will bear heavily on the Interministerial Commission, but all the sacrifices which have so far been made will prove to be profitable.
		- During the engineering period the supplies receive the local design staff and draughtsmen for training in their offices; they have been trained at the centre and then by the Plant Engineer after his return from training abroad (category A - technical libraries).	- There is little risk that the plant will start up with incomplete or uncoded documentation.
		- A second A, B and D team is being trained at the centre, under the control of the A, B and D who have returned from their training abroad. Eventually, the new team could also go for training to the plant.	- Training in cascade continues : the "old guard" control the training of the new staff. Subsequently there will not be any disparities of behaviour between the 8-hour shifts. The future executives of the plant will ensure that this is so.
60	9	- The civil engineering (Plant, camp, environment) is well advanced.	- The first buildings to be completed are those for the general and maintenance departments: the team will be housed here whilst the equipment is being erected.
		- The second A + B team, with the C specialities, has gone abroad for training, with an already trained S executive.	- The second 8-hour shift team will return at the time that the equipment is being erected.

3. The good scenario : "Gently does it ..." (conclusion)

Month	Stage	Actions	Observations
66 to 80	10	- The equipment is erected and the General and Maintenance Departments buildings are fitted out.	The staff, headed by the executives, take up their quarters in the plant which they already know on paper.
		- All the teams previously trained are there in order to : . participate actively in it; . follow-up the developments and modifications; . install and operate the organisation and procedures (particularly safety). - On their arrival the commissioning team from the supplier find an organised team, a basic logistics which functions, the spares and documents all classified, coded and updated, and the materials yards ready in terms of both quality and quantity.	The staff, at all levels, are not spectators. As the hardware is completed the already tested software is put fully into effect, and continues to improve itself. The logistics are 100% ready and run in for the commissioning, the date on which one will have trained personnel on the site for two shift teams The commissioning staff of the supplier can carry out their job efficiently, and the staff of the plant can familiarise themselves with the peculiarities of the equipment which has been purchased.
84	11	- End of the acceptance tests. - Start of the supplier's guarantee year. - The third 8-hour shift leaves the Training Centre and completes its training in the plant: it does not go abroad.	This has not gone badly. Some difficulties in linking the operations together became evident, due more to hesitations resulting from a lack of confidence. It proved possible to overcome these rapidly as a result of the previous preparatory work and the homogeneity of KH, BH and RP. The departure of the commissioning team from the supplier is viewed without giving rise to too much unease.
96	12	- The plant operates on one 8-hour shift, making it possible to run in the plant and the team together. - With three shift teams available one has the flexibility for reforming the teams for the best complementarity of KH, BH and RP. - The rate of production and of consumption make it possible to run in the buying and sales functions. - The quality is being constantly improved, thanks to the assistance from the experts. - The second shift is launched.	The single 8-hour shift sometimes works nights so as to acclimatise the staff to changing shifts (repercussions on family life) and to pass on information. In this way preparations are made for working two shifts.
108	13	- The second team has been operational for one year. The plant is operating at 65% of its capacity. The third shift is launched.	The Interministerial Commission begins to breathe again: there are good chances that the loan will be reimbursed in accordance with the financing plan. It is possible to envisage projects for new industries, following the same scenario.
120	14	- The plant is working on a three-shift basis and at 90% of its capacity. This is limited, in fact, by some failures of the national electricity supply.	Technological mastery is within reach: it will be achieved entirely alone, as it should be.

END OF THE GOOD SCENARIO

4. From the scenario to reality : what is essential ?

4.1. With the final catastrophe of the bad scenario and with the "success" of the good scenario we can turn up the lights again in the projection room and return to real life, whatever that may be.

The actors in the bad scenario have been pictured as exaggeratedly maladroit and unlucky, whilst those in the good scenario have surely been inspired from above: not an error, not a false step, courage and money to spare, and everyone following the lead with total unanimity!

In real life one may have courage without inspiration, without the money to risk in this way without any counterpart through the years. One can be lucky without being adroit, and unlucky although competent: there are always losses in everything one undertakes!

All this is true; reality is more complex! This is why instead of concluding, in a form which would be too normative and necessarily pretentious, with a list of the commandments to be observed when making the right choices for an iron and steel plant and for advancing steadily towards technological mastery, we have preferred to demonstrate the mechanisms of behaviour and to allow them to operate within two scenarios caricatured to be very different. It is these mechanisms which are important; the rest is contingency, the art of the possible and the utilisation of means.

4.2. In fact the two scenarios diverge from the very start, beginning with the same formulation of needs :

- the first (bad) scenario gives priority to the material installation and defers until later the human investment: from the start one adopts the position of a pure buyer, and it is not possible to emerge from this: one goes from purchase to purchase until the point of wanting to purchase mastery - an illusion.

- the second (good)scenario gives priority to the human investment and does not undertake the material investment until it has endowed itself with a minimum of coherent supervisory means: from the start the desire is present to take ones destiny into ones own hands and only to purchase, progressively, that which can be purchased - that is to say the means. Technological mastery is accessible because, from the start one has quite courageously and lucidly placed oneself in a the position of supervisor, even if lacking knowledge.

This difference in attitude from the start can of itself explain the logic of the increasingly divergent interlinkings and how the opposite results are achieved ten years later.

4.3. Does the second (good) scenario cost more than the bad one ?

- Certainly yes, up to the time of commissioning of the plant: it would certainly cost more than the 10% of the material investment costs normally taken into account in the "a priori" profitability calculations;

- Certainly not, in total, when calculated per tonne of steel produced in the established regime operative after the 120th month;

- Certainly not when one integrates the positive influences on the coherence of the environment, a pledge of facility for subsequnt developments which may then be favourably envisaged, since the operation of the plant allows repayment of the loan.

It will be objected that, in the good scenario, it is more difficult to find the financing for the software since it takes place well before the hardware contracts. This is true: the "soft loans" often have to accompany the supplies "with training over and above the contract". This is to be regretted, and it is to be hoped that all the actors in the development scenarios, in the developing and the industrialised countries, will be convinced that their common and fundamental interest, in regard to lasting progress in their trading exchanges, lies in the human investment.

4.4. <u>Ten years: a long time, and yet not very long ...</u>

4.4.1. In both cases we have placed ourself in a not very favourable starting position in regard to human resources and the intensity of the industrial and commercial life so as to be able to scan all the important stages of the access to technological mastery.

Looking more closely at the ten successful years of the second scenario it is little to pay for a mutation of this importance and, above all, a contagious mutation, since :

- the recruitment and training centre created at the start, and put into orbit on the occasion of the iron and steel project, has a multi-disciplinary vocation (technical and non-technical) and is jointly managed by the Department of National Education and by the Industries: it becomes an ongoing institution;

- from the beginning the whole environment has been affected, modified and at some points shaken by the irruption of the iron and steel industry which has not ceased to act, through the Interministerial Task Force, at the highest level of the authorities, nor has it ceased to be, at ground level, the model demanding reliable behavioural patterns;

- the decision-makers, at the highest level of Political Power, can base their development plans on the possible existence of a complex industrial life and with the minimum of assistance from outside.

The efforts and the rigour have paid off: this is a political lesson which marks the start of an epoch.

4.4.2. Quite deliberately, and so as to describe the interlinkings more clearly, we have placed "in series" those activities which, in reality and by taking calculated risks, could involve some overlapping or, in cinema terms, "cross-fading". It is however doubtful whether one could gain more than 10% of the total time, given the same expectations in regard to the results.

4.5. These conclusions come into conflict with sellers in a hurry and the buyers of turnkey development. They also come up against those who are looking for a practical handbook with a title such as "Mastery of the Iron and Steel Industry in ten steps" or a pocket guide entitled "Twenty training programmes for mastering the key functions in iron and steel production": There are many of these, and none of them are bad; there are also many purveyors of training throughout the world, and none of them are bad. It is the way in which they are used which counts.

Let us see again how the team has been formed and how it has matured in the good scenario :

- It has been conceived and born well before the tools with which it will work have been purchased;
- Care has been taken to ensure that its intelligence and its nervous system develop at the same time as its limbs gain strength;
- It has been put under progressive apprenticeship so that it can adapt itself to the ambiance of its trade, and to make it its own;
- In its adolescence it is still being trained by participating in the design and construction of its workshop and its tools, establishing its place in its environment;
- When it is time to start work in earnest, to produce and to earn money, there will be no drama, simply the fact that it has ceased to be a charge on others;
- Its education has been expensive, almost as expensive as its workshop. But it has now become the master who will be able to nourish the growth of the others.

What other conclusion can there be, therefore, than to say "Go, therefore, and try to do likewise ...."

CONCLUSIONS

The present study has first of all tried to specify what may be understood by the "complexity of the iron and steel industry" by carrying out an examination of the difficulties encountered by new production units, not only during their start-up period but equally, as is often the case in developing regions, during the first years of operation.

It is obvious that these difficulties are closely linked with the technical complexity of this industry, so the second part of the study is both an inventory and a description of the production routes, processes and equipment utilised.

Amongst other things this examination has made it possible to move towards a quantification of the complexity of the iron and steel industry (Chapter VI) in relation to the structure of the plants.

Nevertheless our analysis shows clearly (see the first part of the study) that the difficulties encountered by iron and steel plants during the start-up and operation of the installations are essentially linked to the human problems of the whole of the system which constitutes an iron and steel "enterprise".

As the study has decribed the major risk is not the absence of the training of one or more persons as a fact in itself, but rather the way in which the whole of the system itself is made fragile.

It is in order to identify the methods of training and even, more generally, of "taking control" of the iron and steel industry by a developing country, that we have tried to develop :

- firstly the concept of the "key post";
- secondly the concept of "lines of fragility" in the whole of the system.

It would seem that it is in these directions that one should move in order to have the greatest chance of success of achieving technological mastery in the iron and steel industry, in particular in a developing country which does not already possess such an activity, that is to say a country which is a "newcomer" in this industry.

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NORMATIVE GUIDELINES FOR THE MASTERING OF TECHNOLOGY IN IRON AND STEEL THROUGH TRAINING

Part II*

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* The views expressed in this paper are those of the authors and do not necessarily reflect the views of the UNIDO Secretariat. This document has been translated from an unedited original.

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KEY FUNCTION EVALUATION SHEETS

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : CHIEF SPARES BUYER			Code 1 SUPPLIES

1) <u>Objective</u> :

To buy, or to have bought, under the conditions of delivery date and quality as imposed by orders to purchase, and on the best financial terms, all the parts and spares necessary for maintenance.

2) <u>Summary of the functions</u>

Under the authority and the responsibility of the Director for Supplies he carries out, and has carried out by his team of specialist buyers (engineering, electrical, instrumentation) the following tasks :

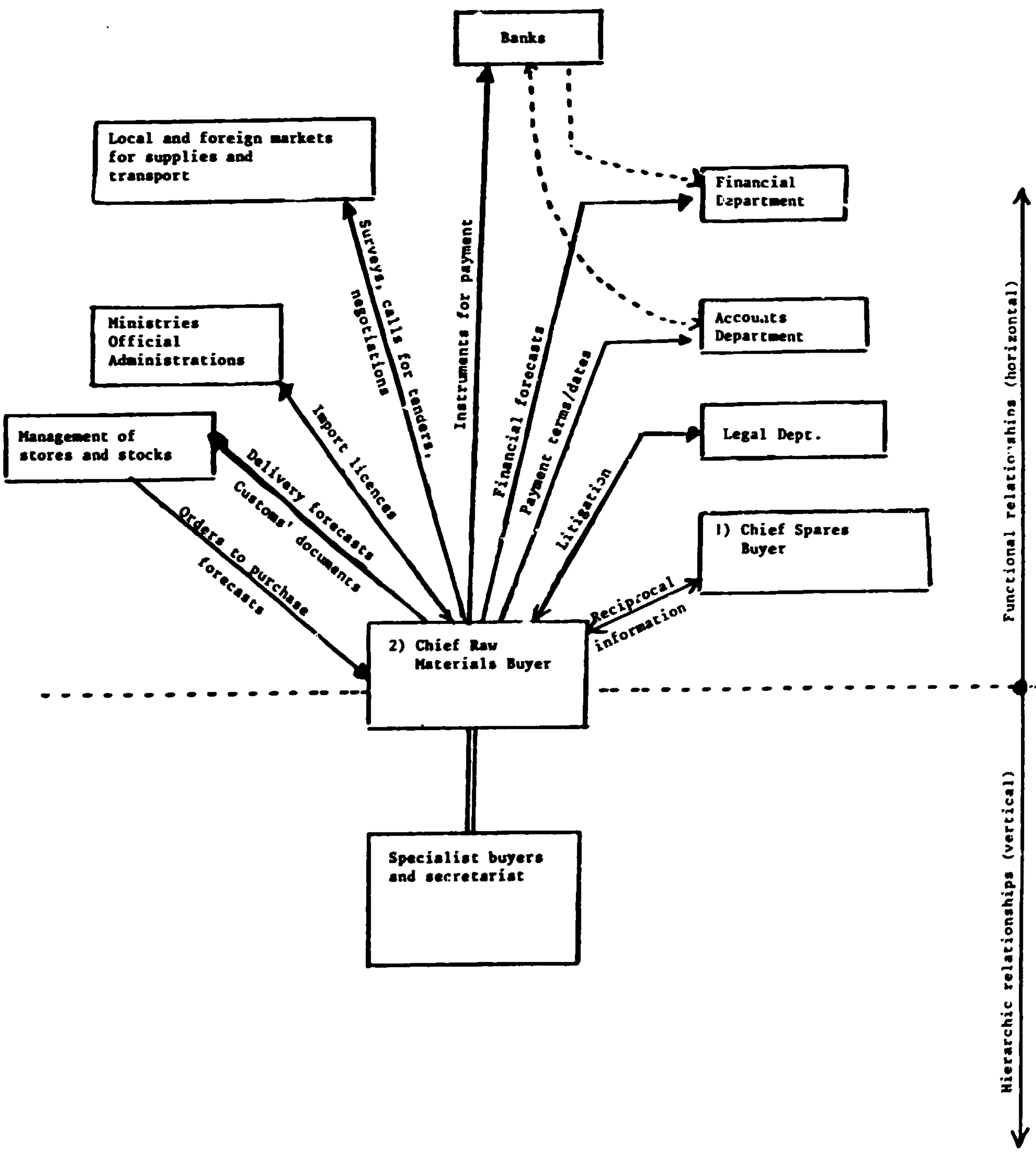
- Reception/grouping and dividing up of the orders to purchase.
- Fixing the work programme and the methods for applying the purchasing procedures for his subordinates, controlling their work and taking in hand the important operations.
- Procedures for calling for tenders, negotiations and the processing and following up of orders.
- Participations in the necessary approaches to the authorities and banks in the case of purchases from abroad.
- Surveys of the market for spares, the updating of files and drawing up purchasing policies.
- Forms the necessary pathway for relationships between the suppliers and the users or other interested persons within the plant.
- Relationships with other departments.
- Various tasks involved in the management of his department.

<u>NOTE</u> :

This is a very important task, given that an iron and steel plant is a very large consumer of spares. Delivery times for supplies are vital and the cost of spares constitutes a significant part of the cost price of production.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : CHIEF SPARES BUYER			Code I SUPPLIES

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : CHIEF SPARES BUYER			Code 1 SUPPLIES

4. Details of the functions

4.1. Processing the requests for purchases, organisation of the tasks.

- To receive from the stores and stock manager the requests to purchase parts and spares.
- To examine and sort the requests for purchases by speciality, seeking to make up "packets" without this being to the detriment of the required delivery dates.
- To fix the working programme of his team of specialist buyers by informing them as to the delivery and budget requirements, and establishing with them :
  - . the list of suppliers to be consulted (minimum of 3),
  - . the special details for the application of the buying procedures (distinguishing in particular the urgent rapid delivery purchases and the routine purchases, allowing longer and more detailed negotiations),
  - . the detailed planning of purchases.
- To deal directly with the more important matters, and in general purchases from abroad.

4.2. Procedures for calls for tenders, negotiations, processing, signing and following up the orders.

- He draws up, adjusts where necessary and has approved by the Directorate all the procedures for supplies under his responsibility.
- He is responsible for circulating details concerning the procedures in force, taking special care that they are understood and strictly applied. He ensures that no obsolete procedure is in circulation.

The procedures cover :

- . The keeping up to date, with the engineering department and the stocks and stores management, of the complete catalogue of the articles used in the plant.
- . Establishing and sending out the calls for tenders dossier.
- . The reception, examination and processing of technically comparable tenders (application of the norms and standards) from the commercial point of view (content and details of the prices, delivery, transport, packaging, payment terms, guarantees, penalties, etc.).
- . Drawing up a comparative table of the tenders with comments on the details (contributions of materials, labour, man-hours cost, etc.).
- . The technical and commercial negotiations (use of letters, telex, direct contacts with the establishment of maintenance reports, etc.).
- . The establishment, verification, signing, despatch and acknowledgement of receipt of the orders dossiers.
- . following up the orders dossiers (inspection, reminders, invoicing, possible visits to the suppliers to settle matters in hand. etc.).
- . Arranging invoices and processing them.
- . Dealing with litigation.
- . Settling an order (final payment, summary note for the file for subsequent use).

Note : If it is sometimes found to be of value to utilise open orders the Chief Buyer will establish, and have approved by the Directorate, the corresponding contract, necessarily supplemented with special utilisation procedures.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : CHIEF SPARES BUYER			Code 1 SUPPLIES

4.3. Case of purchases from abroad

The Chief Buyer initiates all the approaches to the official and private authorities in order to obtain the authorisations to import, to establish the banking instruments for payment, the documents for sea transport and for customs' clearance.

To do this he cooperates closely with the Financial/Accounting Department of the plant, under the authority of the Directorate.

He is the best placed person to establish the most realistic annual forecasts for imports, so as to allow the opening of an annual imports credit and so to avoid the administrative problems generally raised by successions of sporadic operations.

In this specific field he must be conscious of being one of those most responsible for the secure functioning of the plant and for improvements in cost prices.

4.4. Market surveys, updating of the suppliers' files, elaborating purchasing policies.

Arising from the above, and in particular from 4.3., the Chief Buyer must keep himself constantly aware of developments on the local and international markets for parts and spares, to establish and to update the documentation on these, to encourage reflections by the user departments in the plant and to draw up supplies policies.

To do this he subscribes to publications of an economic and technico-commercial type, of various origins, and maintains relationships in the industrialised countries with official, corporate or private bodies capable of elucidating the evolutions on the markets: within his own field he participates in the life of those associations, institutes and trade organisations in his own or in neighbouring countries which share analogous economic or geo-political conditions and which are created in order to compare experiences and, if necessary, to develop common orientations (setting up and maintaining purchasing offices in the industrialised countries).

In his field of responsibility he must be the eyes of the plant on the industrial and commercial world. Other departments must be the eyes of the plant on the technical and technological world: from these two photographs of the world the Directorate of the plant must elaborate its policies, that is to say the way towards "the best possible". In this stereo-photograph the Chief Spares Buyer has an irreplacable role to fulfil.

4.5. Forms the necessary pathway for relationships between the suppliers and the users or other interested persons within the plant.

Every relationship between the world of spares suppliers and any of the personnel of the plant (including the Director) must pass, at least for information, through the Chief Buyer. This is an absolute rule. In order that it is more easily accepted and complied with the Chief Buyer facilitates and organises all contacts of a technical type with the user departments, and provides assistance from his department. He retains exclusivity in regard to all relationships of a commercial type.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : CHIEF SPARES BUYER			Code : SUPPLIES

4.6. Relationships with other departments of the plant

The efficacy of his own department is linked not only with a knowledge of the world of suppliers (cf 4.4. above) but also to a good coordination of the expression of internal needs. In this latter field the role of the Chief Spares Buyer is located on two levels :

- coordination of matters in progress,
- the drawing up of increasingly suitable policies (progressive actions).

We should in particular cite the relationships with :

- stock and stores management (supplementary information on requests for purchasing, modification of re-supply dates because of variable delivery dates, customs' clearance, litigation, etc.);
- engineering and maintenance : technical modifications to parts and/or tools capable of reducing financial costs due to the purchasing of spares;
- technical control : qualitative litigation;
- legal/insurance : drafting contracts for orders, litigation;
- financial and accounting : information on the solvency of suppliers, establishing dossiers for the authorisation of imports, payment instruments, timetables for cash-flow control, transfer of invoices for payment, etc.

4.7. Management of the department

- Updating of the planning of work in hand;
- Forecasting work loads;
- Management of buying personnel : salaries, holidays, replacements, promotions;
- Training of new personnel.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : CHIEF SPARES PUYER			Code 1 SUPPLIES

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : CHIEF SPARES BUYER			Code 1 SUPPLIES

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Higher School Certificate* in technical subjects Diploma from a school or institute of commercial studies Languages : spoken and written commercial English *Baccalauréat					X
5.1.2. Supplementary vocational knowledge	At least 6 months' training in a similar post in a plant in an industrialised market economy country. Numerous contacts with the principal suppliers of equipment and a survey of their sub-contractors (survey and study visits). Training in sales with a manufacturer of equipment is not without value.					X
5.1.3. Diversity of the techniques used	All commercial and commercial law techniques. Procedures in consultations, negotiations, drafting clauses of contracts, following up and settling orders. Application of these to a very wide range of cases.					X
5.1.4. Type and complexity of intellectual processing	Negotiation is the principal activity of the function: this assumes a high level of ability in the rapid processing of numerous and varied items of information, quantifiable or not, the perception of their relative value and the clear formulation of positions. Intelligence and intuition be balanced.					X
5.1.5. Type and complexity of physical activities	Office activities.	X				
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : CHIEF SPARES BUYER			Code I SUPPLIES

5. Evaluation of requirements 5.2. Behaviour	Requirement ratings	1	2	3	4	5
5.2.1. Degree of vigilance	- The information which is useful in negotiations does not all result from systematic working, but may arise unexpectedly and so assumes, if it is to be collected, a certain gift of observation and a mind constantly on the alert. - The control of the application of the procedures requires systematic attention and strict organisation (updated catalogue of the parts used, a check-list, organised reminder systems, follow-up sheets for the dossiers, etc.					X
5.2.2. Degree of contrast of the useful information	- Written or typed documents, listings, brochures, VDU. Conversations, attitudes.			X		
5.2.3. Response time.	- Speed of reaction in negotiations is very important : this must be either fast or slow, but suited to the tactics. Response time very short in the event of urgent orders (breakdowns).					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF KEY FUNCTIONS					Page 9/10
Position : CHIEF SPARES BUYER							Code 1 SUPPLIES
5. Evaluation of requirements 5.3. Responsibilities/Powers		Requirement ratings	1	2	3	4	5
5.3.1. Diversity of the activities		Office - meetings - surveys in the departments of the plant - visits outside - Trips abroad.					X
5.3.2. Type of pilot information for others		- For subordinates : procedures, work programmes, instruction notes, control of operations. - For other departments : information on the markets and on new products. Circulation and explanation of the supply procedures, forecasting expenditure - circuit for the approval and payment of invoices - delivery notes - settlement of litigation. - Outside the plant : statement of needs, negotiations, orders for supplies, requests for import licences, settlement of customs' operations, instruction dossiers for litigation.				X	
5.3.3. Diversity of functions piloted		- Hierarchically : 3 buyers and secretariat. - Functionally : management of stocks and stores, accounting/finances, maintenance and engineering, transport. - Externally : suppliers and providers of services, official authorities, bank, port and airport and customs administrations.					X
5.3.4. Position of the external controls		By the satisfaction of the requesting parties (delivery and quality) and the Directorate (cost). Judgement on the medium term.			X		
5.3.5. Precision of imputation of consequences		The department for which he is responsible is generally the sole origin of the consequences, apart from errors in the nomenclature of the requests for purchases issued by the stores/stocks management			X		
5.3.6. Precision of directives		The directives indicate a result to be achieved (delivery, quality, cost) : it is the responsibility of the office holder to determine the strategy, to choose the necessary procedures and to organise matters so that the objective is attained.					X
SUB-TOTAL		Responsibilities/Powers					

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : CHIEF SPARES BUYER			Code I SUPPLIES

6. Summary of the requirements ratings

	Points	%
Sub-Total : Know-how	21/25	84
Sub-Total : Behaviour	13/15	87
Sub-Total : Responsibilities/Powers	25/30	83
TOTAL		254

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

1) Objective :

To obtain, under the best conditions of quality/purchase price, delivered to the plant, scrap, ferro-alloys, non-ferrous metals (mineral and metallic additives), wood etc., against calls for deliveries and orders.

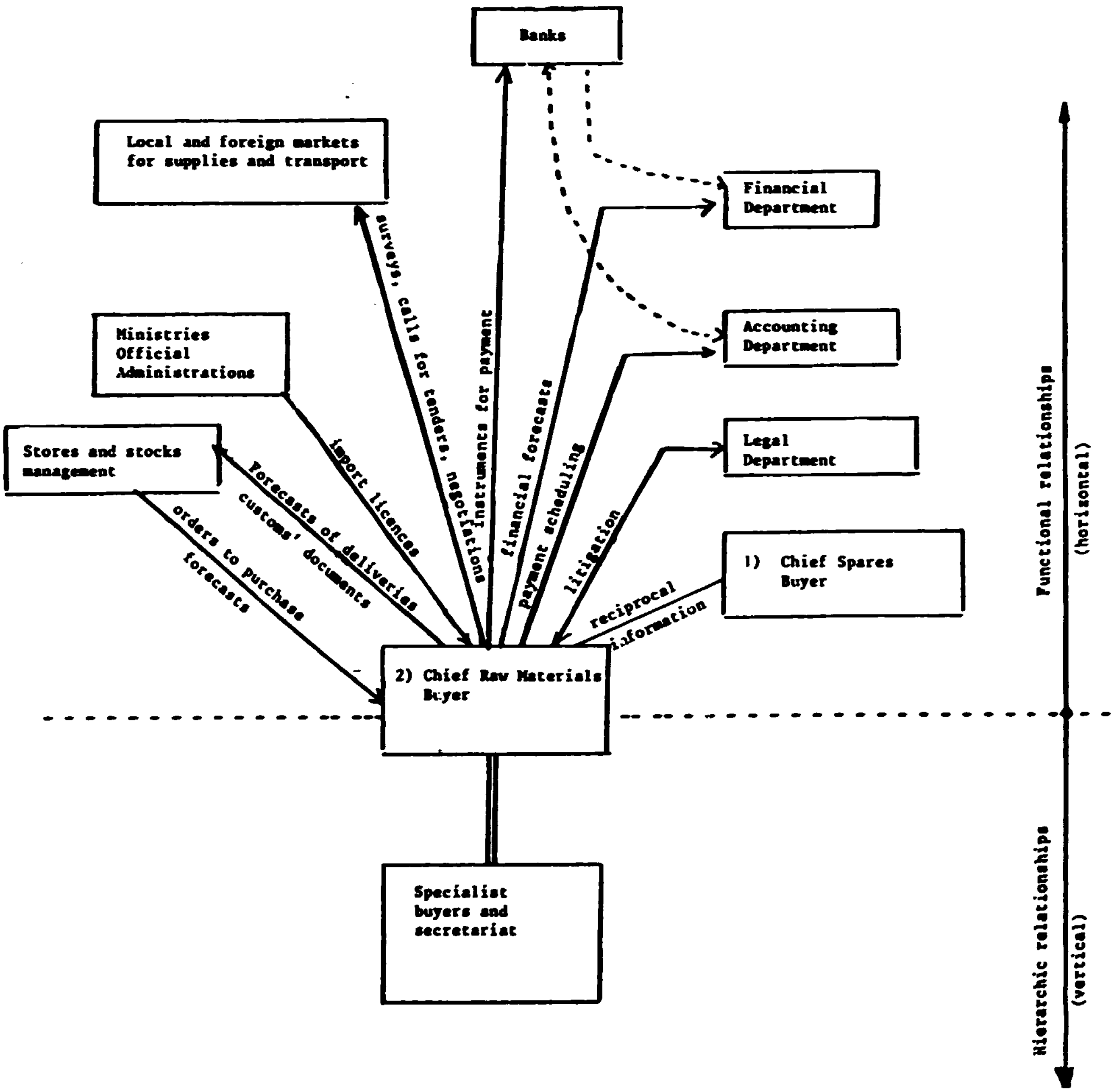
2) Summary of the functions

Under the authority and the responsibility of the Director of Supplies he carries out, and has carried out by his team, the following tasks :

- Materials and products concerned :
  - scrap,
  - ferro-alloys,
  - non-ferrous metals,
  - minerals -
    Spar
    Dolomite
    Lime
    Limestone flux,
  - casting additives,
  - refractories;
  - semi-products and flat and long metallurgical products for use in the workshops;
  - wood :
    packing timbers
    pallets
    packaging wood.
- Procedures for calls for tenders and orders.
- Instruction and settlement in litigation.
- Knowledge of the market and filing information on it.
- Relations with the local official authorities and financial bodies.
- Management of the personnel under his control.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

3) <u>Diagram of the relationships</u>



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

4. Details of the functions

4.1. Procedures for orders and calling for tenders

4.1.1. "Open order" procedure

- Negotiated on a yearly basis.
- Consultation three months before renewal on the basis of quantitative and qualitative indications (forecasts) from the requesting departments (call for tenders).
  . reminders if needed.
- Collating the replies.
- Drawing up comparative tables.
- Choosing and dividing up the quantities between the suppliers.
- Drafting the open order and presenting to the Directorate for signature.
- Calling off deliveries on monthly stock management reports.
- Follow up of deliveries and invoicing.
- Drawing up and following up bank, customs and insurance documents.

4.1.2. "As required order" procedure

- Handled as required on request for purchasing issued by the requesting person (normal and urgent purchase order procedures) and forwarding after verification with the stock management.
- Consultation - call for tenders - eminders.
- Collating the replies.
- Comparison table.
- Choice of the supplier by the Buyer or on the advice of his hierarchy and of the requesting person, according to the importance of the order.
- Drafting of the order, typing and submission for signature.
- Follow up of deliveries (reminders before and fter forecast date of delivery, up to time of effective delivery) and of the invoices.
- Drawing up and following up of bank, customs and insurance documents.

NOTE : Variations in procedures according to the size or urgency of the orders, according to the regularity of the supplies and of relationships with them : telephone + telex + regularisation of the order.

4.2. Instruction and settlement of litigation

4.2.1. Quantitative litigation initiated on reception

- Request to supplier to investigate.
- Invoice may be blocked until settlement of litigation or payment against promise (written, according to supplier) of subsequent settlement (debit or additional product).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

4.2.2. - Qualitative litigation resulting from a divergence (more than 0.1) between the seller's and buyer's analyses, may open the way to either party to analysis for arbitration purposes.

4.2.3. - Qualitative litigation detected after analysis (without exchange)

If the divergence is not important rediscussion of the price. In the extreme, rejection of the product.

4.2.4. - Invoices returned by invoice control for non-conforming prices

After investigation by the supplier and according to the contract the invoice may be cancelled, or a credit required, or acceptance if the price is justified (justification provided by the supplier).

4.2.5. - Possible recourse to the insurers

4.3. - Understanding of the market data and filing of the details

4.3.1. - All surveys, documentation, expert advice on the state and evolution of the markets, list of known or potential suppliers, with their nearest contacts, the history of relationships, etc., should be filed (with data processing if possible) and kept updated.

4.3.2. - Recording and updating of the principal economic indices affecting price changes, accompanied by their application procedures.

4.3.3. - Issuing recommendations on forecasts for better economic conditions when issuing orders (a dialogue with stock management to guide the decisions of the Directorate).

4.4. - Relationships with the local official authorities and financial bodies

- with the Financial/Accounting department of the plant, obtaining and processing the instruments for payment (total sums, scheduling of payments, expected payment dates, documentary letters of credit, etc.) with the banking bodies, and obtaining the import licences.

- with the selected forwarding agent the processing and follow up of the customs documents and the import procedures: all the effective customs' clearance operations are under the responsibility of stocks and stores management.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

4.5. Management of the buying personnel under his direct control :

- attendance, absences, etc.
- holidays
- assessment.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

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UNIDO No. 3/84	ChAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Higher School Certificate + School of Commerce. Foreign languages : spoken and written commercial English				X	
5.1.2. Supplementary vocational knowledge	Experience in several buying posts with more than 6 months in each, one involving experience abroad in an industrialised country				X	
5.1.3. Diversity of the techniques used	Techniques of a buyer and a minimum of technical competence in regard to the materials to be purchased so as to be able to negotiate usefully. Some concept of commercial law.				X	
5.1.4. Type and complexity of the intellectual processing	Numerous parameters to be processed, not always quantifiable. Choice of supplier as a function of the quality and price of the products, of delivery dates as compared with the competition, and former performance (constancy of relationships, quality, etc.) and the possible evolution of all these variables.				X	
5.1.5. Type and complexity of the physical actions	Work on written texts. Some work with a calculating machine.	X				
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 8/10
Position : CHIEF RAW MATERIALS BUYER							Code 2 SUPPLIES
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.2. Behaviour							
5.2.1. Degree of vigilance		During the negotiations (direct oral, by telephone, telex or letter) to seek those indications making it possible to ascertain the real position rather than the displayed attitude of the seller. Special attention to drafting letters and contractual clauses. A good memory is essential, as is also discretion.				X	
5.2.2. Degree of contrast of the useful information		Simultaneous utilisation of handwritten documents and telephone conversations; variety of behavioural patterns in person-to-person contacts.			X		
5.2.3. Response time		Close deadlines are exceptional (emergencies). In general a buying operation should be initiated as far in advance as possible of the limiting date for concluding it: the buyer must there fore anticipate.			X		
SUB-TOTAL Behaviour							

UNIDO No. 3/34	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

5. Evaluation of requirements

5.3. Responsibilities/Powers

	Requirement ratings	1	2	3	4	5
5.3.1. Diversity of the activities	Purchasing procedure with numerous variants (litigation, analyses) and obligatory relationships with the departments to resolve their supply problems (technical and economic aspects).			X		
5.3.2. Type of pilot information for others	- Hierarchically : instructions to the secretariat for typing the documents (letters, orders). - Functionally : - exchanges of information with other buyers, - providing factors for the financial forecasts to the Finance/Accounting Department, - giving working documents to the stores/stocks management for the reception and customs clearance of deliveries, - outside the plant, an influence on the attitudes of suppliers which may contribute towards the development of the local market, - coordination of the various departments and bodies in solving disputes.			X		
5.3.3. Diversity of functions piloted	Suppliers, buying employees, stocks and stores management, transport and accounting departments, banks, customs, port and forwarding agent.				X	
5.3.4. Position of the external controls	Medium and particularly long-term control by the technical and financial results of operation.				X	
5.3.5. Precision of imputation of consequences	Work of the buying team under his control.		X			
5.3.6. Precision of directives	May himself organise his activity as a function of the requests received (importance, delivery, examination of the priorities, etc.) and even by anticipation of the needs in order to influence or to test the market.				X	
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : CHIEF RAW MATERIALS BUYER			Code 2 SUPPLIES

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	16/25	64
Sub-Total Behaviour	10/15	67
Sub-Total Responsibilities/Powers	20/30	67
TOTAL		198

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

1) Objective

To ensure, or to have ensured, at the minimum cost the continuing levels of the stocks of raw materials, miscellaneous items of equipment, spares, tools and individual or collective items.

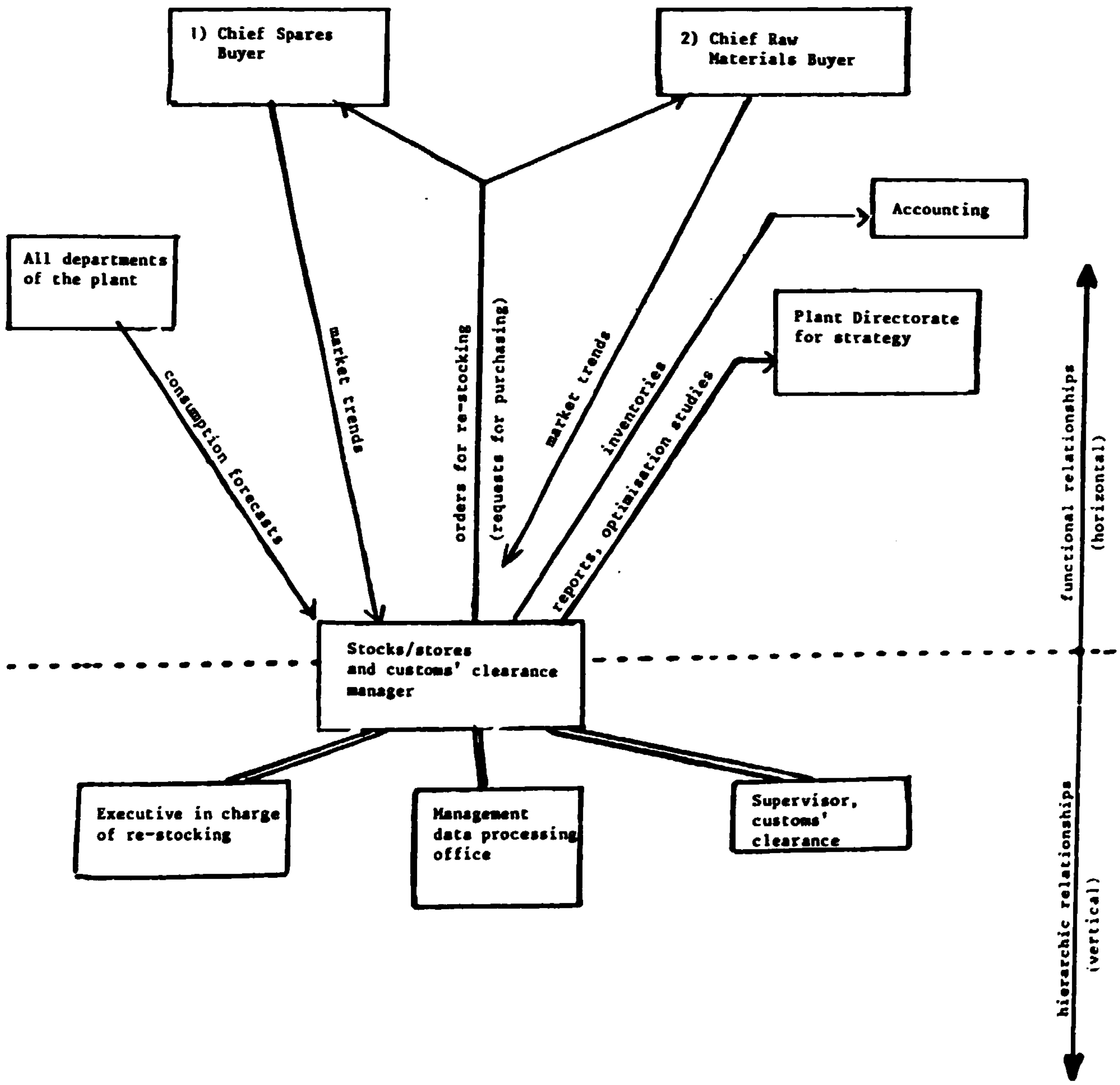
2) Summary of the functions

Under the authority and the responsibility of the Director of Supplies he carries out, or has carried out by his personnel, the following tasks ;

- the study and optimisation of stock levels (EDP management);
- the reception and processing of all requests for purchasing and the notes for withdrawals from stores or stocks;
- issues orders for re-stocking to the buying department;
- operation of the stores and central stocks in conjunction with the sectoral stores;
- customs' clearance operations;
- management of the personnel placed under his control.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

3) <u>Diagram of the relationships</u>



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

4. Details of the functions

4.1. Organisation of the work of the personnel under his control

The manager organises and coordinates the work of the various working groups (see under 3) above : Diagram of the relationships). On the basis of the instructions received he is responsible for having the procedures applied, whilst including the variants needed to solve special cases. On his own initiative he intervenes at re-stocking level to settle litigious cases : equipment essential for production, security equipment, stock breakdowns, etc. in coordination with the departments concerned.

In the case of the management group he guides their studies, calling for the issuing of statistical summaries based on the data which seem to him to be necessary to take note of and to correct any anomalies or problems revealed in this manner.

He is also responsible for inputting into the computer such information as is essential for the satisfactory re-stocking of materials by means of punched cards in the data processing office.

4.2. Study and optimisation of stocks

Aim :

To know, in detail, the composition of the stocks and, consequently, to make the necessary modifications to optimise it.

Means :

The manager requests computer print-outs from his data processing office, giving him all the information which he judges to be of value so that he can have the most "meaningful" facts :

- Articles for which no provision for re-stocking is laid down (NPR) { total - NPR stock = 0 - NPR stock ≠ 0 consumption
- Transferred articles { by type of follow-up value of stock, transfer, transfer alert consumption value, etc.
- Safety stock (SS) { SS greater than X weeks and ≠ 1 SS = 1 ... with their values
- Breakdown by mean weekly consumption tranches (MWC) (based on tranches utilised by invoice control) { values of stock, SS, MWC number of articles by tranche, etc.
- Excess stocks { Stock higher than a multiple of MWC (n to be determined) with stock values, SS and excess stocks.
- Resale - sending to scrap (estimate of the value.
- Graphical management (stock value, SS, MWC, etc.)
- Preparation of plan for routine re-stocking { consumption ≤ X (to be determined) price 50 Francs (or other value to be determined).

For each case the manager requests an in-depth study from the management/computer group, making it possible to adjust the stock of the various articles from the point of view of the maximum reduction (economies), by utilising in certain cases a replacement article until the latter is exhausted.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

4.3. <u>Reception and processing of all requests to purchase and notes for withdrawals from stores or stocks</u>.

4.3.1. <u>Reception and distribution of mail</u> (from the secretariat)

- Sorting of notes and distribution to the groups involved (1) except for special cases which are analysed and handled by the manager.
- Sorting of Purchase Orders (P.O.)
  - a) P.O. for Equipment managed by the department ⟶ Re-stocking. (are passed on to the Buying Department after verification of price and quantity - if necessary contact issuing person for clarification).
  - b) P.O. for Equipment out of stock handled by production (tools).
- Verification of requests for entry into stock
  - a) General consumption items : sent to authorised signatories
  - b) Other items - verify the correctness of the request, based on the utility of the item and its price.
    - sent to the authorised signatories who may request justification before authorisation.
  - c) Items covered by a technical manager not having buying authorisation.

4.3.2. <u>Grouping and processing of the purchase orders</u> (P.O.)

At the end of each day the re-stocking manager passes on the verified P.O.s.

The manager :

- visually checks the figures on all the P.O., especially those involving items of equipment;
- initials the P.O and passes them to the Buying Department for action;
- in the event of an anomaly on a P.O. -
  - ⟶ justifications to re-stocking manager
  - ⟶ indicates if necessary the procedure to be adopted, including such variants as he feels to be of value.

4.3.3. Follow up of activity

a) Of the data processing/management office;

b) Of the Purchase Orders from the re-stocking section (daily and monthly);

c) Of the studies in hand by the management group;

d) Of all the activities of the department on a table :
. Number of withdrawals
. Number of transfers
. Number of receptions;

e) Of messages from data processing :
. Shown on VDU
. Sent out each week and each month
. Filed by the department;

f) Monthly check of the Purchase Orders by technical manager (computer listing) :
. P.O. number
. Date of issue
. Part number

Making it possible to cancel or issue reminders on old P.P.'s.

4.3.4. Forecasting purchases of working clothes (jackets, trousers, boiler-suits)

To be done 4 months in advance so as to order from suppliers who have problems obtaining their raw materials.

4.3.5. End of year inventory (from manual file)

Indicating the code, the text and the stock; passed to analytical accounting.

4.3.6. Control of the work of each group

This control is intermittent and can only be effected by sampling or on the occasion of an investigation or, more specifically, in the event of a problem (e.g. loss of stocks).

4.3.7. Information

The holder of the position is very frequently asked by various sectors to explain the procedures to be applied or to give information concerning supplies.

4.3.8. Issuing catalogues

A - Request for computer listing by families of items. These listings indicate the items concerned by code and specify :
. the storage area
. the unit
. the price
. the existing stock.

This listing is then produced as a volume, reduced in size and bound by families. A distribution list is drawn up.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

4.4. Customs' clearance and reception operations on deliveries

These are carried out in the central stores or stocking areas or in special areas as arranged with the Customs' Office so that the customs officers can operate. On the plant side these operations are supervised by Chief Stores and Stocks Foreman and his shift teams, under the holder of the present position.

4.5. Management of the personnel under his control

The manager, with the assistance of his heads of groups, is responsible :

- for the attendance of his personnel (absences, illness, authorisation to leave the plant, etc.)
- for planning the paid holidays
- for training newly appointed personnel.

He also has to settle problems which may arise at personnel level; he gives his advice to the head of the Department in regard to appointments, changes of post and promotions (as required).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Higher School Certificate with stock management training (Technical College, Supplies studies) Course in computer management				X	
5.1.2. Supplementary vocational knowledge	Stream followed : Re-stocking office (several years) Re-stocking manager (1 to 2 years) and in this post (long experience)				X	
5.1.3. Diversity of the techniques used	Fields : stock management - personnel management, specifically in the administrative and informatics fields		X			
5.1.4. Type and complexity of intellectual processing	The holder of the position has the data provided by the statistical statements. After making contact with the persons involved he modulates these elements according to the frequency of use of the items and their value. On the basis of this new data he determines the most valid mode of management to meet the needs of the requesting parties, avoiding excess stocks or stock breakdowns.			X		
5.1.5. Type and complexity of the physical activities	Writing, with frequent use of the computer keypad.	X				
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 8/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER							Code 3 SUPPLIES
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.2. Behaviour							
5.2.1. Degree of vigilance		Control of the work carried out by his subordinates				X	
5.2.2. Degree of contrast of the useful information		Utilisation of written documents, computer listings and visualisation using a VDU		X			
5.2.3. Response time		Normal deadlines, but urgent situations may arise			X		
SUB-TOTAL Behaviour							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Three procedures : Stock management with the corresponding studies; Personnel management (work organisation, attendance, paid holidays, internal job changes, etc.) Relationships with the buyers.			X		
5.3.2. Type of pilot information for others	Determining the work programmes for the managers, utilising the informatics programme and by specifying the stages, the final objective and, where necessary, a deadline. Also specifies the re-stocking procedures for special cases, and controls the application of these		X			
5.3.3. Diversity of functions piloted	Buying (P.O.'s, special cases, reminders, economic quantities, etc.), Managers (procedures to be followed, changes of type, follow up etc.), data processing (setting up and modifying grids), accounting (prices and delivery), requesting personnel (information), Stores, Pool, Stock control, Reception (conformity of materials).				X	
5.3.4. Position of the external controls	Modifications to the re-stocking procedures cannot be validated except during or after processing (stock breakdown). Drawing up working instructions without prior control.				X	
5.3.5. Precision of imputation of consequences	Training of teams carrying out different work (re-stocking - managers - punched card operators - employees)		X			
5.3.6. Precision of directives	The procedures being fixed in advance the manager must choose them and adapt the necessary variants as a function of the characteristics needed and the objects being handled. Furthermore work organisation is essential to meet the needs of the requesting personnel.			X		
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : STORES/STOCKS/CUSTOMS' CLEARANCE MANAGER			Code 3 SUPPLIES

6. <u>Summary of the requirement ratings</u>

	Points	%
Sub-Total Know-how	14/25	56
Sub-Total Behaviour	9/15	60
Sub-Total Responsibilities/Powers	18/30	60
TOTAL		176

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : STOCK CONTROL MANAGER (RE-STOCKING)			Code 4 SUPPLIES

1) Objective :

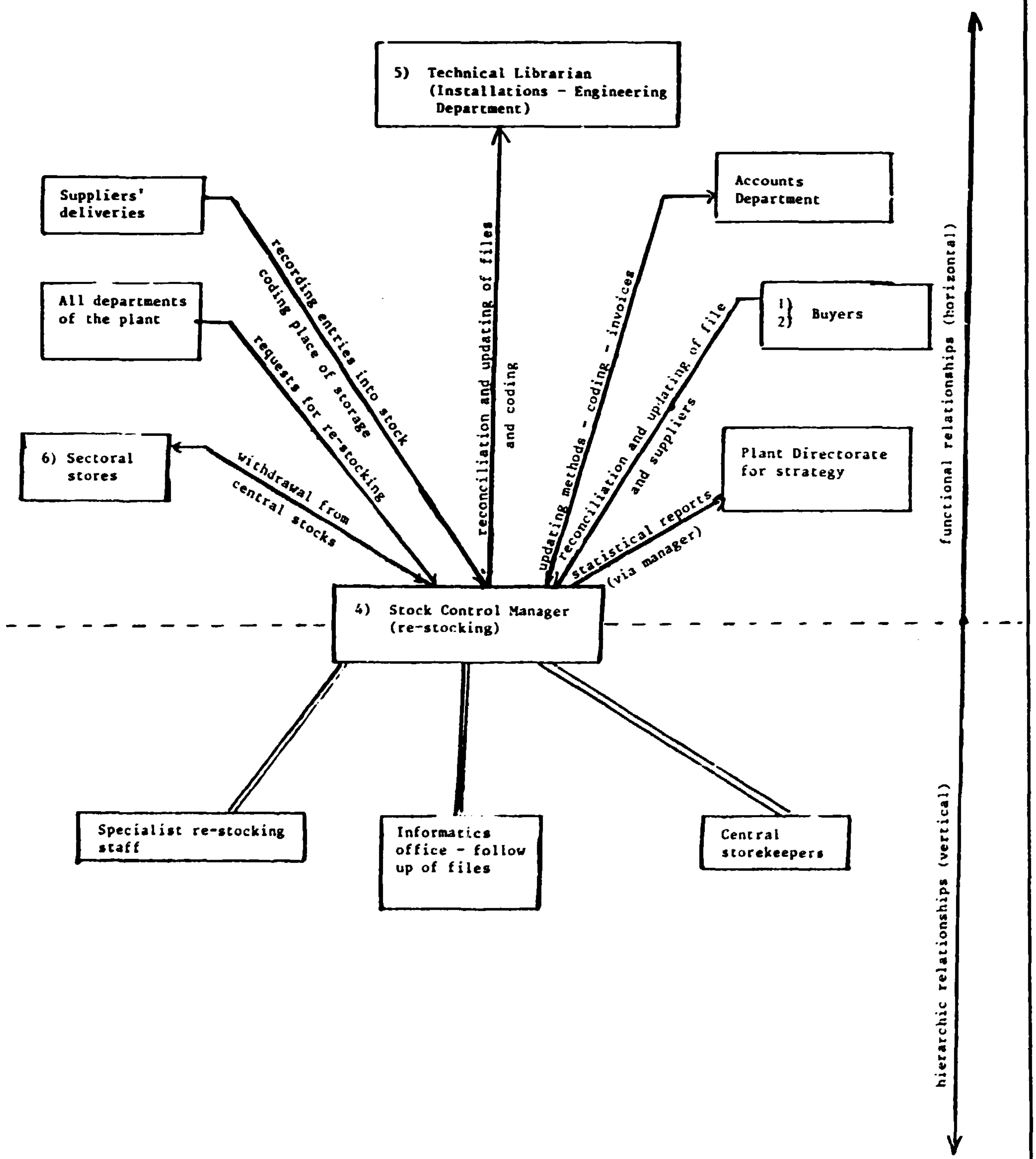
To maintain stocks at their safety value by issuing purchase orders in good time.

2) Summary of the functions

- Establishing and maintaining up-to-date a complete file of all current consumption articles for the plant.
- Ongoing completion and statistical utilisation of the file by items in stock :
  - . Follow up of the ingoing and outgoing operations,
  - . Setting a limiting value for re-stocking as a function of changes in consumption and of delivery dates.
- Processing the stock withdrawal notes and issuing purchase orders.
- Issuing reminders to the buyers.
- Circulating statistics with a view to improving stock management.
- Administrative work in the control and management of the stock and stores management department.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

3) <u>Diagram of the relationships</u>



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

4. **Details of the functions**

Under the authority and the responsibility of the Stock and Stores Manager he carries out or has carried out the following tasks :

4.1. **Complete file of the items for consumption** :

4.1.1. Computerised file (provision for about 40,000 items) constituting the sole reference for all the plant, allowing the unequivocal indentification of all consumption needs : materials, parts, tools, office or sanitary supplies, clothing, etc.

4.1.2. This file is established in cooperation with :

. the department of engineering and new works which holds and updates all the technical documents (specifications, drawings, notices, nomenclatures) with their modifications.

. the maintenance/workshop department and its sectoral branches to take their working methods into account.

. the production, general services and utilities departments, for their information and for any comments which they can make.

. the buying and accounting departments.

4.1.3. The coding scheme is designed to allow the addition of items resulting from technical modifications and the development of the plant.

4.1.4. No modification of the file may be made without the written agreement of the parties concerned (cf. above 4.1.2.), and they must verify that all the basic documents (drawings, notices, specifications, nomenclatures, etc.) have been made coherent and circulated with an instruction to destroy the obsolete documents.

4.2. **Ongoing completion and statistical utilisation of the file**

4.2.1. The file constantly indicates the quantity of each item in stock, in the central store and in the sectoral store.

4.2.2. Every operation of addition to or removal from the central stocks and stores and the sectoral stores is recorded in the file on the date of signing of the stock entry or stock withdrawal note (joint signatures of the storekeeper and the recipient).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

4.2.3. Every request for re-stocking (purchase order) is to be the subject of a note on the file on the date of issuing it, with an indication of the quantity.

4.2.4. For every item the file includes the following notes :

- the forecast mean consumption (weekly, monthly or yearly) or the indication "safety" when it involves an item not normally consumed but for which the absence of stock could prove to be very prejudicial in the event of an accident (rotor of the motor for the rolling stand, for example).

- the codes identifying the place of storage: stocks and central or sectoral stores, and stock movements between them.

- the real mean consumption as actually found, so as to identify deviations from the forecasts.

- the mean delivery time separating the date of issuing a purchase order and the date of effective entry into stock.

- the reference value to trigger re-stocking. This reference value may change, being a function of the statistical processing of the consumption figures and the delivery times: it is the manager of the stocks and stores management department which fixes it, after processing the statistics produced by the stock control manager and after investigation of the causes (systematic or random) of any anomalies.

<u>NOTE</u> : Informatics facilitates the management operations and demands rigorousness in the application of the procedures, but it is only a means and does not relieve the stock control manager and the other departments concerned of the effort necessary to forecast, observe, reflect, organise and optimise.

4.3. <u>Processing the stock withdrawal notes and issuing the purchase orders</u>

4.3.1. <u>Stock withdrawal notes</u>

- Normal case : registration by informatics follow up - evaluation of the deviation from the reference value for re-stocking and provision made for purchase order (planning of work load).

- Anomalies :

  . withdrawal notes not honoured : investigation into causes (possible breakdown in a sectoral store ? obsolete item replaced by another, concerning which the requesting party has not been notified ? consequence of a decision to maintain nil stocks ? etc.) - Rapid reaction to resolve the problem.

  . items unknown : verify the code and, if necessary, carry out an investigation. Search for a replacement item with the requesting party, or request for urgent supplies after having entered the new item in the file, according to the procedures as indicated above (cf. 4.1.4.).

  . withdrawal note honoured but dispute as to the quality of the item. Make a replacement and send the report to the Buying Department for litigation.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

4.3.2. Purchase orders

- Issued by the department as a result of the triggering of re-stocking (reference value reached).

- Verification of the purchase order on three principal points :

. quantity requested and delivery : function of delivery dates (verify from buying department if the known dates are still valid) and of the mean consumption (statistical trends);

. safety stocks (central + sectoral) more or less breached by the latest withdrawals;

. price of the item (if high, avoid major stocks);

. transmission to Buying via signature of the stock manager;

. information to stock follow up file.

4.4. Reminders to the Buyers

Consciousness of being the essential lung between supplies and consumption. This function goes far beyond that of a storekeeper. It is more related to that of a retailer-distributor, desiring always to satisfy its consumer clientele.

The holder of the post thus organises a circuit for systematic reminders to the Buying department in order to ascertain at each instant the position of the purchase order in regard to planning and, if necessary, to indicate the orders of priority before actual situations of urgency, which are always costly, appear. This is a regulating function, involving a considerable contribution from intelligence, from care for details and from a desire to result in stable and economic operation.

4.5. Circulating statistics with a view to improving management

The monthly report should indicate :

- the stock situation
- stock movements
- anomalies in stock movements and their probable causes (following an investigation if necessary)
- forecasts of probable dates of stock breakdowns
- the situation regarding purchase orders.

This monthly report is the subject of circulation via the stocks and stores manager who will add to it, for the Directorate, comments and suggestions for improvements (see sheet on the functions of the head of the stocks and stores management department manager).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

4.6. Administrative work

- Distribution of the work to subordinates;
- Personnel training;
- Personnel management (holidays, absences, salaries, etc.);
- Utilisation and drafting of inter-departmental notes to instruct and settle litigation, to obtain or provide further details, etc.
- Is capable of replacing the Stores and Stocks Manager when the latter is absent.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Secondary studies, technical HSC level and/or BTS.* Serious training in management statistics. Knowledge of computer theory and solid practical experience in the use of computer keypads *Higher Technical Diploma				X	
5.1.2. Supplementary vocational knowledge	Operational training of a minimum of 3 months as a storekeeper, and a minimum of 6 months as re-stocking operative in an equivalent steelworks			X		
5.1.3. Diversity of techniques utilised	- Maintaining the complex centralised file (informatics dialogue) - Simple statistical operations.			X		
5.1.4. Type and complexity of intellectual processing	Little complication in the processing, but a large number of subjects to be handled			X		
5.1.5. Type and complexity of the physical actions	Essentially office work		X			

SUB-TOTAL Know-how	

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	The origin of costly disorders is generally to be found in errors in the coding of items, the use by other departments of outdated listings or catalogues and faults in inputs into the computer. The Stock Control Manager is also the corrector of errors, maintaining a clear and reliable common language between supplies and consumption.				X	
5.2.2. Degree of contrast of the useful information	Written documents (manuscript or typed). Computer print-outs (listings). VDU displays.		X			
5.2.3. Response time	In the absence of emergencies, which should be rare, response time is not of primary concern. The regularity and accuracy of processing is much more important		X			
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

5. Evaluation of requirements 5.3. Responsibilities/Powers	Requirement ratings	1	2	3	4	5
5.3.1. Diversity of the activities	Maintenance and control of an efficient routine administrative service, based on totally rigid procedures.		X			
5.3.2. Types of pilot information for others	- Purchase orders - Statistical reports			X		
5.3.3. Diversity of functions piloted	- Storekeepers - Punched card operators and computer operators - Buying, via the stock/stores manager		X			
5.3.4. Position of the external controls	Judged in the medium and long term on the regularity and the reliability of the department on the one hand and on improvements in the cost of stock management on the other.			X		
5.3.5. Precision of imputation of the consequences	Exceptionally the sole person responsible for the results, but generally the sole person responsible for the value of the strategic operation of his statistical reports.			X		
5.3.6. Precision of directives	The procedures are precise and strict, the use of the computer does not tolerate divergencies or impasses. However considerable latitude is left in the day to day organisation and in the choice of priorities in the processing of the purchase orders.		X			
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : STOCK CONTROL MANAGER			Code 4 SUPPLIES

6. <u>Summary of the requirement ratings</u>

	Points	%
Sub-Total Know-how	15/25	60
Sub-Total Behaviour	8/15	53
Sub-Total Responsibilities/Powers	15/30	50
TOTAL		163

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position :		TECHNICAL LIBRARIAN (RESPONSIBLE FOR THE TECHNICAL DOCUMENTATION COVERING THE INSTALLATIONS IN THE ENGINEERING AND NEW WORKS DEPARTMENT)	Code 5 ENGINEERING

1) Objective :

To be responsible for the classification, conservation and circulation of a complete technical documentation, kept updated and coherent in respect of all the installations.

2) Summary of the functions

Directly under the authority and the responsibility of the Chief Engineer of the Engineering and New Works Department :

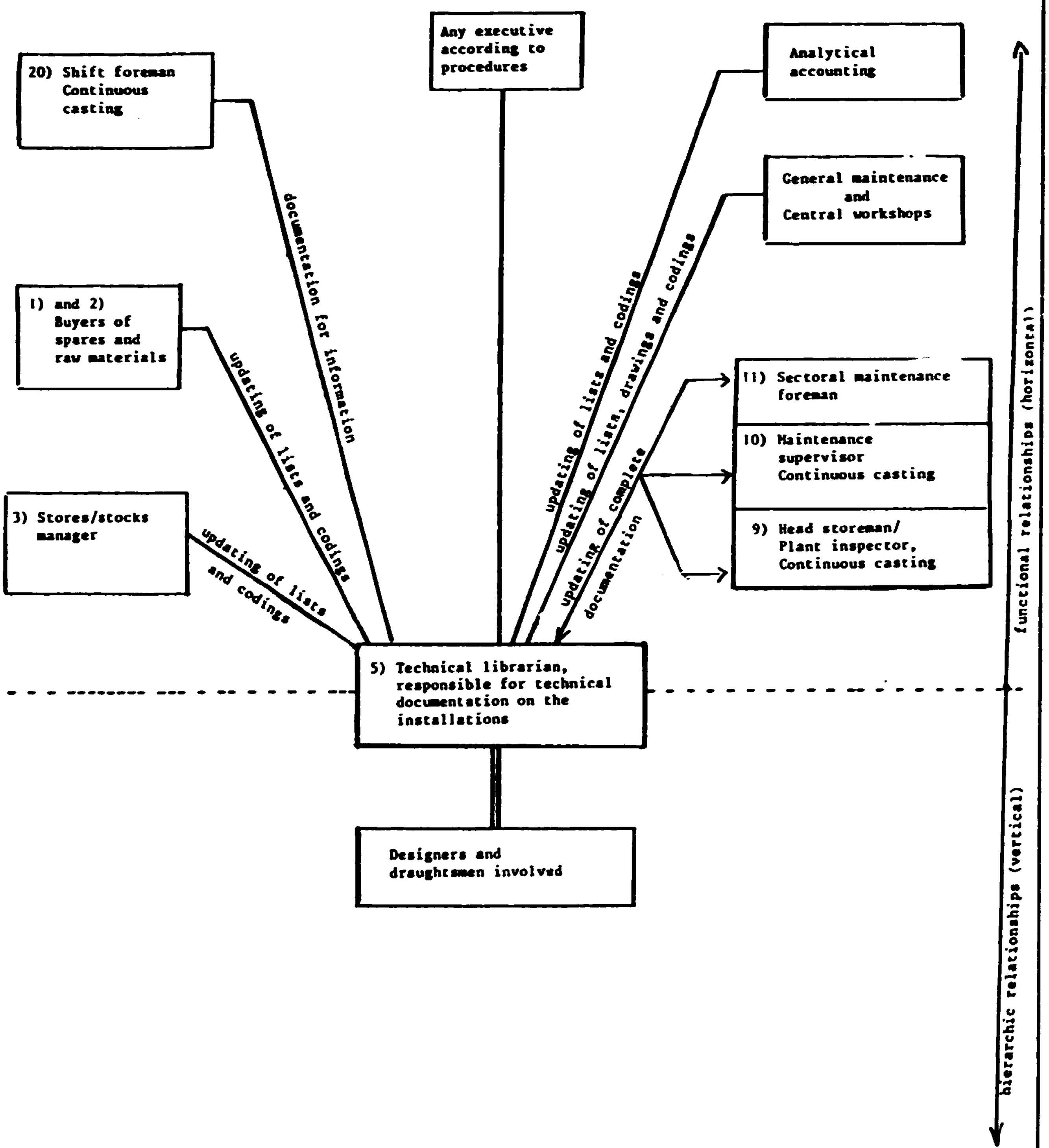
- he retains, supplements if necessary and keeps constantly updated a coherent and codified collection of the technical documents supplied by the equipment suppliers, the design consulrants and the construction enterprises which participated in the construction and commissioning of the plant, and covering all subsequent modifications. This collection of documents is the sole original and legal basis.

- he is kept informed on all the maintenance operations which have led to the replacement of a part.

- he distributes to every user of the documentation, and according to a totally rigid procedure, all those copies which are necessary and sufficient for him, indicating those documents bearing outdated edition numbers which are to be withdrawn from circulation. This function is an important one since it ensures a common and unequivocal language for production, maintenance, supplies and the study of modifications.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

4. Details of the functions

4.1. Retention of the complete, codified and updated collection of the technical documentation

4.1.1. Foundations of the function

The technical documentation handed over by the suppliers of the installations, the design consultants and the construction enterprises which participated in the construction and the commissioning of the plant do not, generally, form a coherent collection and do not always include the degree of detail required by operation, maintenance and the provision of supplies of consumable parts. Furthermore not everything has been necessarily designed and calculated according to the same norms and standards, and this may make difficult or hazardous any subsequent modifications if one does not have the calculation notes.

Finally at the time of construction and commissioning modifications may have had to be made locally which have not been the subject of a consistent updating of the documents delivered with equipment which had not at that time been installed.

The Engineering and New Works Department has therefore, as a priority task and as soon as installation is completed, to collect, supplement and present in a form suitable for utilisation all the technical documentation.

No coherent and continuing operation can be undertaken whilst this considerable amount of work remains uncompleted, work which cannot be sub-contracted.

This necessarily team work must have a coordinator. This coordinator is also the guarantee that none of the documents utilised in the plant at any given date can represent "counterfeit currency".

4.1.2. Listing and codification of the documents

4.1.2.1 - to verify that, for every item of machinery, appliance or sub-assembly, the file includes :

- The general installation drawings
- The sub-assembly drawings
- The detail drawings with nomenclature
- The execution drawings (at least for the wearing parts and the civil engineering work)
- The basic, developed, isometric and other layouts
- The specifications
- The cabling diagrams and drawings of the connections
- The calculation notes (for the structures)
- The operating and maintenance notes
- The catalogues
- The identifications and the origins of the components (name and address of the suppliers and their distributors, type, series numbers, etc.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

4.1.2.2 - <u>To codify all these documents in such a way</u> :

. That the coding key for the parts and spares is compatible with the management systems for the stocks and stores, buying and analytical accounting (this assumes cooperation of the operational research type between the departments concerned well before the time of commissioning, so that all the management supports are defined and operative for commissioning).

. That the coding system makes it possible to find easily the relationships and correspondences between the general documents and the detailed documents.

This is important when it involves, as a result of even a minor modification, the consequent modification of all the documents concerned and in this way ensuring the continuing coherence of the parent documentation.

This parent documentation is regarded, throughout the plant, as the sole reference and the sole original from which copies which may be validly utilised are circulated. The parent documentation is retained in a closed and protected enclosure.

4.1.2.3 - The document file, indicating the progress of updating, is maintained by the technical librarian (a computerised system is desirable, from the point of view that it lightens the material work of the technical librarian, requires the rigorous compliance with the procedures and allows those with consoles to find rapidly the information required without the need to handle piles of paper: this is provided that the codification has been correctly carried out from the beginning and that the search program has been written very carefully).

4.2. To be able to accomplish his task the technical librarian is required to keep himself informed concerning <u>all</u> the maintenance operations which have resulted in a repair or to the changing of a part.

. Case of repairing a breakdown :

This is, by definition, an emergency and hence non-programmed intervention.
The technical librarian, who maintains a constant relationship with the sectoral and general maintenance personnel, receives a copy of the report on the work carried out and then makes enquiries to know how the repair work was carried out.

. Case of a programmed operation :

Every programmed operation which involves changing a part or a modification, <u>however minor</u>, must be submitted to the Engineering and New Works Department for approval, and is the subject of an information note to the technical librarian. As in the former case of a breakdown he must be kept informed during and after the work of any modifications which have <u>effectively</u> been carried out.

4.3. He circulates the updating of the documentation, according to totally rigid procedures, and according to a laid down circulation list.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

This information is circulated at two levels :

- Information level No.1 :

  Updating list indicating the list of the documents modified, the latest index numbers as at that date, together with the list of the documents with an obsolete index number which must be withdrawn from circulation.

  If the management of the technical documentation is computerised this note will be the sorted print-out after the updating of the follow up file. This note has a very wide distribution, and the circulation list is appended to the note.

- Information level No.2 :

  As soon as the modified documents, as indicated in the Note No.1, have been verified and initialled by the hierarchy copies of these documents are circulated to the users, according to a more restricted circulation list, each of the users receiving the necessary and sufficient number of copies for his specialist use.

The circulation list for each document is appended to the document and a note circulated at level 1. This repeats the list of obsolete documents which must be withdrawn from circulation.

NOTE : The above assumes that, from the start of operation of the plant, each specialised department or service which is to receive the updatings of level 1 and/or level 2 has been provided with a system of standard files, conforming to the procedures, making it possible to replace the obsolete documents with the updated documents. Nothing is more dangerous, in regard to the classification of technical documentation, than to leave everyone free to choose their method of classification and the supporting equipment used.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	- BTS/Technical Studies Bureau level, general installation. - Technical English. - Course in the use of computer files.				X	
5.1.2. Supplementary vocational knowledge	Minimum of 6 months' training in the Engineering and Works Department of an efficient steelworks before participating in the complete follow up of the engineering during the construction of the plant (2 years), as documentalist in the client's team and in supervising the writing of the file follow up computer program.					X
5.1.3. Diversity of the techniques used	No great specialisation is required, but a good understanding of the relations and constraints between various techniques is very desirable.				X	
5.1.4. Type and complexity of intellectual processing	Understanding of the interdependencies of documents of various types and contents. Memory and method are more important than processing capability.			X		
5.1.5. Type and complexity of the physical activities	Handling of files and of a computer keypad.		X			
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	The coherence of the documents is established by utilising check-lists: nothing must be forgotten, since if coherence is lost it is subsequently very difficult to re-establish. Information on the modifications actually carried out in the installation must be scrupulously verified before being recorded in the documentation					X
5.2.2. Degree of contrast of the useful information	Handwritten or typed documents, layouts, diagrams, sketches, drawings, microfilm readers. Consultation of the files on paper, on a VDU and on print-outs.		X			
5.2.3. Response time	Rarely very short (urgent breakdown repairs). The work is generally programmed.	X				
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINEERING

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Management of the file and classification. Drafting the work programmes for the design office and of the notes for circulation. Sometimes transfer to the interior of the plant for investigations.			X		
5.3.2. Type of pilot information for others	Issuing information notes, circulation of working documents.		X			
5.3.3. Diversity of functions piloted	Production - Sectoral and general maintenance - Engineering and works - Stock and stores management - Supplies.				X	
5.3.4. Position of the external controls	Little control possible at the time: any failure in regard to the coherence of the documentation generally appears well after the time when it was committed				X	
5.3.5. Precision of imputation of consequences	Attributed to the technical librarian or to the Engineering and Works Department (quality of the documents) unless it is proved that the modifications made to the installation have been concealed.			X		
5.3.6. Precision of directives	Fixed and totally rigid procedures	X				
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : TECHNICAL LIBRARIAN			Code 5 ENGINFERING

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	18/25	72
Sub-Total Behaviour	8/15	53
Sub-Total Responsibilities/Powers	17/30	57
TOTAL		182

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

1) Objective :

To be responsible, during his shift, for storing and distributing materials from the steelworks store (miscellaneous materials, tools, health and safety equipment), together with the packaging up of dirty working clothes and their re-distribution after cleaning.

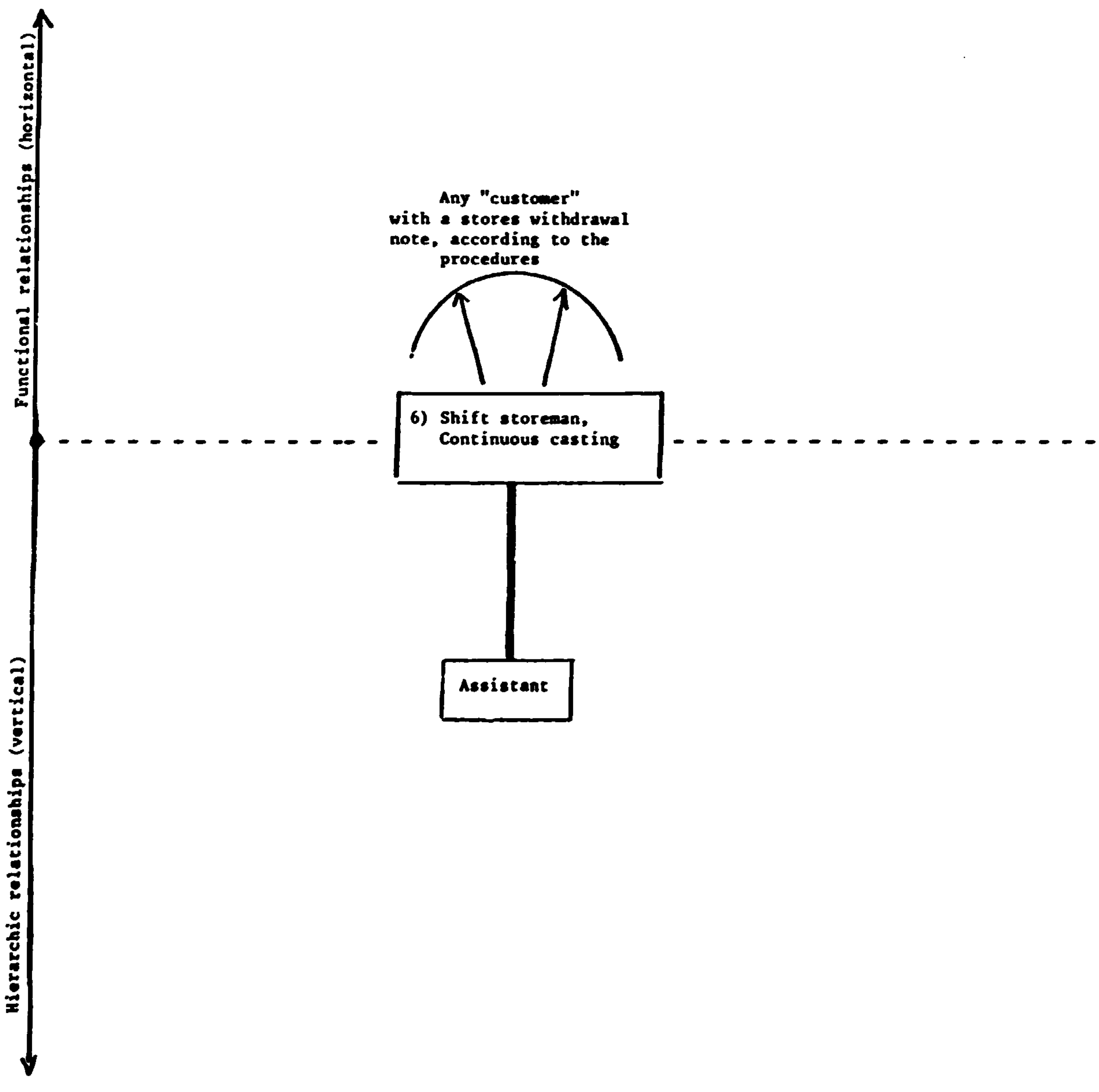
2) Summary of the functions

Under the control of the Head Storeman (staff) :

- Entry into store of electrical and mechanical equipment;
- Withdrawals from store of electrical and mechanical equipment;
- Maintenance of the equipment and order and cleanliness in the store;
- Management of clothing and safety equipment;
- Updating the inventory.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

4. <u>Details of the functions</u>

Under the control of the Head Storeman (staff, not shift) :

4.1. <u>To record entries of electrical + mechanical equipment</u>

- On the basis of the delivery note accompanying the goods :
  . to check the conformity of the delivery, if so requested by the Head Storeman.
- In the event of an anomaly or of non-conformity :
  . to warn the Head Storeman.
- According to the location plan updated by the Head Storeman :
  . to arrange the equipment on the shelves
  . to update the shelving register (or the stock card) by indicating :
    - the quantity entered
    - the cumulative stock in hand
    - the date of movement
    - his initials.

4.2. <u>To record withdrawals of electrical + mechanical equipment</u>

- On presentation of the withdrawal note, or on simple request in the case of a series of items as specified to him :
  . to take out the equipment requested if it is available (free service)
  . to update the shelving register (or the stock card) as in the case of entries of equipment.
- When the ordering point is reached :
  . to complete the note and hand it to the Head Storeman.

4.3. <u>To ensure the maintenance of the equipment and the cleanliness of the premises</u>

4.4. <u>Working clothes and safety equipment</u>

- To bag up the dirty clothing brought to him, grouping it by section of origin.
- To affix a label to the outside of the bags, according to their provenance.
- After the return of the cleaned clothes, and at the request of the persons involved :
  . to return the cleaned clothes
  . to sign any claims from the Head Storeman, providing him where necessary with the object of the dispute.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

4.5. <u>To carry out inventory-type checks</u>

- At the request of the Head Storeman :

  . Carry out inventory-type checks and indicate to him any anomalies found.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	CEP (General Certificate of Education).	X				
5.1.2. Supplementary vocational knowledge	About 6 months stores experience. Driver of fork-lift truck	X				
5.1.3. Diversity of the techniques used	Technique [illegible] a storeman/distributor	X				
5.1.4. Type and complexity of intellectual processing	No complexity. Control of conformity. Supervises the levels in relation to the points of ordering and issues a re-stocking request if necessary.	X				
5.1.5. Type and complexity of the physical activities	Machine driver, locating objects with limited constraints on alignment		X			
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	- Operations of shelving and control, demanding systematic application. - Precise operation of a fork-lift truck with some non-permanent risks. - Scrupulous verification of entries and signature of withdrawal notes, so as to avoid fraud. - Checking that no person outside the function can enter the store.				X	
5.2.2. Degree of contrast of the useful information	Reading labels and delivery notes		X			
5.2.3. Response time	Good reflexes when driving a fork-lift truck.		X			
SUB-TOTAL Behaviour						

UNIDO No. 3/84	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING		Code 6 MAINTENANCE

5. Evaluation of requirements

5.3. Responsibilities/Powers

		Requirement ratings 1	2	3	4	5
5.3.1. Diversity of the activities	Procedures of a distribution store with stock, with variants. Contacts with operatives in the same sector.		X			
5.3.2. Type of pilot information for others	Re-stocking request when the re-ordering point is reached (quantity already fixed).	X				
5.3.3. Diversity of functions piloted	Transmitted to the Head Storeman.	X				
5.3.4. Position of the external controls	Non-conformity of the stock record with the actual stock makes it necessary to carry out an investigation.				X	
5.3.5. Precision of imputation of consequences	Imputation from evidence to the team of assistant storemen taking over the shift.	X				
5.3.6. Precision of directives	All variants in the procedure will be indicated to him.	X				
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SHIFT STOREMAN, CONTINUOUS CASTING			Code 6 MAINTENANCE

6) Summary of the requirement ratings

	Points	%
Sub-Total Know-how	6/25	24
Sub-Total Behaviour	8/15	53
Sub-Total Responsibilities/Powers	10/30	33
TOTAL		110

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

1) Objective :

To carry out the operations linked with the operation and minor maintenance of the various cooling water circuits and hydraulic installations within the limits of the steelmaking and continuous casting departments.

2) Summary of the functions

Under the authority and responsibility of the Shift Foreman, Continuous Casting Maintenance :

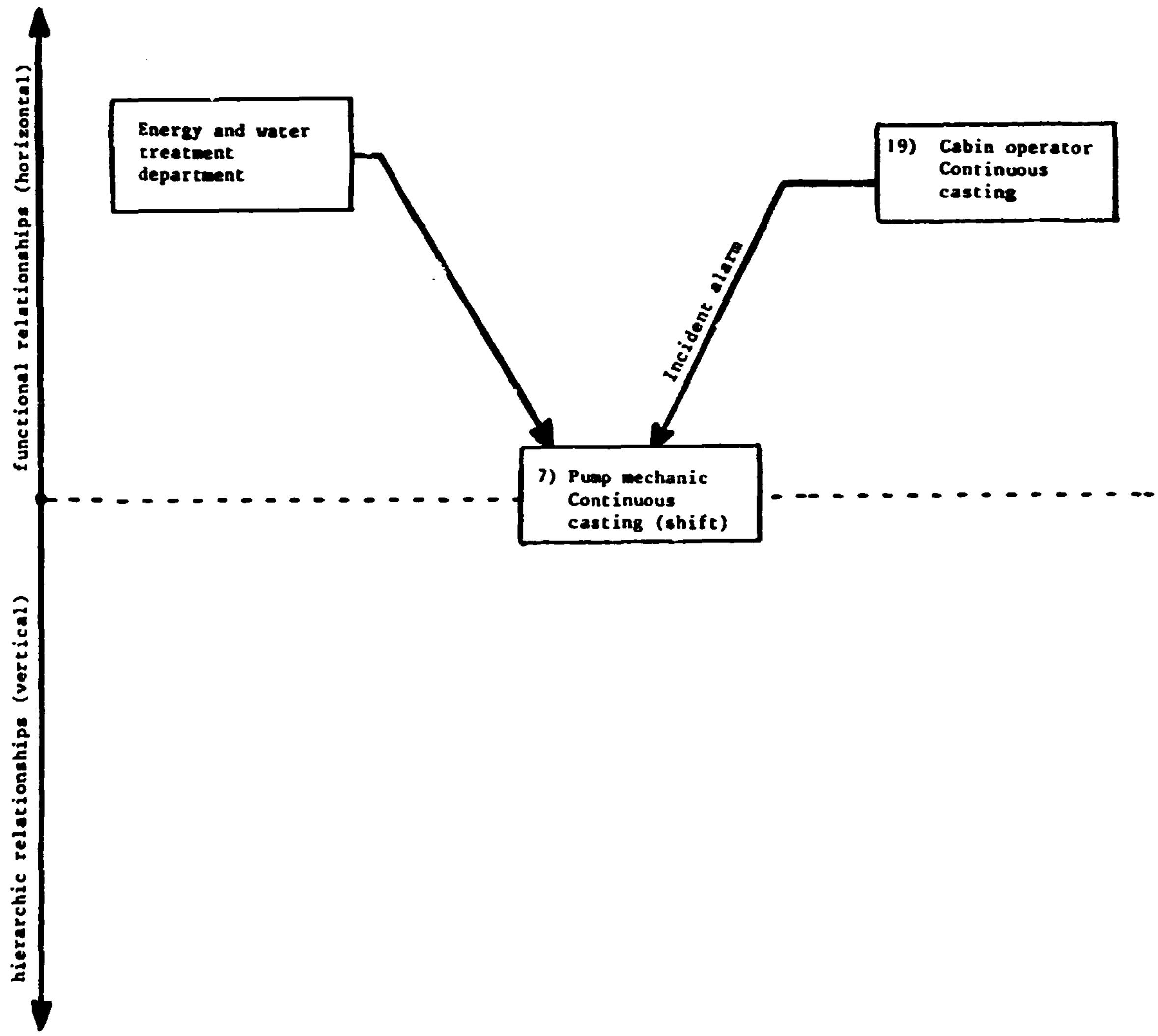
1. Surveillance rounds,
2. Minor maintenance of the installations and adjustments when requested.

The correct operation of the production equipment is largely dependent on their cooling circuits (process water, demineralised water, iced topping-up water) and on their hydraulic circuits.

This position, despite its lowly position in the hierarchy, is a position in which trust has to be put.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

3) Diagram of the relationships



UNIDO No 7/..	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

4. Details of the function

4.1. Surveillance rounds

The Pump Mechanic makes four rounds every shift. The rounds at the start and the end of the shift are most detailed: the other rounds are made more rapidly.

He checks the condition and the operation of the installations. He takes particular care to detect any abnormal noises, heating up, leaks, etc.

He warns the Production Water Treatment Foreman of any anomalies which he finds, and reports them to his own Shift Maintenance Foreman.

4.2. Minor maintenance of the installations and adjustments when requested

The Pump Mechanic carries out the normal maintenance operations of cleaning, draining, topping up the oil and greasing.

He also intervenes, up to the limit of his competence, in breakdowns (changing membranes, dismantling and re-assembly of the valves, tightening the packing glands) after shutting down the installation and flushing through.

He carries out the operations of adjusting the pumps, adding sodium bicarbonate, as a function of the rate of production of the equipment and on the indications of the continuous casting cabin operator.

4.3. Demineralisation station

Every two hours the Pump Mechanic will record the various parameters describing the operation of the demineralisation line in service :

- Input meter
- Flowrate
- Capacity
- Resistivity.

He has a kit with which he can carry out some rapid analyses (TH, TA, TAC, TAF, chlorides). He enters the results which he obtains on a follow up sheet which is sent to the Thermal Energy/Control section.

When the product (cubic metres passed in 2 hours times the TAF) reaches 30,000° the demineralisation line must be regenerated.

During regeneration the Pump Mechanic carries out the necessary chemical analyses. He compares the results with the norms to be achieved and changes over to "Manual" in the event of any problems.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

He completes the follow up sheet for the regeneration operations : time at the start and end of each phase, amounts of water and reagents, results of the chemical analyses.

He supervises the neutralisation of the effluents resulting from regeneration before they are sent to waste.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Completed primary studies (CEP). Trained as mechanic (sea-going mechanic valuable qualification).		X			
5.1.2. Supplementary vocational knowledge	Experience in the job during a period of at least six months so as to understand water treatment installations and the procedures for chemical analyses.		X			
5.1.3. Diversity of the techniques used	Operations of supervision, cleaning, maintenance and repairing breakdowns in water treatment and hydraulic installations. Chemical analysis of water after demineralisation.			X		
5.1.4. Type and complexity of intellectual processing	- Simple analysis of causes of common anomalies - Comparison of the results of chemical analyses or of reading an indicator with the norms or with instructions - significance of divergencies		X			
5.1.5. Type and complexity of physical activities	- Manual ability of adjuster-assembler. - Simple chemical laboratory operations (addition of a reagent until a colour change occurs)			X		
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	- Surveillance by way of display panel/alarms. - Application and method for the rounds (Check list). - Alert attention.					X
5.2.2. Degree of contrast of the useful information	- Reading apparatus, detection of drips and leaks, recognition of colours (chemical analyses) - Perception of abnormal noises in a noisy environment.					X
5.2.3. Response time	Very rapid reactions in the event of an incident to guarantee the continuity of cooling and to give warnings.					X
SUB-TOTAL Behaviour						

UNIDO Nc. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	- Observation and simple interventions in a relatively compact installation. - Very succinct and codified shift report.			X		
5.3.2. Type of pilot information for others	- Routine : transmission of results of demineralisation analysis to thermal control section. - Incidents : alarm by intercom with cabin operator, reports on incidents for the shift maintenance foreman, who will circulate them.		X			
5.3.3. Diversity of functions piloted	- Water treatment operations. - Thermal control. - Cabin operator.		X			
5.3.4. Position of the external controls	By the shift maintenance foreman and the cabin operator.	X				
5.3.5. Precision of imputation of consequences	Generally to others (water treatment, maintenance) apart from culpable negligence on the part of the pump mechanic			X		
5.3.6. Precision of directives	All the procedures and methods are defined. General supplementary instructions are given at the start of the shift, instructions for adjustment by the cabin operators	X				
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : PUMP MECHANIC (SHIFT)			Code 7 MAINTENANCE

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	12/25	48
Sub-Total Behaviour	15/15	100
Sub-Total Responsibilities/Powers	12/30	40
TOTAL		188

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

1) **Objective :**

Is responsible, with his shift team, for interventions on all the Continuous Casting Department installations, with a view to carrying out :

- repairs in the event of breakdowns,

- interventions consequent upon programmed shut-downs.

2) **Summary of the functions**

Under the authority and the general responsibility of the Head (Staff) Maintenance Foreman, Continuous Casting (non-shift) in regard to the quality of the work, but in close liaison with the Shift Foreman, Continuous Casting Production, who is his client :

1. Repairs to breakdowns on emergency calls : procedures for rapid interventions, the initiation and control of the operations.

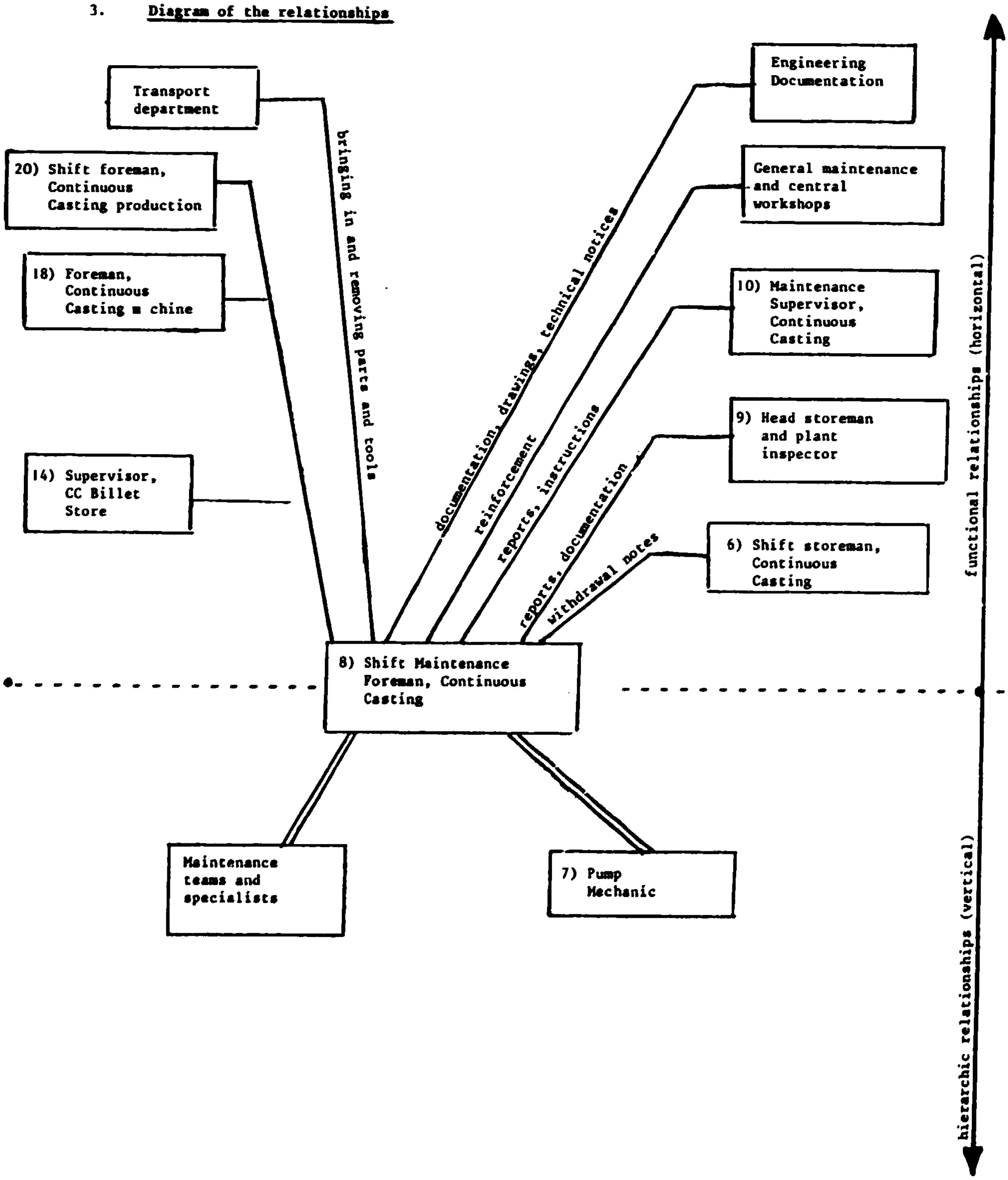
2. Programmed operations : organisation, implementation, compliance with planning programmes and instructions.

3. Miscellaneous functions (systematic overhauls, investigations, reports).

4. Personnel management.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

3. Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

4. Details of the functions

4.1. Breakdown repairs

4.1.1. Initiating information

- By telephone calls from the various production posts.
- By inter-post information and instructions (continuation of a breakdown repair undertaken at the previous post).

4.1.2. Procedure for rapid interventions

- Request to the informant for precise details so as to obtain an idea of the urgency and the gravity of the incident. Make contact with the Shift Production Foreman.
- Enter the requests on a pad :

. compare them and estimate their urgency and gravity.

If it is felt that the intervention is not serious : give the directives directly to the Head of the team concerned (nature of the intervention - tools and personnel to be taken).

If it is felt that the intervention is a serious one :

* The Shift Maintenance Foreman goes to the site with the Head of the team concerned;

* and carries out a diagnosis to define the origin of the breakdown and the way to cure it.

→ gives directives to the head of the team to specify the approach to be taken, the equipment necessary and the personnel required.

→ negotiate with the production superviser to make the equipment available - for example to position the moving parts, or the machine, or for cleaning.

→ draws up the request for making available
- the installations concerned
- give to production for agreement.

→ draws up the instructions and work authorisation :
- number of work authorisation
- nature of the availability
- zone to be available - forecast duration
- indicate availability : to the electrical, fluids or engineering sections according to the nature of the availability required.

- Give the authorisation to the intervention team.

The Foreman follows up the intervention :

- he directs the activities of his subordinates

- completes where necessary the stores withdrawal notes

- In the absence of the technical office personnel, and so that the breakdown can be rapidly repaired by the general maintenance department	- completes where necessary the handing-over notes (in the absence of the technical office personnel); - completes where necessary the requests for intervention by general maintenance/workshops; - requests reinforcement personnel, if needed.

At the conclusion of the repair work the Shift Maintenance Foreman requests provisional or definitive clearance (to check correct operation).

Clearance is followed by the return to availability (authorisation for production or re-use of the installation).

Clearing the work site :

- Recovery of equipment and of used or broken parts for subsequent examination.

- Where necessary return of loaned equipment to other sectors.

4.2. <u>Maintenance on programmed shut-downs</u>

In order to "saturate" the work-load of the shift teams (provided to repair breakdowns) the shift maintenance foreman receives a list of the work to be carried out (morning - afternoon shifts; during the night there are no actual interventions but only preparations for interventions - bringing up equipment, etc.).

4.2.1. <u>Initiating information</u>

- Shift planning (completed by the Continuous Casting Maintenance Foreman).

- Programme of shut-downs.

- Withdrawal notes.

- Information which he has to seek from the centraliser.

- Oral requests made by the day supervisory foreman.

4.2.2. <u>Process of intervention</u>

- As a function of the tasks in hand and the available personnel the shift maintenance foreman distributes the various activities. (Care to distribute equitably - variety in the work, whilst at the same time utilising the "capacities" of each person, etc.).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

- The Shift Maintenance Foreman visits the various sites to confirm that there are no special problems (directives if necessary - adjustment of the original procedures).
- At the end of the work :
  . Checking the work carried out (the amount of control exercised will depend on the member of staff nominated by the foreman; question of confidence level which is attributed to different subordinates).
- Cleaning the site :
  . Recovery of equipment and the worn or broken parts for expert examination, sending them to the workshops/general maintenance.

4.3. Miscellaneous functions

- Relative to technical problems :
  . If, during the course of repairs to breakdowns and other interventions, the shift maintenance foreman notes modifications and improvements to be made, in order to increase the efficacy of the intervention -
  - he is to indicate this to the Head Maintenance Foreman, Continuous Casting (orally and on the shift report with sketch if necessary).
- Relative to safety problems :
  . Once a quarter the shift maintenance foreman is to carry out a training session for his team covering safety matters.
  - he will receive a subject from the hierarchy (accident report)
  - he will prepare it (making provision for the questions and answers to be given)
  - he will set before his subordinates -
    . a sketch on the table
    . a description of the accident.
  - he will initiate a dialogue between the various subordinates
  - he will present, in a written report
    . the questions asked
    . the replies given

4.4. Personnel management

- Management, attendances, holidays, etc.
- Evaluation every 6 months in a document covering the criteria (put forward by the hierarchy).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 7/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING							Code 8 MAINTENANCE
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.1. Know-how							
5.1.1. Basic general and technical knowledge	Level - B.T. Engineering				X		
5.1.2. Supplementary vocational knowledge	Long experience in maintenance jobs. Courses in hydraulics and electrics. More than 6 months experience as foreman					X	
5.1.3. Diversity of the techniques used	General electrical/mechanical engineering with specific continuous casting application. Personnel evaluation and management				X		
5.1.4. Type and complexity of intellectual processing	Breakdown repair work on installations where the mechanical, hydraulic and electrical assemblies have linked functions; isolation of one function to see its effect on the others. Locating the origin of a fault by the successive eliminations of these, the mechanical and hydraulic functions being linked.					X	
5.1.5. Type and complexity of the physical actions	Essentially administrative post. Exceptionally manual interventions, presupposing long previous practice.				X		
SUB-TOTAL Know-how							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

5. Evaluation of requirements 5.2. Behaviour	Requirement ratings	1	2	3	4	5
5.2.1. Degree of vigilance	Control operations (diagnostic - origins of anomalies, etc.) depending on very extensive experience					X
5.2.2. Degree of contrast of the useful information	Perception of detailed indices (temperatures - abnormal noises, falls in characteristics, etc.) shown by a generally healthy assembly.				X	
5.2.3. Response time	Rapid diagnosis and mobilisation in order to respond to emergencies (repair of breakdowns)					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

5. Evaluation of requirements

5.3. Responsibilities/Powers

	Requirement ratings	1	2	3	4	5
5.3.1. Diversity of the activities	Various procedures (repair of breakdowns, interventions during programmed shut-downs) applied to the entirety of the continuous casting installations. Technical reinforcement of the specialist subordinates			X		
5.3.2. Type of pilot information for others	For the original breakdowns the foreman defines completely the work of his subordinates : - operations to be carried out - equipment to be used (tools, parts, etc.) - control. In the longer term, and guided by his observations on the reports, decisions on modifications for improvements.				X	
5.3.3. Diversity of functions piloted	- Heirarchically the specialist subordinates and any reinforcements. - Functionally the maintenance teams on other shifts, the production teams, general maintenance and the workshops, general services and engineering				X	
5.3.4. Position of the external controls	Control by the satisfactory operation of the repaired equipment, in the short and long term					
5.3.5. Precision of imputation of consequences	Supervisory post (2 subordinates and intervention teams)				X	
5.3.6. Precision of directives	Total latitude in the organisation of work to respond to an urgent breakdown. For this the shift maintenance foreman will rely on his considerable experience in the field of interventions (origin of the breakdown - way in which it is to be repaired, taking into account the problems already encountered, the quality of the personnel, etc.)					X
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SHIFT MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 8 MAINTENANCE

6. <u>Summary of the requirement ratings</u>

	Points	%
Sub-Total Know-how	17/25	68
Sub-Total Behaviour	14/15	93
Sub-Total Responsibilities/Powers	20/30	67
TOTAL		228

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : HEAD STOREMAN / PLANT INSPECTOR, CONTINUOUS CASTING (NON-SHIFT)			Code 9 MAINTENANCE

1) Objective :

To ensure the efficient operation of the stores in the continuous casting sector, and to carry out the systematic inspections/surveys of the production equipment in the sector.

2) Summary of the functions

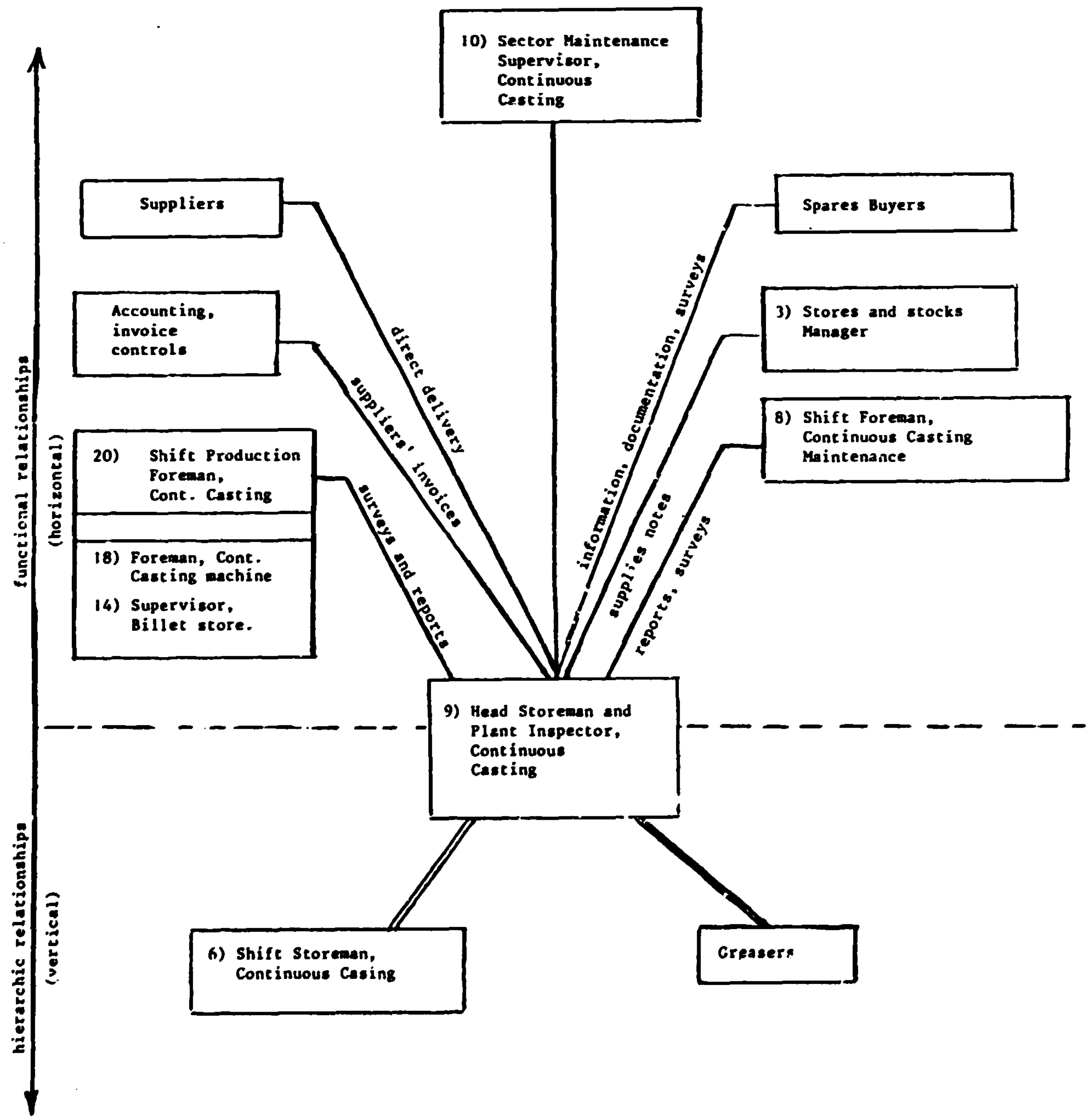
Under the authority and the responsibility of the Maintenance Foreman, Continuous Casting, and in close collaboration with the Maintenance Supervisor, Continuous Casting :

- to manage the stores in the continuous casting sector : administrative tasks and checks relating to efficient supplies of materials, tools and individual equipment.

- to carry out systematic surveys and inspections of the production equipment, paying particular attention to greasing.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

3) **Diagram of the relationships**



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

4. Details of the functions

4.1. Operations of the C.C. store

The Head Storeman /Plant Inspector :

Is responsible for the functioning of the Continuous Casting store.

Organises the store, shelving, maintenance of cards and records, establishing the documents and circuits to be followed.

Determines the ordering points for items as a function of the half-yearly consumption reduced to a weekly consumption and the time for obtaining supplies from the central stores.

Re-adjusts the ordering points as a function of changes in orders. The management criteria being that there should be neither stock failures nor costly excessive stocks, so falsifying the methods for supplying the central stores.

Draws up the catalogue of articles in the store, with weekly updatings sent to all holders of the catalogue.

Verifies the conformity of the stores withdrawal notes (Code No., Allocation No.) before passing to the Central Store.

Checks the internal withdrawal notes and sends them to the heads of the departments to which the persons withdrawing the goods belong.

Establishes the end-of-year inventories (fittings, tools, parts).

Carries out random inventories.

4.2. Supplying the store

The Head Storeman/Plant Inspector :

Draws up and records the purchase orders, materials specified by the supervisor, indications to the buyers on a supplier and approximate prices.

Sends purchase order to buyers through general maintenance for approval.

Receives and files the orders with circulation to store.

Receives the delivery note from the Head Storekeeper, who has received the orders delivered directly from the supplier, and then sends an internal reception note to the central stores.

Maintains the stock records for sheets and sections for re-supplying and movements.

Reminds the Buying Department concerning orders not completed (according to the purchase order record book).

Gives approval for payment of invoices (invoice control).

Corresponds with suppliers for requests for documentation, technical discussion with supplier and supervision during visits, requests for prices.

Seeks equipment, supplier and prices at the request of supervisor or executives.

Visits gas supply unit daily with orders for supplies (oxygen, acetylene).

Maintains and updates the tooling file.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

Follows up the tools of the personnel with periodical inventories (frequency of losses).

Maintains stocks of office materials and distributes them to the personnel.

Records the withdrawal notes completed by the maintenance personnel (consumable materials, spares) transmitted for follow up of expenditure.

Informs the personnel regarding code numbers for tools (file).

Follows up checks and repairs on blowlamps. Approval for payment, control of invoices.

Makes contact with official body which checks safety equipment (belts, slings).

Makes contact with Cost Control for changing investment account.

Makes contact with social affairs for clothing withdrawal notes.

Approves invoices for cleaning and repair of working clothes (as a function of the list of numbers allocated by the store).

Makes contact with the cleaning enterprise in disputes (rejection of badly cleaned clothing).

4.3. Systematic inspection/surveys

Under the directives of the supervisory office the Head storeman/Plant inspector is required to :

Take note of the programme for weekly surveys.

Distribute part of his work load, according to availability, to the various maintenance teams.

Determine the timetable of the progress of his weekly survey programme.

Checks the points specified on his survey sheet, and generally, in respect of :

- Wear
- Levels
- Play
- Nuts and bolts
- Lubrication
- Seals
- Temperature
- Condition of a mechanical part.

Draw up the survey reports :

- Specifying (if necessary) the nature of the damage.

Dismantle or have dismantled, during his surveys :

- Flanges, inspection panels, etc.

The above surveys are to be carried out :

1. During the operation of the installation :
   - in the non-dangerous sector.

2. During a shut-down in production :
   - throughout the whole installation
   - on a request (where necessary) from the shift Foreman
   - warns production of his intention to require access to a machine. Requests authorisation for access.

3. During a programmed shut-down.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

Note : he is required to detect anomalies on the working installations, for example by "abnormal noises" in the reducers, coupling rods, universal joints etc.

Draw up a report on surveys

. by entering them, as a matter of priority, in the log of work to be carried out.

Suggest modifications in respect of :

. The points to be inspected,

. Their periodicity.

Make notes on each survey of wearing parts, in the wear "control" log, so making it possible to follow up any abnormal play.

Carry out and check the routine greasing operations.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	B.E.P.C.*/C.A.P.** in General Engineering Clear concepts of statistics * Higher Certificate of Education. ** Vocational Studies Certificate.		X			
5.1.2. Supplementary vocational knowledge	Experience in the position of maintenance mechanic for 3 years + storeman (6 months) + course as buying agent (6 months)				X	
5.1.3 Diversity of the techniques used	Stock control with various supplementary specific requirements - General engineering - pipework and hydraulic circuits - general but solid concepts of electronics.				X	
5.1.4. Type and complexity of intellectual processing	- Calculates, determines and revises the stock level minima at which it is necessary to restock, as a function of consumptions and delays in obtaining supplies. - As surveyor/inspector needs to memorise the norms and also appreciate the deviations found in relation to these norms (wear, levels, positioning, deformations, etc.).			X		
5.1.5. Type and complexity of the physical activities	- Administrative work. - Manual controls : handling gauges, micrometer, sliding stand, opening/closing of valves, keys on small bolts, inspection openings, etc.			X		
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10

Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)

Code 9
MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	- Precision in reading documents. - Non-deviation from procedures. - Rigorous management. - Constant awareness during inspection visits (deviation from the norms) - Preventive sense : to anticipate and to make safe diagnoses					X
5.2.2. Degree of contrast of the useful information	- Documents of a very wide range of formats and presentation. - Detection of "abnormal" noises in an environment with a very high sound level, detection of the beginings of failures, wear, leaks from parts which are dirty, greasy and poorly or badly lit (to possess "flair")					X
5.2.3. Response time	- No special constraints on the response time, but the need sometimes to interrupt current routine work because of an emergency, and then to methodically pick up the routine work again.			X		
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	- general procedures concerning supplies, follow up, management control, recording and transmitting information. - statistical forecasts and calculations. - procedures for surveys and inspection : considerable diversity of equipment and possible causes of incidents or accidents. Always involved in prevention, so the diagnoses must be certain.					X
5.3.2. Type of pilot information for others	- indication of procedure to storekeeper. allocation sheets (analytical accounting). verification and approval of invoices for blowlamp repairs - washing (invoice control). - indications to GM for spares, to Buying for other materials, regarding quantities, suppliers and possible prices. His survey reports will allow the supervisory office to programme the preventive works carried out.				X	
5.3.3. Diversity of functions piloted	- direct subordinates : shift storemen and greasers. - hierarchic relationships : maintenance supervisor, shift production foreman. - functional relationships : analytical accounting, buying and invoices, general maintenance, central stores, transport, external suppliers.				X	
5.3.4. Position of the external controls	- Judged on the efficient operation of the store and adequate supplies for the supervisor and intervention teams. - Function as surveyor/inspection : the positive or negative effects can only be evaluated in the long term.				X	
5.3.5. Precision of imputation of consequences	- Store and supplies : chains of responsibility shared with subordinates, supervisor, general maintenance, buying and central stores. - Surveyor/inspection : negligence or errors in diagnosis are imputable.		X			
5.3.6. Precision of directives	- Rigid administrative circuits (supply procedures) and well-defined programmes for systematic inspections. - Autonomy in the organisation of work schedules.		X			
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KE" FUNCTIONS	Page 10/10
Position : HEAD STOREMAN / PLANT INSPECTOR, C.C. (NON-SHIFT)			Code 9 MAINTENANCE

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-ho.	15/25	60
Sub-Total Behaviour	13/15	87
Sub-Total Responsibilities/Powers	21/30	70
TOTAL		217

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/11
Position : MAINTENANCE SUPERVISOR, CONTINUOUS CASTING (NON-SHIFT)			Code 10 MAINTENANCE

1) Objective :

To orientate, define and develop all the logistics organisation for the maintenance interventions in the Continuous Casting Department, and to reduce the shut-down times on the installation.

2) Summary of the functions

Under the authority and the responsibility of the Head Maintenance Foreman, C.C., of whom he is the operational deputy, he is in particular responsible for the scheduling of all the maintenance operations, technically and administratively, with the follow up of the work and its control.

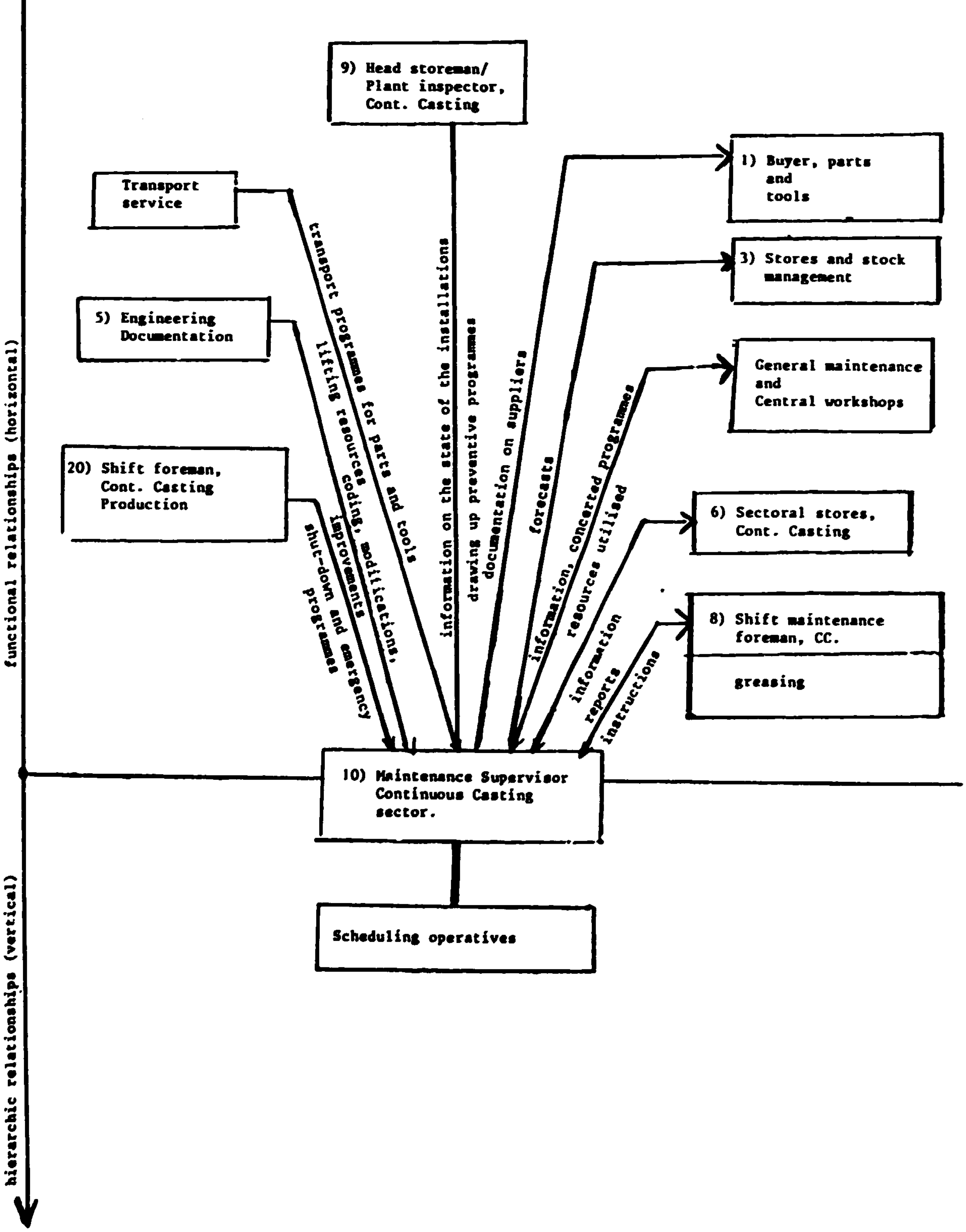
In conjunction with the Engineering Department he establishes and manages the technical dossiers for the installations (life-log for each machine).

He participates in all progress research.

This is one of the most important functions in each Production Department.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)			Code 10 MAINTENANCE

3. Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)			Code 10 MAINTENANCE

4. Details of the functions

4.1. Scheduling

4.1.1. Collecting information

The collection of information, the preliminary to analyses of the situations and the commencement of work, is carried out by contact with the issuing personnel, miscellaneous documents or the findings from incidents.

Direct contact :

- Daily report : this meeting including the Engineer, Head Maintenance Foreman, CC, Supervisor, General maintenance and Engineering, makes it possible to specify and to comment on the important interventions and to take note of the hierarchic directives.
- Maintenance service : comments on engineering work or work having an influence on the latter.
- Production services : enquiries on breakdowns, comments, date of shut-down.
- General maintenance : spares, parts for repair.
- Engineering : situation regarding new work, modification of drawings, technical dossiers on the machines.
- Technical control : subsequent to analysis report.

Documents (non-limitative list)

- Shift report : comments on important incidents occurring during the shift.
- Technical control report : report on analyses or readings.
- Systematic survey report : work relating to periodicity, detection of anomalies.
- Work notes : requests for interventions issued by all the Maintenance, Production, General Maintenance and Engineering departments.
- Manufacturing programme : makes it possible to identify the programmed shut-downs.

Incident findings : this is carried out on the spot :

. from the origin of a breakdown,
. on a defective part (dimensional checks),
. during the intervention.

4.1.2. <u>Technical preparation</u>

4.1.2.1. <u>Establishment of the work card</u>

The supervisor establishes, on the basis of the overall and detail drawings, the technical breakdown of the coding and "visual" information collected on the installation (understanding of the constraints due to the environment), and establishes the method of operation of a unit (dismantling - re-assembly).

The method of operation defines :
- . the chronology of the operations,
- . the personnel to be allocated to these operations, together with their skills,
- . the duration of the intervention (per operation),
- . the means : tools - mode of handling.

It also defines the preparatory work :
- . the positioning of the parts to be dismantled, or which hinder this dismantling,
- . the tools and handling equipment for shifting equipment such as walkways,
- . any scaffolding required,
- . the sectors to be shut down (safety).

<u>N.B.</u>:
The work card is re-adjusted as a function of the problems encountered during the effective interventions on the installation.

4.1.2.2. <u>Establishment of the materials withdrawal notes or the transfer notes</u>

- <u>materials withdrawal note</u> :
  - . printed form established for withdrawing a part from the central stores. The form is handed either to the storeman in the stores or to the transport services (in the case of large parts). He is required to check the conformity of the part.
- <u>transfer note</u> :
  - . printed form allowing the temporary removal of a part from the central stores.

4.1.3. <u>Administrative procedures</u>

Establishes the request for intervention.

- . Completes the form : imputation code, recipient, etc.
- . Specifies : - the work to be done
  - the time for completion.
- . Appends either a "work card" or a note specifying the means (men and equipment) and the replacement of the parts, if necessary, by the materials withdrawal note.
- . Establishes the detailed planning.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/11
Position : MAINTENANCE SUPERVISOR, I.C. (NON-SHIFT)			Code 10 MAINTENANCE

Procedures for programmed shut-downs

. Establishes the request for intervention according to the procedures described above.

. Establishes the shut-down notes and the authorisations to work on the installations concerned.

. Prepare for opening the workshop, in particular presentation of the workshop to the executives of external enterprises.

. Establishes a summary of the work by team and/or by enterprise (copies circulated).

. Is required to participate in programmed shut-down meetings. It is at these that the work to be carried out is definitively decided on.

N.B. 1): During the programmed shut-down follows up the work for any re-adjustment of the work cards.

N.B. 2): The maintenance planning must be established with considerable rigorousness and constantly kept under control.

Daily planning :

Detailed programme of work for the various teams.

The person responsible establishes this by listing the work which has to be carried out by the various maintenance departments (Mechanical, Electrical, Electronics, Instrumentation), Engineering and Production, the planning defining the various operational phases and showing, on a graph of execution against time, the incompatibilities of execution or coordination of the various works :

. overlapping of the operations,
. technical imperatives (shutting down),
. handling (machines, simultaneous movements),
. energy requirements,
. manpower.

- A meeting grouping together the Executives of the Departments concerned makes it possible to stabilise the work programme and to establish the definitive planning of the programmed shut-down (circulation to the departments concerned).

- The external enterprises being concerned in these interventions the necessary service orders are established to obtain the necessary personnel :

. Choice of the enterprise
. Nature of the works,
. Personnel concerned (number and skills),
. Time allowed,
. Means,

and specifying the characteristics.

- At the level of the external enterprises engaged the necessary technical information is supplied to them for the execution of the work.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)			Code 10 MAINTENANCE

4.1.4. Control of execution

- The realisation of the work is followed up by :

  . the return of the annotated Requests for Intervention } daily planning
  . the shift report }
  . active control }

- Active participation in programmed shut-downs, in operations such as :

  . delivering the work authorisations,
  . establishing the shut-down requests,
  . modifying the operational methods,
  . adjusting the planning as a function of the actual progress of the operations,
  . the tests during starting up the installation,

  allow permanent control of the correct adjustment of the documents issued.

N.B. :

  . the secondments signed by the foreman and initialled by the Executive,
  . the executive gives his evaluation on the choice of service enterprises, as a function of the prices and competence of the latter.

4.2. Drawing up and managing the technical dossiers

For the correct establishment of the work cards (see above, 4.1.2.1.) and the materials withdrawal notes (cf. 4.1.2.2.) it is necessary to establish dossiers for the machines and installations, and these must be followed up and updated very conscientiously. This is one of the essential tasks of the Engineering and New Works Department, duly initiated by the sectoral maintenance supervisors of the Production departments.

No improvements in maintenance, and hence of the availability of the installations for production, and no effective management of spares can be effected unless all the machines and all the appliances and instruments are described in every detail in the technical dossiers which, in addition, form the history of the installations, and which integrate the latest modifications, decided on and realised in common between the Production, Maintenance and Engineering and New Works Departments. Furthermore it is imperative that all the technical services and all the administrative services involved (spares buying and stores) work on the same coherent and updated documents (overall and detail drawings, codings, notices, lists of parts, etc.).

It is the Sectoral Maintenance Supervisor who is responsible for the updating of the technical dossiers and the "life-logs" of the equipment, whether he carries out the work himself or whether it is sub-contracted to the Engineering and New Works Department.

He gives the necessary directives and provides his professional knowledge and experience.

4.3. Progress research

4.3.1. The Maintenance Supervisor is at the centre of all progress research in his sector : optimisation of the levels of availability of the installations by the establishment of a real preventive maintenance system, appropriate methods in the maintenance operations so as to minimise the times taken for interventions, technical modifications to make easier these operations or to make it possible to use tools, parts or components which are available locally instead of having to import them, etc.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)			Code 10 MAINTENANCE

This is a matter of operational research where he is the best placed person to motivate a task force. He therefore participates in all the actions decided on by the hierarchy by suggesting, by piloting the research work if necessary, by controlling the tests and by drawing up the summary reports and the recommendations.

4.3.2. He must be conscious of being one of the most important actors in regard to succes or failure, a turntable between the activities of production, maintenance, studies and supplies.

4.3.3. He exchanges information with his equivalents in the Production and Maintenance Departments so as to homogenise experiences and methods.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS				Page 8/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)						Code 10 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Technical H.S.C. level - mechanical or electro-mechanical options - Technical diploma in supervision and in scheduling.				X	
5.1.2. Supplementary vocational knowledge	Considerable experience as shift foreman in Maintenance, long courses in an Engineering Design Office and in Workshops				X	
5.1.3. Diversity of techniques used	General Mechanical and Electro-mechanical. Metrology and general instrumentation. Planning techniques. Reading drawings.				X	
5.1.4. Type and complexity of intellectual processing	Operational method : for a large assembly must coordinate the various operations in the operational method, taking account of the technical safety imperatives and the constraints due to the environment. - determine the urgency of requests for intervention, - design the tools suited to different installations, - establish the daily planning and programmed shut-downs, taking into account the urgency, the work load, the resources, the proximity of a major shut-down or the progress of production and the work carried out by the other Maintenance services.				X	
5.1.5. Type and complexity of the physical actions	- Administrative work. - Dimensioned sketches. - Control of parts.			X		
Sub-Total Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 9/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)							Code 10 MAINTENANCE
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.2. Behaviour							
5.2.1. Degree of vigilance		In-depth and summarising analysis of various documents Exhaustive research into all the parameters involved in the programming of tasks. Anticipation of possible incidents.					X
5.2.2. Degree of contrast of the useful information		Diversity of formats and handwritings on the working documents		X			
5.2.3. Response time		To modify his own programme as a function of declared urgencies. To organise and launch the urgent operations rapidly, so as to minimise production shut-down times. To draft and circulate directives rapidly and clearly. May be disturbed at his home at night.					X
Sub-Total Behaviour							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 10/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)							Code 10 MAINTENANCE
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers							
5.3.1. Diversity of the activities		- In-depth knowledge of the installations of very diverse types in the C.C. sector, in reality and in their documents. - Well understood and well utilised procedures. - Direction of progress research, grouping together persons of various origins and experience.				X	
5.3.2. Type of pilot information for others		- Documents : . Chronology of interventions, detailed planning sheets by shift interventions, means utilised. . Operational methods and ranges for intervention teams. . Service orders to other Departments. . Routine planning of inspection visits and greasing. - Meetings for developing interventions for maintenance or progress research.				X	
5.3.3. Diversity of functions piloted		- Direct subordinates : 2 scheduling operatives. - Indirect subordinates : Shift intervention teams, sector stores, greaser. - Functionally : the Engineering, General Maintenance and Workshops, Production, Buying and Central Stores Departments.			X		
5.3.4. Position of the external controls		Preparation of the work programmes, the coherence and solid basis of which can only been verified when they are carried out.				X	
5.3.5. Precision of imputation of consequences		Programming work entirely imputable to the supervisor and to his direct subordinates. - Execution of the work imputable to the indirect subordinates.		X			
5.3.6. Precision of directives		Procedures in force; however, the Supervisor must know how to adapt these, in a justified way, to each urgent case.				X	
Sub-Total Responsibilities/Powers							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 11/11
Position : MAINTENANCE SUPERVISOR, C.C. (NON-SHIFT)			Code 10 MAINTENANCE

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	19/25	76
Sub-Total Behaviour	12/15	80
Sub-Total Responsibilities/Powers	21/30	70
TOTAL		226

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : SECTORAL MAINTENANCE FOREMAN, CONTINUOUS CASTING			Code 11 MAINTENANCE

1) Objective :

- To maintain the installations in a mechanical and electrical state able to ensure production, and in compliance with the safety rules. This is to cover both preventive action and the repair of breakdowns.
- The emphasis is placed on the establishment of a preventive maintenance system, so as to reduce emergency shut-downs.

2) Summary of the functions

Under the responsibility of the Chief Engineer of the Continuous Casting Department he is responsible for :

- making provision for
- preparing for
- directing
- coordinating and
- controlling

all the maintenance interventions in the whole of the Continuous Casting Department.

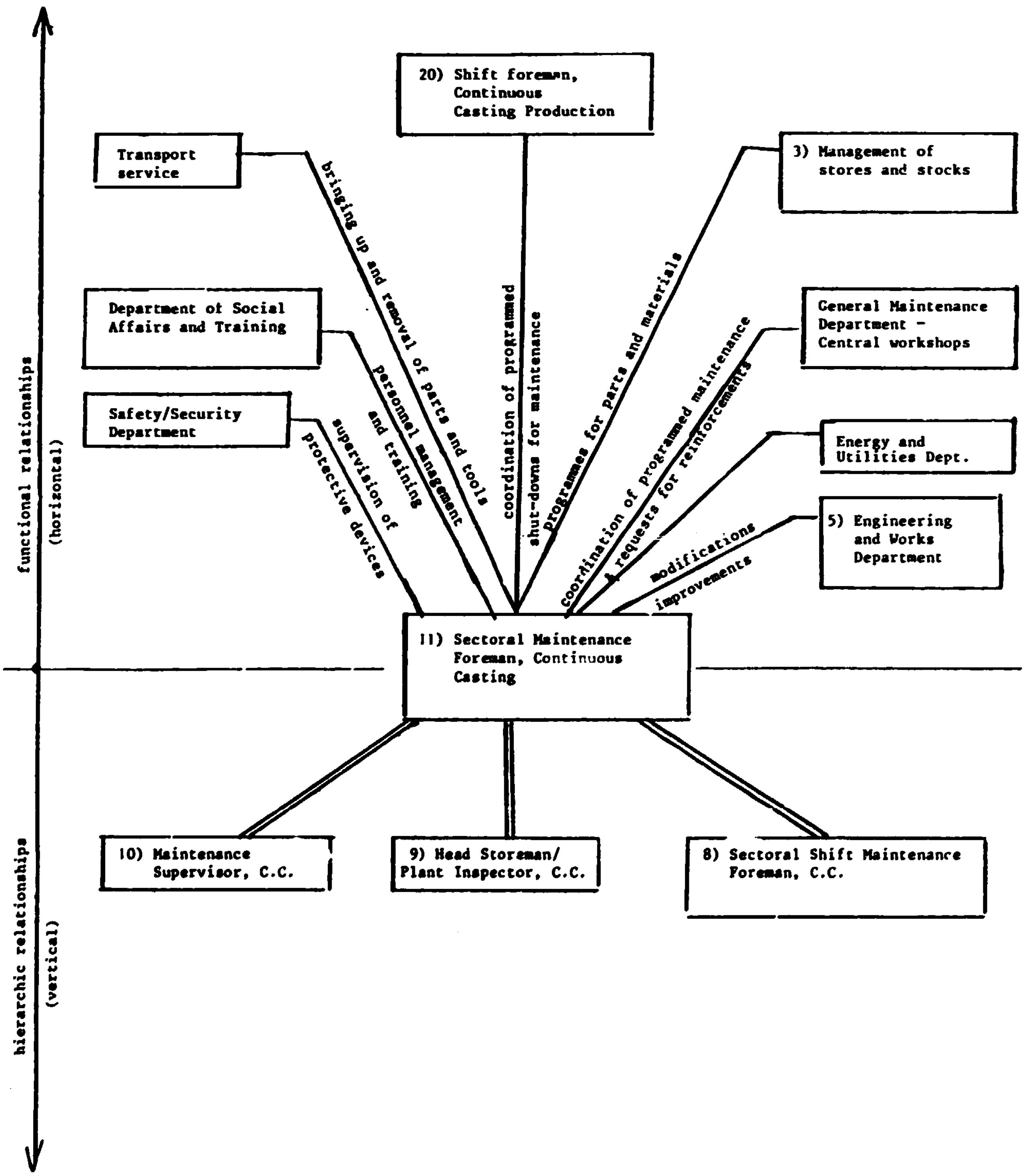
He has under his responsibility :

- the supervising office,
- the store for the C.C. sector and [illegible] ntenance inspector,
- the shift maintenance teams in the [illegible] tor.

He proposes improvements in techniques a[illegible] procedures. He manages and trains his personnel.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.			Code 11 MAINTENANCE

3. Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.			Code 11 MAINTENANCE

4. Details of the functions

4.1. To Make provision for, Direct and Coordinate maintenance interventions

Supervising office

- Defines the nature and urgency of the work (daily planning - programmed shut-down)
- Defines the administrative and technical circuits.
- Concepts on the means to be utilised.
- Participates in personnel training (optimising their natural capabilities).

Intervention teams

a) in the case of major incidents :
specifies the operational methods and the means.

NOTE : Takes the decision to shut down the installation (for the necessary time) with a view to preventing "crashes". May be called at his home out of working hours for emergencies.

4.2. To control

Supervising office

- content and triggering of the programmed shut-downs.
- range and means utilised during these shut-downs.
- survey sheets (making it possible to establish emergencies in regard to the interventions).

Intervention teams

- Study of the shift reports.
- Effective control of the installation, particularly during and after the resultant work.
- Pays particular attention to the work carried out by outside enterprises.

4.3. Studies on improvements

Is required to propose modifications to the installation as a result of the analysis of the causes of the most frequent breakdowns. Reports followed up with the Engineering Department.

Modifies the procedures (inspection) making it possible to "follow up" the mechanical state of the installation.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.			Code 11 MAINTENANCE

4.4. Miscellaneous functions

- Establishes the planning for - personnel training
  - paid holidays.
- Participates in departmental meetings.
- Is required to assist and participate in opening the site for programmed interventions (security).
- Selects outside enterprises on the basis of services rendered and costs.
- Programmes the work during systematic shut-downs (modification).
- Registers the day personnel. Checks the registers for shift personnel.
- Participates in meetings of Foremen, Production and Electrical Department for allocating down times. If necessary requests production shut-downs for work in hand.
- Follows up the situation regarding parts undergoing urgent repair.
- At the general maintenance meetings describes and comments on the most significant incidents and suggests the modifications which could be made to the installations.
- Participates in personnel management :
  . giving advice in the case of supervisory staff,
  . makes effective proposals in the case of workmen.
- Ensures that the health and safety rules are applied.
- Establishes requests for sanctions.
- Miscellaneous notes.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.			Code 11 MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.			Code II MAINTENANCE

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10

Position : SECTORAL MAINTENANCE FOREMAN, C.C. — Code 11 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	General Electro-mechanical BTS level, acquired either : a) by college education, or b) by training of the EMOM type + supplementary courses				X	
5.1.2. Supplementary vocational knowledge	Vocational experience as shift foreman, inspector and assistant chief shift foreman for 10 years. Courses in oleo-pneumatics, safety, handling and organisation					X
5.1.3. Diversity of techniques used	General engineering : all specific areas - good electrical engineering - Iron and steel : knowledge of the manufacturing processes in the sector. Handling - use of slings Personnel administration				X	
5.1.4. Type and complexity of intellectual processing	Must ensure the summarising of all the information received in order to : coordinate the work - orientate the work programmes (urgency and time available) - modify the planning. Determine the procedures making it possible to follow up the mechanical state of the installation (preventive).				X	
5.1.5. Type and complexity of the physical activities	- Administrative work. - occasionally participates in the operations of breakdown repair. - taking measurements		X			
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10

Position : SECTORAL MAINTENANCE FOREMAN, C.C.

Code 11
MAINTENANCE

5. Evaluation of the requirements 5.2. Behaviour	Requirement ratings	1	2	3	4	5
5.2.1. Degree of vigilance	- Attentive observation of the operation of the installations. - Checking documents - reading indicating and recording instruments. - Intervenes in respect of the installations to establish a diagnosis in the most difficult cases.					X
5.2.2. Degree of contrast of the useful information	Checking handwritten documents. Participates in the detection of visible or audible faults (wear - breakage - overheating - abnormal noises).			X		
5.2.3. Response time	Rapid decisions with the object of reducing to the minimum the down time of the installation or the cost of the intervention.					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 9/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.							Code 11 MAINTENANCE

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Complex and vast installation. No specific procedures: these remain to be adapted to meet the problem posed : Technical (diagnostic - coordination) or human (optimisation of the personnel - promotions)				X	
5.3.2. Type of pilot information for others	Defines the work to be carried out during the programmed shut-downs. Defines the personnel to be allocated (possibly also personnel from an outside enterprise). The means. Gives the objectives to the scheduling office (eg. make provision for operational ranges) and the intervention teams (eg. reduce the shut-down times). Makes recommendations to Engineering for improvements.				X	
5.3.3. Diversity of functions piloted	Hierarchically : . scheduling office . sector stores and inspector . shift foremen and their teams. Functionally : . Foreman, shift production foremen . General technical services (utilities), Engineering, General maintenance/workshops, supplies, transport, safety, Training.				X	
5.3.4. Position of the external controls	Statistically by an improvement in the levels of utilisation of the production installations					X
5.3.5. Precision of imputation of consequences	The work is carried out by the scheduling office and the intervention teams: imputation largely collective in the absence of a flagrant fault in forecasting and organisation on the part of the Maintenance Foreman. The installations may be the object of incorrect utilisation by production.			X		
5.3.6. Precision of directives	Overall objective : must adapt - modify - create systems making it possible to install a preventive system. Defines the means (men and equipment), the operational ranges and the planning for installation shut-downs.					X
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SECTORAL MAINTENANCE FOREMAN, C.C.			Code 11 MAINTENANCE

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	20/25	80
Sub-Total Behaviour	13/15	87
Sub-Total Responsibilities/Powers	25/30	83
TOTAL		250

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : FOREMAN, REFRACTORIES SHOP, CONTINUOUS CASTING			Code 12 PRODUCTION

1) Objective :

To organise and control the activities of the personnel responsible for maintaining and remaking the hot and cold distributors, ensuring production rates compatible with casting needs.

2) Summary of the functions

Under the authority and the responsibility of the Shift Foreman to ensure or to have ensured the execution of the following tasks :

. Cleaning the worn distributors (hot or cold)

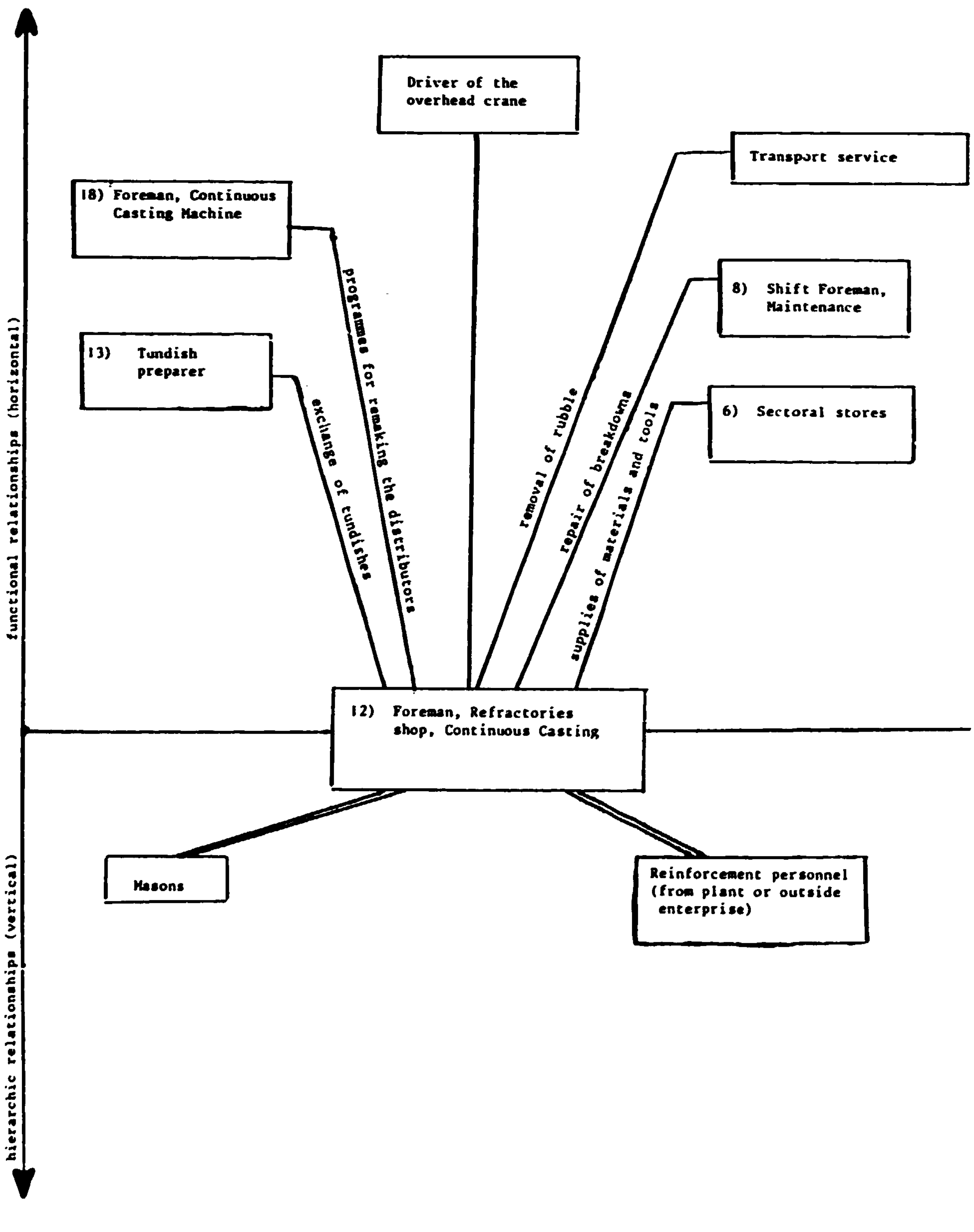
. Repairing, and lining with refractories, the distributors and making them available for the casting team

. Supplying the shop with refractories, maintenance of the equipment and cleaning the site.

. Administrative follow-up of the equipment and the materials utilised - Reports.

UNIDO No. 3/84	CAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : FOREMAN, REFRACTORIES SHOP, C.C.			Code 12 PRODUCTION

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : FOREMAN, REFRACTORIES SHOP, C.C.			Code 12 PRODUCTION

4. Details of the functions

4.1. Cleaning the worn distributors (hot or cold)

4.1.1 Hot distributor

. Take down the distributor.

. slacken the screw to move aside the stopper rod movement arm.

. have the distributor placed on the stripper and withdraw the protective plates.

. turn on the sprinkler ramp to cool the shadrach.

. when the shadrach is black turn the distributor over to strip.

. have the distributor placed on the fan cooler stand.

. then have it placed in the preparation pit :

- demolition of the seating bricks and the refractory cement
- checking the bricks for wear
- lining the distributor with TUNFIX refractory cement
- laying the protective bricks at the point of impact of the jet.

. have the distributor lifted by the crane and placed on a waiting stand.

. also carry out the remaking of the hot distributor protection half-covers: cooling in the open air, declinkering with blowlamp, washing over with quicklime.

4.1.2 Cold distributor

. Take down the distributor.

. move aside the stopper rod movement arms.

. remove the clips which hold the CARNFX refractory slabs.

. allow the distributor to cool in the open air then have it placed on the stripper for turning over.

. then have it placed on the fan cooler stand.

. then place the distributor in the preparation pit and proceed to repair the distributor : demolition and partial or total repair of the refractories, replacement of the seating bricks, placing the silica and then the CARNEX slabs on the bottom of the distributor, placing the protective plates and then sand on the sides, etc.

. at the end of the operation place the distributor on stand-by for the casting team.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : FOREMAN. REFRACTORIES SHOP, C.C.			Code 12 PRODUCTION

4.2. Repair of the refractory lining of the distributors and making available for the casting team

- Check that the masonry work on the distributors has been done according to the norms.
- decide on the demolition and the partial or total repair of a refractory after checking the condition of the distributor.
- supervising the quality of the work (quantity of water in the refractory cement - thickness of the spreading - behaviour of the refractory after heating - correct positioning of the refractory slabs, etc.).
- directing tests, at the request of the hierarchy, on masonry work with different mixes, bricks, slabs, suppliers, etc.
- train the personnel on the job and control the activity of the whole of the site and, in the case of necessity, request reinforcing personnel.
- have the distributors fitted with nozzles and stopper rods (two company operatives); check the correct execution of the work so as to avoid accidents during casting; verification of the uprightness and fitting of the nozzles, checking the position of the stopper rods and the operation of the movement control, checking the nozzles and the whole of the lining after heating the nozzles, etc.
- have the half-covers of the distributors cleaned.
- have the overflow and splits tanks repaired and bricked up.
- supervise the cleaning of the inside of the shop.
- ensure liaison with the casting team.

4.3. Supplying the shop, maintaining the equipment and cleaning the site

- Order from the stores, and stock in the shop, all consumable products : propane cylinders, wearing bricks, seating bricks, jointing compounds, refractory slabs, fuels, nozzles, sleeves, stopper rods, etc.
- check the state of the stock in the shop daily and re-order as required (stock withdrawal notes).
- draw up the requests for interventions for the repair of the installation or the equipment in the shop: pneumatic picks, blowlamps, stopper rod linkages, overflow and splits tanks, etc.
- ensure responsibility and the follow up of materials in transit between the general services and continuous casting.
- supervise the disposal of shadrachs and scrap produced on the site : nozzles, distributor covers.
- supervise the recovery of the stopper rods (cold and hot distributors), the clips for fixing the refractory slabs, the argon tubes.

4.4. Draw up the distributor follow up notes, together with the daily report and the instructions log

- Draw up the various notes on the life of the materials and the equipment used : life of the refractory bricks, number of castings carried out with one distributor, number of repairs and their magnitude - demolition.
- carry out particular follow up on tests requested by the hierarchy.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : FOREMAN, REFRACTORIES SHOP, C.C.			Code 12 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : FOREMAN, R 'RACTORIES SHOP, C.C.			Code 12 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 7/10
Position : FOREMAN, REFRACTORIES SHOP, C.C.							Code 12 PRODUCTION
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.1. Know-how							
5.1.1. Basic general and technical knowledge	C.A.P. Bricklayer and stove-setter			X			
5.1.2. Supplementary vocational knowledge	Experience acquired on the job in a refractories shop (distributor ladleman) and in the post (min. 6 months)			X			
5.1.3. Diversity of the techniques used	Technique of mason/ladleman Specific requirements : ordering materials - training personnel - follow up of materials. (life-logs, etc.)			X			
5.1.4. Type and complexity of the intellectual processing	Distribution of the work according to the given data : manpower available, number of distributors to prepare and possible emergencies.		X				
5.1.5. Type and complexity of the physical activities	Laying bricks with constraints on alignment and jointing				X		
SUB-TOTAL Know-how							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 8/10
Position : FOREMAN, REFRACTORIES SHOP, C.C.							Code 12 PRODUCTION
5. Evaluation of the requirements		Requirement ratings	1	2	3	4	5
5.2. Behaviour							
5.2.1. Degree of vigilance		Control operations on the distributors : degree of wear on a refractory - uprightness of a nozzle, etc.			X		
5.2.2. Degree of contrast of the useful information		Verifying the appearance of the surface of a refractory during and after heating.			X		
5.2.3. Response time		Rapid reaction to the requests of the casting team.				X	
SUB-TOTAL Behaviour							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10

Position : FOREMAN, REFRACTORIES SHOP, C.C. — Code 12 PRODUCTION

5. Evaluation of requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Varied procedures and frequent contacts with other services (general services - stores - production - personnel of outside enterprises).			X		
5.3.2. Type of pilot information for others	Distribution of the work (4 persons). Ordering consumable materials for the shop.		X			
5.3.3. Diversity of functions piloted	General directives to subordinate or reinforcement personnel. Requests for intervention to the General Services, stores, production, maintenance services.		X			
5.3.4. Position of the external controls	Distribution of the work to his team : productivity. Transmission of distributors after remaking: their quality will be judged during casting.			X		
5.3.5. Precision of imputation of consequences	Work imputable to the team			X		
5.3.6. Precision of directives	On the basis of precise directives the foreman should organise his activity and that of his team as a function of the details imposed by the casting team and of any emergencies		X			
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : FOREMAN, REFRACTORIES SHOP, C.C.			Code 12 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	10/25	40
Sub-Total Behaviour	10/15	67
Sub-Total Responsibilities/Powers	15/30	50
TOTAL		157

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : DISTRIBUTOR (TUNDISH) PREPARER, CONTINUOUS CASTING			Code 13 PRODUCTION

1) Objective :

To prepare the distributors in regard to the assembly and adjustment of the stopper rods and the immersed nozzles.

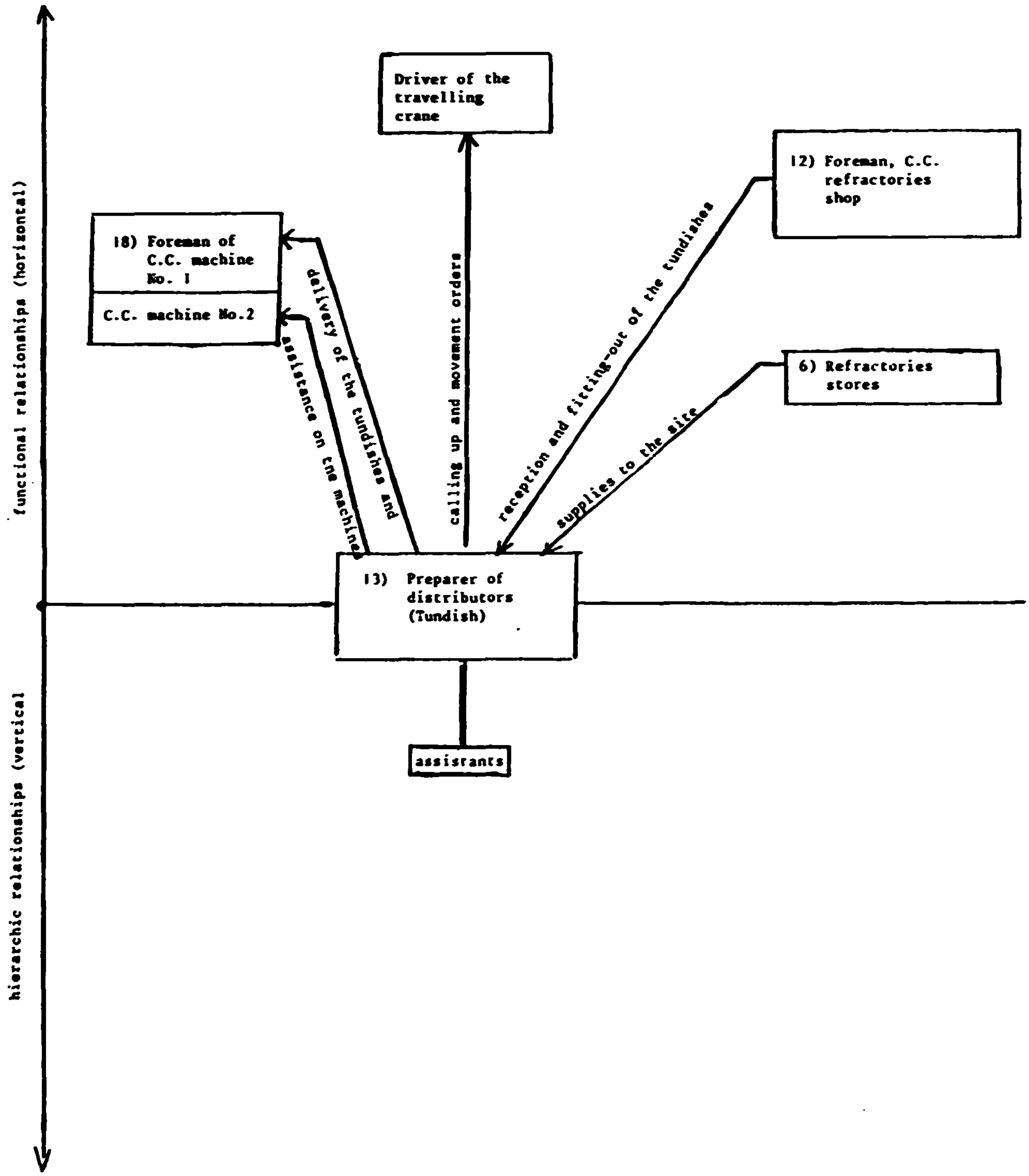
2) Summary of the functions

Under the authority and the responsibility of the Shift Foreman to carry out the following operations :

- removal from the equipment of the used distributors;
- reception and preparation of the distributors after remaking in the distributor maintenance workshop;
- related work of assistance to the casting team.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

4. Details of the functions

4.1. Removal of the used distributors

- The pouring having been completed and the distributor removed to above the emptying tanks, he proceeds to carry out the following two operation :
  . breaking out the nozzles (masse)
  . lowering the distributor carrier into the low position
  . request for crane
  . controlling the operations of slinging and removal of the distributor to the remaking shop.

4.2. Reception and preparation of the distributors (after remaking in the distributors shop) :

4.2.1. Reception

As soon as the assembly stand is available he receives a distributor coming from the refractories shop. He directs the movement of the crane to position the distributor on the stand.

4.2.2. Preparation

a) Positioning of the nozzles (2 per distributor).
- Cleaning out the interior of the distributor with a broom.
- Positioning the immersed nozzles in their housings. Checking uprightness with a level. Checking that the evacuation orifices are in the axis of the distributor.
- Ensure the sealing of the nozzles with a refractory product.
- Wrap the visible part of the nozzles with an asbestos sleeve.

b) Positioning the distributor plates
- Controls the movements of the crane and fixes the slings.
- Protects the central orifice by applying a refractory product and square plates.
- Makes the joints between the distributor and the plates, particularly on the distributor pouring side.

c) Preparation of the stopper rods
- Drill a hole (electric drill) at the base of the stopper rod to allow the passage of the argon.
- Fix a threaded rod to the upper part of the stopper rod.
  Seal with a refractory product.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

d) Positioning the stopper rods

- Fix the stopper rods to the stopper rod carrier by means of the threaded screw (2 washers - 1 nut).
- Adjust the opening and closing of the nozzle (lever in high position, nozzle closed).
- Fix the argon tube (refractory for sealing).
- Check the correct operation of the stopper rods.
- Any necessary cleaning and greasing.
- Removal towards distributor carrier.
- Inform foreman as to the number of the available distributor.

4.3. Related work

- He is required to :
  . Change the mechanism opening the stopper rods.
  . Renovate the recovered threaded rods.
  . Recover the washers (possible use of blowlamp).
- He is responsible for :
  . Cleaning his workshop.
  . Ensuring supplies for the workshop, using a fork-lift truck.
- He may be required to carry out the cleaning and refractory maintenance of : the overflow spout - removal of stand-by tanks and channels.
- To carry out all the handling work at the request of the hierarchy.

4.4. Controlling and training his assistants.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 7/10
Position : DISTRIBUTOR PREPARER, C.C.							Code 13 PRODUCTION
5. Evaluation of requirements		Requirement ratings	1	2	3	4	5
5.1. Know-how							
5.1.1. Basic general and technical knowledge	CAP level, Bricklayer and stove-setter			X			
5.1.2. Supplementary vocational knowledge	Training on the job (6 months)			X			
5.1.3. Diversity of the techniques used	Bricklayer stove-setter - Some small jobs as mechanic (driving fork-lift truck) - conversant with work of driving the travelling crane.			X			
5.1.4. Type and complexity of the intellectual processing	Correcting the inclination of the nozzle in relation to the levels found. Adjusting the opening/closing of the nozzle by adjusting the stopper rod screw. Interpretation of deviations.			X			
5.1.5. Type and complexity of the physical activities	Positioning of the : nozzles and stopper rods. Remaking of the overflow spouts using refractory bricks. Controlling the movements of the crane.					X	
SUB-TOTAL Know-how							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10

Position : DISTRIBUTOR PREPARER, C.C.

Code 13
PRODUCTION

5. Evaluation of the requirements

5.2. Behaviour

	Requirement ratings	1	2	3	4	5
5.2.1. Degree of vigilance	Information always present. The information is found in the state of the distributor.		X			
5.2.2. Degree of contrast of the useful information	Positioning of the nozzles in relation to a level. Positioning of the stopper rod in relation to the nozzle. The environment (lighting, noise, heat) is not conducive to this work of precise adjustment				X	
5.2.3. Response time	Must complete the remaking within the given period, but in general the number of distributors available means that it is not necessary to take account of the random nature of production			X		
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	A consistent procedure with the interlocking of several operations. Reception and removal of distributors. Preparation of stopper rods and nozzles. Some related bricklaying work.		X			
5.3.2. Type of pilot information for others	Directs the movements of the crane for positioning the distributors.	X				
5.3.3. Diversity of the functions piloted	Driver of the travelling crane.	X				
5.3.4. Position of the external controls	The quality of the work carried out may be verified at the moment of pouring into the ingot moulds, badly made joints and poor closing of the nozzles.		X			
5.3.5. Precision of imputation of the consequences	The faults will appear during pouring, and if they can be attributed to poor remaking will be imputable to the post.	X				
5.3.6. Precision of the directives	All the phases of the work have been defined in the post, modifications being specified by the hierarchy: the variants are due in particular to the state of the equipment (eg stopper rod closing defective) and remain close to the model. Stock re-ordering of materials is carried out before zero stock.	X				
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : DISTRIBUTOR PREPARER, C.C.			Code 13 PRODUCTION

6. <u>Summary of the requirement ratings</u>

	Points	%
Sub-Total Know-how	12/25	48
Sub-Total Behaviour	9/15	60
Sub-Total Responsibilities/Powers	8/30	27
TOTAL		135

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : SUPERVISOR, CONTINUOUS CASTING BILLET STORE			Code 14 PRODUCTION

1) Objective :

Responsible for all the activities taking place at level 0, from the extraction stands to the removal of the billets to repair, marking, storage and/or the rolling mill.

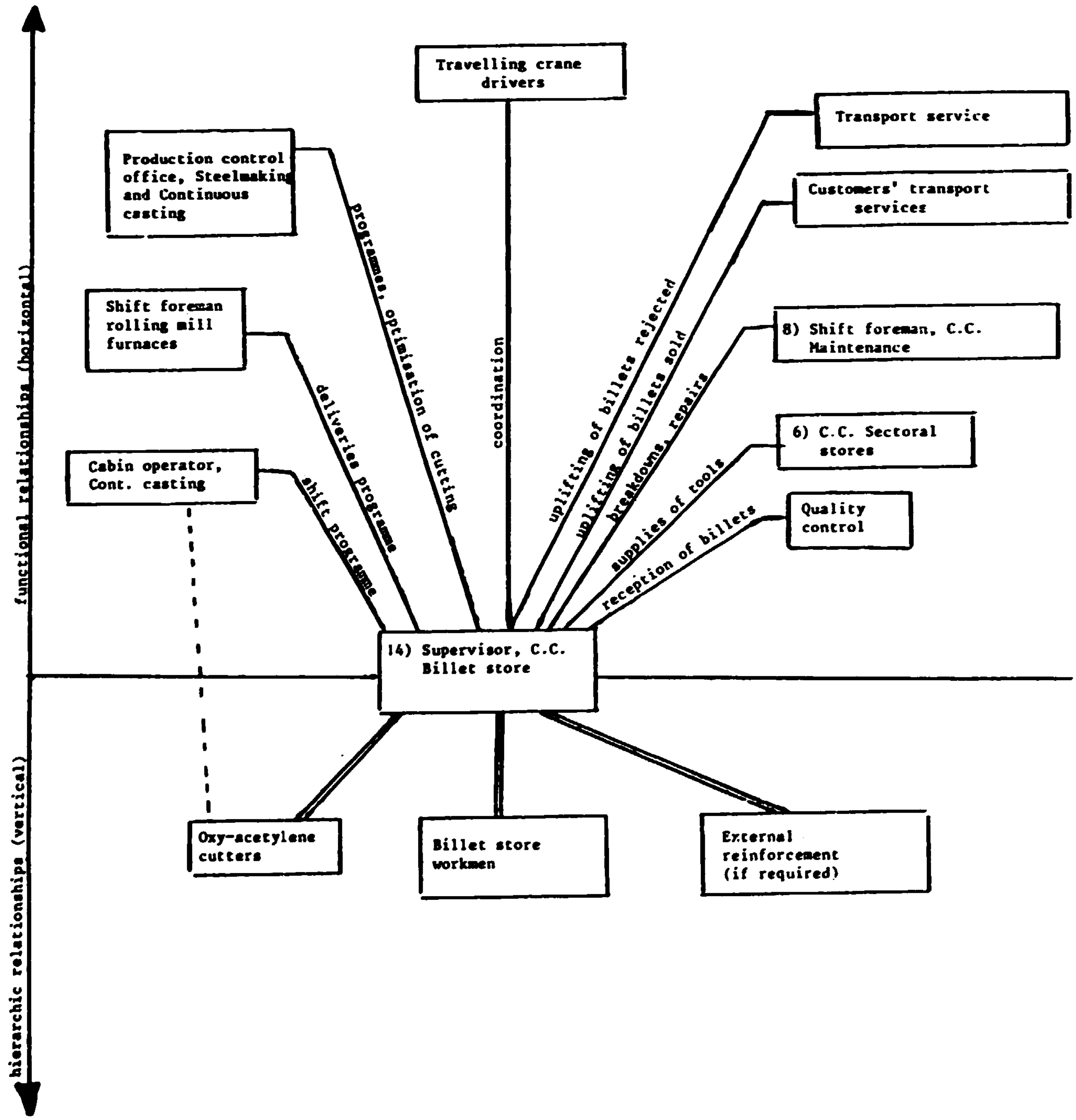
2) Summary of the functions

Under the authority and the responsibility of the Shift Foreman, Continuous Casting, he carries out and/or has carried out the following operations :

- identification of the billets according to the production programme;
- optimisation of their cutting;
- identification of defects;
- organising and controlling the work, from extraction, cutting and marking up to delivery to the rolling mill, passing through repair and storage or not;
- obtaining any necessary interventions from the various general services and/or outside enterprises;
- writing the shift report;
- managing and training the personnel under his control.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

3) <u>Diagram of the relationships</u>



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

4. Details of the functions

4.1. Optimisation of the cutting

4.1.1. General

During castings, whether sequential or not, a certain number of actions located at the ingot mould level have the effect of producing defects at billet level.

Locating these defects, fixing them at the level of a cut, at the head or the foot of a billet, whilst complying with the production programme at least in respect of the standardised lengths, makes it possible to avoid :

. rejected billets (length shorter than the smallest standard length),

. billets for cropping (usable when cropped).

This location, taken into account by quality control, allows, when combined with other parameters, the destination of the billet to be determined :

- repair,
- billet store,
- removal whilst hot to the rolling mill.

4.1.2. Identification of the origin of the defects

The various operations carried out at the ingot mould level may generate defects on the billets :

- changes in the distributors,
- exposure to oxygen,
- slowing down,
- changes in the grade of steel,
- halting pouring,
- opening the ladle, etc.

The supervisor of the billet store follows up all these operations and interprets them to optimise the production/quality functions.

4.1.3. Initial information

→ At the start of the shift contact the cabin operator to ascertain the order of the programme and the numbers of the castings.

→ Take note of the programmes, transmitted by printer, which indicate the type of billets, the steel grade, the identification symbol for the casting, the format of the billets and the theoretical length of cut.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

4.1.4. Optimisation of the cuts

→ Indicate to the cutting station the lengths of the billets as a function of the types required by the programme : total length near the maximum of the range, corrected for the coefficient of wear on the measuring roller.

→ Calculate the theoretical weight of the billets so as to make a check of agreement with the weight measured on the weighbridge.

→ Enter into the computer, if the plant is so equipped, the parameters for the casting :

. number of the casting

. programme number

. steel grade

. format of the billets

. number of billets of each type.

The computer optimises the cutting of the billets and establishes the cutting instructions : foot crop, number of billets, format, location of the defects in relation to the foot and the total length.

→ Check the cutting instructions - where necessary make the necessary corrections, then pass to the operator.

→ In the event of a problem with the computer, or if the plant is not so equipped, make the optimisation calculations by hand. Also carry out the optimisation of any haltings in casting by hand.

Attempt, as far as is possible, to conform to the succession of types of billets requested by the theoretical programme.

4.2. Work at level 0

The supervisor is responsible for the operations carried out in the sector which extends from the extractor stands to the billet store.

→ Control and organise the work of the operatives involved in this sector of Continuous Casting: cutter, overseer used, store workmen, crane drivers, outside enterprises, quality control staff : distribution of the work, control and defining the priorities.

→ Intervene effectively in the event of an incident or in delicate operations : moving the stands for grades of steel which cannot be mixed, decoupling the head of the drive roll, etc.

→ Check the billets visually to detect appearance faults (cracks) which require a shut down in casting.

→ Carry out regular control surveys of the installation so as to verify the correct operation of the tools.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

→ To coordinate and control the operations of passing the hot billets, without defects to the rolling mills, or for repair of the defects.

4.3. Shift report

At the end of the shift he completes the shift logbook :

. work carried out

. incidents

. despatches

. interventions outside the continuous casting department

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	BEPC/CAP level		X			
5.1.2. Supplementary vocational knowledge	More than 6 months experience in the post.			X		
5.1.3. Diversity of the techniques used	Several specific techniques: - continuous casting manufacturing process - billet store management - use of computer.			X		
5.1.4. Type and complexity of intellectual processing	Optimisation of billet cutting as a function of the location of defects, of the production programme and of the standards in force. - distribution and organisation of the work at level 0 : allocation of the personnel, definition of priorities and emergencies, intervention on problems, multiple relationships with other departments.			X		
5.1.5. Type and complexity of the physical activities	Effective participation in certain delicate operations : movement of the stands, decoupling, feeler head. Practical mechanical sense.		X			
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	Visual control of the billets. Control of agreement between theoretical weight and measured weight. Vigilance on the intercom.				X	
5.2.2. Degree of contrast of the useful information	Visual appreciation of defects in the billets (cracks)			X		
5.2.3. Response time	Calculation of optimisation and rapid decisions imposed by incidents.					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Two procedures : - optimisation of the cutting - responsibility for operations at level 0.		X			
5.3.2. Type of pilot information for others	Defining the cutting programme for the oxy-acetylene cutter. Training of the utilities overseer, of the store personnel, of the crane drivers and of operatives from outside the continuous casting department. Activity report.			X		
5.3.3. Diversity of the functions piloted	- Under direct command : oxy-acetylene cutter + three store workmen + external reinforcement operatives. - Horizontally : cabin operator, quality control, two cranes, transport services, maintenance, stores + all users of the cutting optimisation report.			X		
5.3.4. Position of the external controls	In the absence of a major incident, control is by the results statistics.				X	
5.3.5. Precision of imputation of consequences	Apart from flagrant exceptions the imputation is distributed over the whole of the continuous casting shift team.				X	
5.3.6. Precision of directives	In compliance with the constraints of the programme, of the standards in force, to optimise the cutting and to organise the work at level 0. Fairly broad autonomy.				X	
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SUPERVISOR, C.C. BILLET STORE			Code 14 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	13/25	52
Sub-Total Behaviour	12/15	80
Sub-Total Responsibilities/Powers	20/30	67
TOTAL		199

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : SUPERVISOR OF UTILITIES AND AUXILIARIES, CONTINUOUS CASTING			Code 15 PRODUCTION

1) Objective :

- To ensure the correct adjustment and the efficient functioning of the fluids circuits (cooling and hydraulic).
- To participate in mechanical regulation downstream of the ingot moulds.

2) Summary of the functions

Under the authority and the responsibility of the machines foreman he carries out the following tasks :

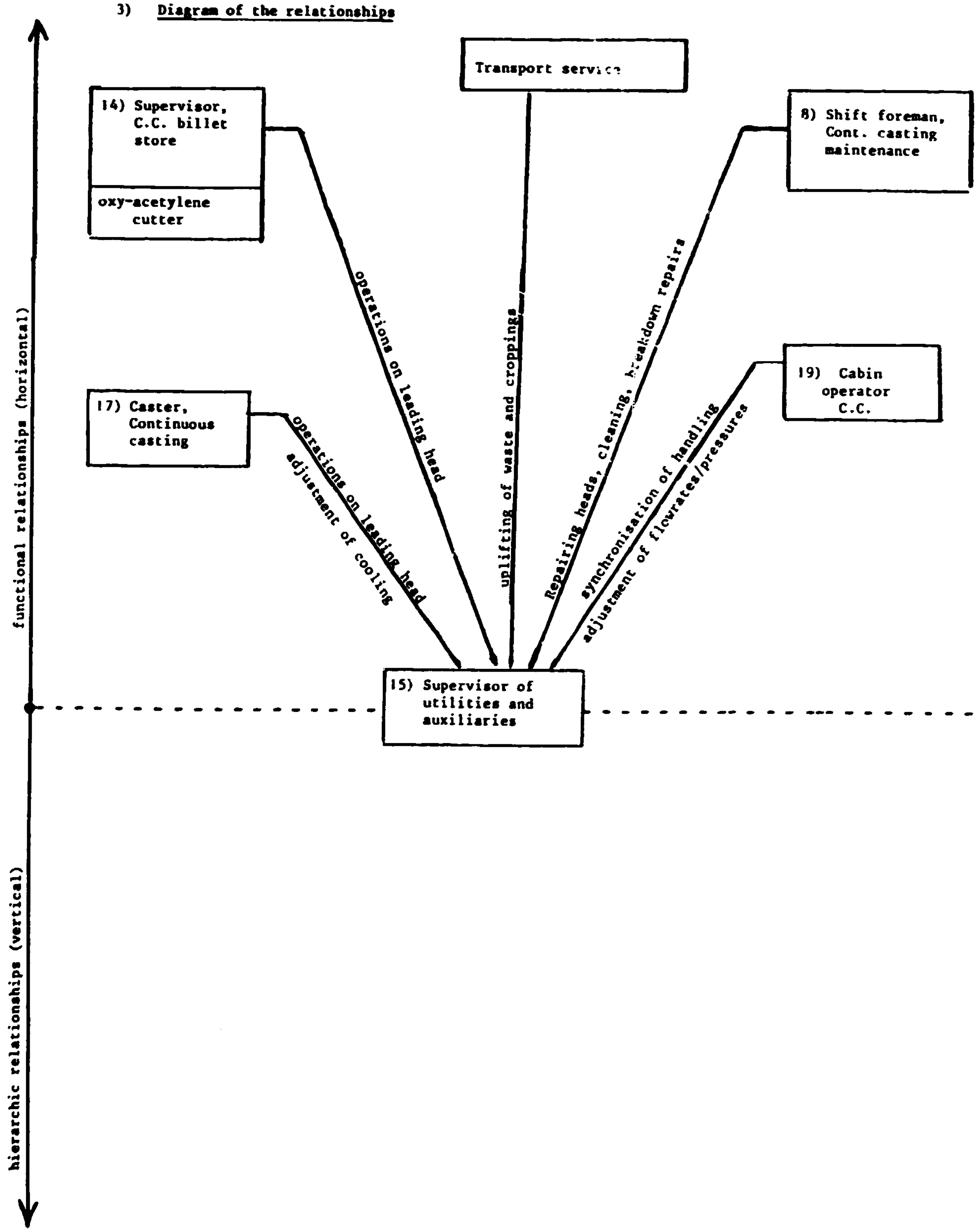
. adjustment and surveillance of the auxiliaries and utilities.

. preparation and handling operations relating to the leading head.

. related operations.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : SUPERVISOR OF UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : SUPERVISOR OF UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

4. Details of the functions

4.1. Adjustment and surveillance of the auxiliaries and utilities

4.1.1. Operations carried out before casting on two lines

- Modify the flowrates in the cooling circuits on the instructions of the operator. Opening and closing of the valves according to a scheme adapted to the format of the billets to be produced.

- Control the hydraulic pressures on the stands (secondary and straightening zones).

- Ensure that the stands in the spray zone are well closed.

- Simulate the passage of the billet (straightening zone) to check the operation of the stands. This operation is carried out under manual control.

4.1.2. Operations carried out during casting :

- Control the closing of the stands during the passage of the billet (straightening zone). In the event of the automatic system not operating supplement it by manual control.

- Supervise the lowering of the measuring roller as the foot of the billet pas[illegible]rough. Initiate the manual action of the oxy-acetylene cutter in the event of an incident.

4.2. Preparation and handling operations relating to the leading heads :

These operations are carried out jointly with the head preparer.

4.2.1. Changing the format : one or two lines

According to the intended format of the billets, and at the request of the operator, choose the type of leading head previously prepared by the mechanical maintenance Service.

- remove the head to be changed from the extraction line (using a crane with suspended control pod and a controlled lifting beam). Removal.

- position a head suitable for the format (crane and lifting beam as above).

4.2.2. Preparation of a head before putting into service

- Clean the head from any slag which could be adhering to it.

- Position and light the gas banks (after changing the head or a shut down of more than 2 hours).

- Spray "Nalcot" on the head until it is completely covered (The heating may be maintained after spraying).

N.B. : If no head of the desired format is available proceed to carry out the "Setting to format" operations on the one in place :

- Slacken the holding rods
- Disengage the packing piece by spacing out the extremities (use of hydraulic equipment)
- Position a packing piece of the new format
- Retighten the head ends (rods).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

4.2.3. Introducing the head into the line

- One head per line. Each line is served either by the supervisor or by the preparer.

- Order the introduction on the instructions of the operator from the control desk located at the entry to the line.

- Check that the head is completely dry.

- Adjust the speed of advance of the head, in the line, as a function of its position. When the head is in the proximity of the ingot mould the control is automatically taken over by the casting distributor. Nevertheless it is necessary to be able to respond to any incident during the whole of the introduction.

4.2.4. Uncoupling the head and the billet

- Supervise the uncoupling of the head and the billet on leaving the stands (automatic operation) and the locking of the table.

N.B. : if uncoupling does not take place then :

a) act on the tightening of the stands,

b) immediately inform the operator who will carry out the shut-down operations,

c) effect the emergency shut-down of the line.

In this case proceed to the oxy-acetylene cutting of the head of the billet so as to ensure its separation from the leading head.

4.3. Related operations

- Supervise the removal of the croppings from the heads and feet of the billets. In the event of the non-operation of the automatic system operate this removal by manual control.

- Ensure the removal and replacement of the croppings bin (order bin and truck from transport service).

- Ensure the removal of the dross from the hydrocyclone.

- Carry out the manual oxy-acetylene cutting of the billets in the event that such cutting cannot be carried out on the lines.

- Keep updated the statement of the leading heads which are available.

- Participate in cleaning, particularly in the removal of slag adhering to the rollers, etc.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS						Page 7/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.								Code 15 PRODUCTION
5. Evaluation of the requirements		Requirement ratings	1	2	3	4	5	
5.1. Know-how								
5.1.1. Basic general and technical knowledge	CAP level, preferably fluids engineering option			X				
5.1.2. Supplementary vocational knowledge	Training in the post of leading head prepaper. Training in the maintenance of hydraulic circuits. (Total 6 months)			X				
5.1.3. Diversity of the techniques used	Iron and steel industry : preparation of leading heads - Control of hydraulic installations and cooling circuits.			X				
5.1.4. Type and complexity of the intellectual processing	Checking the validity of the pressures on the pressure gauges. In the event of anomalies seek out the cause and warn the Engineering service. In the event of the non-operation of the automated systems effect the operation manually.			X				
5.1.5. Type and complexity of the physical actions	Position the leading head in the extraction line, using a hoist with a suspended control pod. Modify the formats of the leading heads.			X				
''B-TOTAL Know-how								

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

5. Evaluation of the requirements	Requirements ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	During casting an incident may arise at any moment, necessitating an immediate response. Mechanical and hydraulic incidents: (particularly critical points are the separation of the leading head or a sudden failure in the water pressure).					X
5.2.2. Degree of contrast of the useful information	Use of intercom in a noisy environment. Evaluation of the length of the billets in relation to a fixed rule in the event of incidents concerning the measuring roller				X	
5.2.3. Response time	Must react immediately to incidents, either by ordering the shutting down of the line or by making corrections (eg separation of the head, closing the stands). Must inform the cabin operator immediately.					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Different procedures : 1) Supervising the auxiliaries and utilities 2) Leading heads		X			
5.3.2. Type of pilot information for others	In the routine work to guide the head preparer in his operations. To inform the operator as to the availability of the line and of incidents taking place during casting. To initiate the activity of the distributor caster. During oxy-acetylene cutting to give cutting signals or to lower the measuring roller in an incident. To order the bins from the transport service.		X			
5.3.3. Diversity of the functions piloted	Leading head preparer - operator - distributor caster - oxy-acetylene cutter - transport and maintenance services.		X			
5.3.4. Position of the external controls	Surveillance of the lines. Corrective or other operations are integrated into the production process.			X		
5.3.5. Precision of imputation of consequences	Surveillance of a continuous process; incidents are due either to a defective automated system or to an error. Confirmation by simple investigation.		X			
5.3.6. Precision of directives	Preparation of leading head. Head changing is ordered by the operator. The process is always the same. Surveillance of the lines: the control exercised on the installation must make it possible to rectify any automation incidents, thus excluding a precise definition of all the possible incidents.		X			
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SUPERVISOR OF THE UTILITIES AND AUXILIARIES, C.C.			Code 15 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	10/25	40
Sub-Total Behaviour	14/15	93
Sub-Total Responsibilities/Powers	13/30	43
TOTAL		176

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : GRADE ADJUSTER, CONTINUOUS CASTING			Code 16 PRODUCTION

1) Objective :

Is responsible for carrying out the treatment operations in the ladles :

- blowing argon to homogenise the bath;
- injecting aluminium;
- introducing scrap to adjust the temperature.

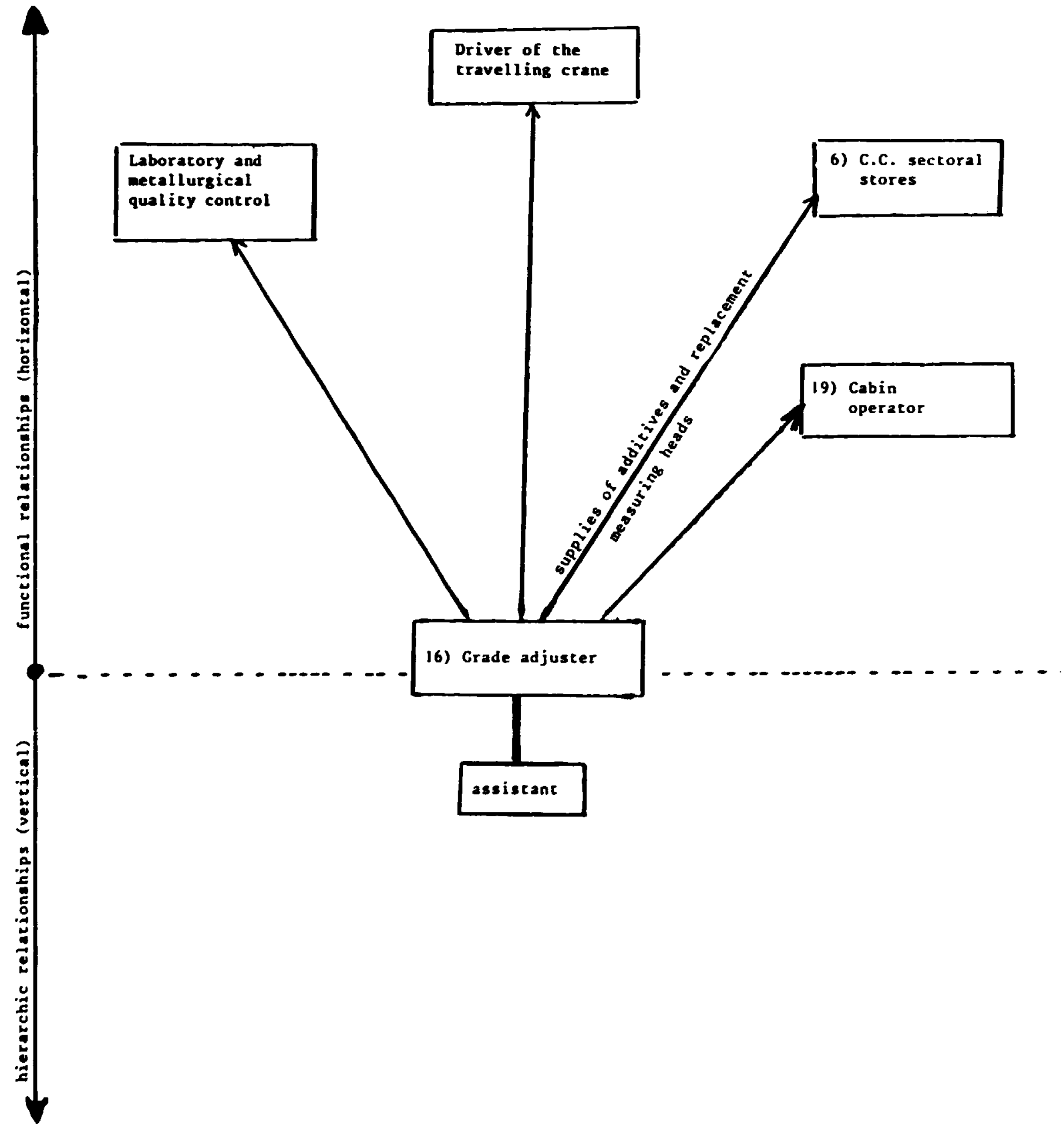
2) Summary of the functions

Under the authority and the responsibility of the C.C. Machine(s) Foreman he carries out, and/or has carried out by his assistants, the following operations :

- transfer of the ladles filled with liquid steel from the casting furnaces hall to the C.C. supply hall,
- treatments in the ladles;
- bringing the ladles up to the C.C. machine;
- returning the empty ladles to the steelmaking section;
- supplying and cleaning the work-place.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

4.1. Transfer of the full ladles between the pouring hall and the continuous casting supply hall.

- receives information from the cabin operator indicating that a full ladle is available;
- requests the transfer crane;
- ensures that the passage for the ladle is free;
- proceeds to transfer the ladle, ensuring safety;
- controls the crane operator, by gestures, when placing the ladles on the treatment stand.

4.2. Treatment in the ladles

- distributes insulating powder over the surface of the bath in the steel ladle by dumping bags.
- controls the pressure in the argon line (standard fixed flowrate);
- connects the argon hose to the ladle;
- controls the stirring from the console, by opening the admission valve;
- closes the valve after 2 minutes;
- takes temperatures and samples;
- verifies the temperature curve and validates the information to the cabin operator;
- checks the appearance of the sample;
- writes the number of the casting on the adhesive tape and fixes it to the cartridge;
- sends the sample to the laboratory and receives the empty cartridge;
- receives the information concerning the addition of aluminium and scrap from the operator -
  a) the aluminium injection is effected from the injection machine. Push-button operation. Indicator shows quantity injected.
  b) the scrap is added by means of a weighing hopper, controlled from the control desk after entering the weight and read-out on the screen.
- prepares the pyrometer cane and the sample tube for new samples;

N.B. : On the basis of the results the operator has one or more supplementary steps carried out until the desired values are obtained.

- disconnects the argon tube.

4.3. Bringing the ladle up to the C.C. machines

- Directs the operations of the crane to uplift the ladle from the treatment station and transfers responsibility for handling to the lines foreman.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

4.4. <u>Return of the empty ladles to the steelmaking unit</u>

- Orders up the transfer crane and positions it.
- Returns the empty ladle to steelmaking, ensuring that the passage is free and that safety is observed.

4.5. <u>Supplies and cleaning the work-place</u>

- With the assistance of a fork-lift truck or a crane obtains supplies of :
  . tips for taking temperatures;
  . tubes for samples;
  . aluminium reels (also ensure the machine is loaded);
  . scrap for cooling;
  . insulating powder.
- cleans the treatment station and the supply hall.

<u>Note</u> :

- At the request of the hierarchy he clears all materials from the casting floor and participates in all cleaning operations.
- Fulfils the function of caster's assistant when operating "stand-by" casting (casting into an ingot mould).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 7/10
Position : GRADE ADJUSTER, C.C.							Code 16 PRODUCTION
5. Evaluation of the requirements		Requirement ratings	1	2	3	4	5
5.1. Know-how							
5.1.1. Basic general and technical knowledge	C.E.P.		X				
5.1.2. Supplementary vocational knowledge	Must hav held the position of assistant, plus training in the position (Total 6 months)			X			
5.1.3. Diversity of the techniques used	Elementary steelmaking knowledge. Must have licence to drive a fork-lift truck. Must be a qualified "crane handler".			X			
5.1.4. Type and complexity of intellectual processing	Must judge if the quantity of (thermally) insulating powder is sufficient. Determines the amounts of the materials needed for supplying the work-place			X			
5.1.5. Type and complexity of the physical actions	Driving fork-lift truck. Precise gestures to travelling crane driver.			X			
SUB-TOTAL Know-how							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	Attention to intercom calls for receiving and giving signals. Correct assembly and immersion of the apparatus for taking temperatures and samples. Accurate reading of indicators. Safety when transferring the ladles				X	
5.2.2. Degree of contrast of the useful information	High adaptation of vision with the contrast between observing the bath and reading the apparatus.					X
5.2.3. Response time	Average in general, rapid at the time of making injections for adjustment.				X	
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Procedures for treatment in the ladle repetitive, but variations in the level of the operations (incidents). Driving fork-lift truck.		X			
5.3.2. Type of pilot information for others	Supplies samples to the laboratory. Provides temperatures for the operator. Specifies the handling operations to his assistant. Directs the movements of the crane.		X			
5.3.3. Diversity of the functions piloted	- Laboratory. - Cabin operator. - Crane. - Assistant.		X			
5.3.4. Position of the external controls	The operations are followed up by a quality controller in a consistent manner. The product is checked before he leaves his shift. Samples taken. Temperature.		X			
5.3.5. Precision of imputation of consequences	Ladle treatment is solely carried out at this work station.	X				
5.3.6. Precision of directives	The procedures are defined. The taking of samples and temperatures and the quantities of the additions are specified. Work-place supplied according to needs.	X				
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : GRADE ADJUSTER, C.C.			Code 16 PRODUCTION

6) Summary of the requirement ratings

	Points	%
Sub-Total Know-how	9/25	36
Sub-Total Behaviour	13/15	87
Sub-Total Responsibilities/Powers	10/30	33
TOTAL		156

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : CASTER, CONTINUOUS CASTING (ONE PER INGOT MOULD)			Code 17 PRODUCTION

1) Objective :

To carry out, on the platform of the machine, those operations which ensure the continuous and regular supply of liquid steel , by acting on the distributor (tundish) flowrate and on the speed of extraction of the billet.

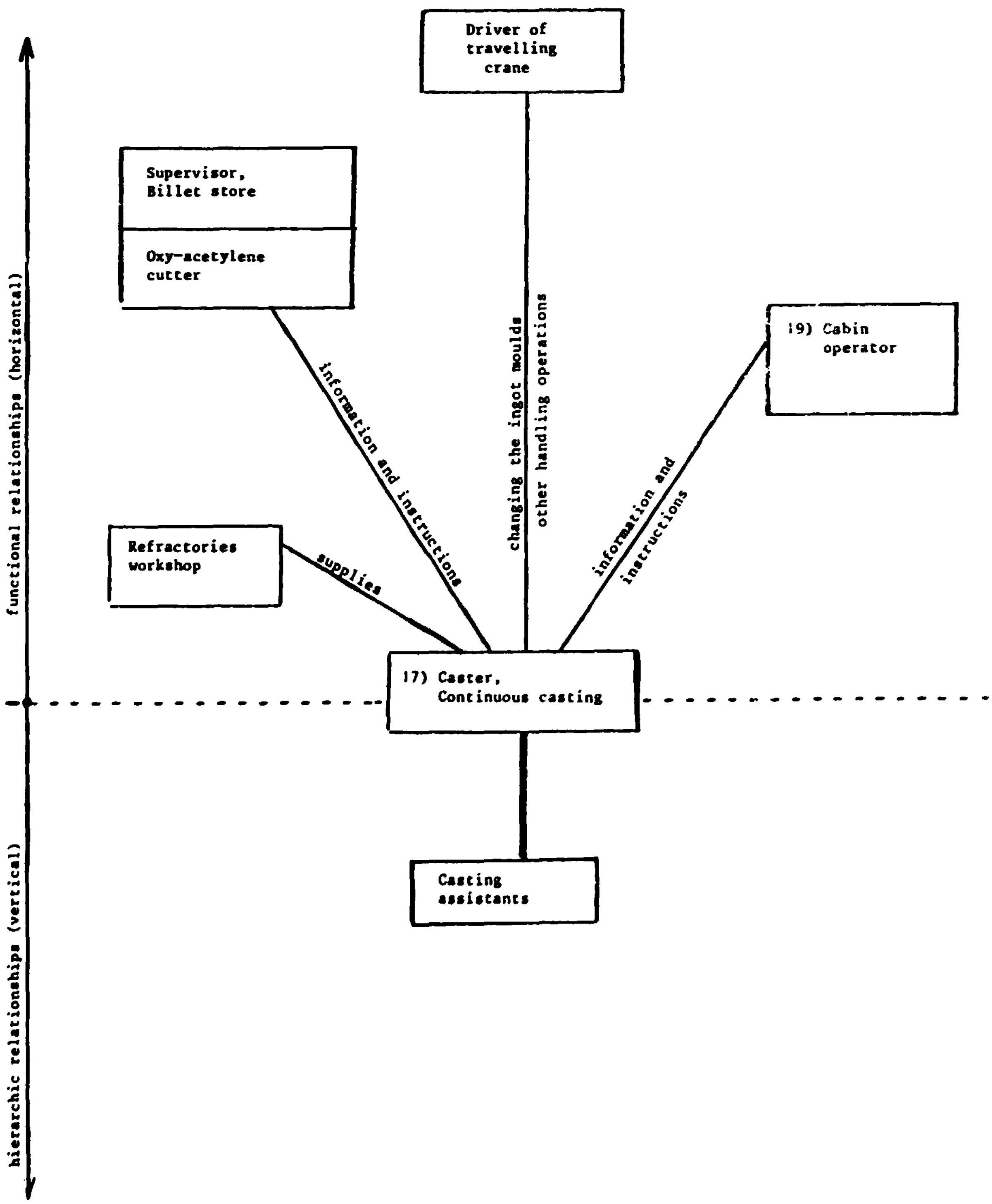
2) Summary of the functions

Under the authority and the responsibility of the Machine(s) Foreman he himself carries out, or has carried out by his assistants, the following functions :

- preparation of the work-place
- casting in the ingot mould
- operations in the event of incidents
- cleaning operations.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : CASTER, C.C.			Code 17 PRODUCTION

3) **Diagram of the relationships**



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : CASTER, C.C.			Code 17 PRODUCTION

4. Details of the functions

4.1. Preparation of the work-place

4.1.1. Changing the ingot mould

- Taking down the ingot mould and zone 1 after removing the hoses and protective sheets from the cover.
- Guide the movements of the crane.
- Cleaning the seating plates (water gasket) with emery cloth.
- Install a new ingot mould and zone 1 (1 assembly).
- Check watertightness of the water-box. Purge the ingot mould.

4.1.2. Preparation of the ingot mould after casting

- Checking the state of the walls of the ingot mould.
- Removal of any roughnesses (emery cloth) and slag adhering to the grilles of zone 1 (scraper).
- Checking the squareness of the faces.
- Make the cover of the ingot mould tight with a refractory cement and an asbestos ring.

4.1.3. Preparation of the distributor

- Order the positioning of the distributor carrying trolley over the ingot mould.
- Position the nozzles in respect of the larger faces of the ingot mould. The nozzle must always be centred. This centring is carried out visually (possible to check with a rule).
- Order the positioning of the trolley to the preheating stand.
- Order the movement (push buttons) of the descent of the burners. Adjust the rate. Heating of the distributor is carried out in two stages and on the orders of the operator.
- Position the heater nozzles.

4.1.4. Preparation of the leading head

The initiation of this operation is the responsibility of the operator, as soon as a ladle arrives at the treatment station. When the leading head is near the ingot mould the operator gives the order to the line foreman.

- Position the head (side under the upper level of the ingot mould) by varying the speed of the line, at the end of the operation. Ongoing checking during positioning (risk of catching, lifting of scrap).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : CASTER, C.C.			Code 17 PRODUCTION

- Ensure that the leading head is sealed to the ingot mould using a refractory cement, asbestos ring, iron filings, iron shot and corner irons.

- The shot is dried, the corner irons cut to the dimensions.

4.1.5. <u>Supplies to the work-place</u>

- Have the necessary covering powder available near the ingot mould.

- Ensure that the stock of powder is sufficient.

- Check that the tools are present : slag bucket, rod for removing lumps of slag, water lance, oxygen lance.

- Arrange for supplies if necessary. Use :
  . of a fork-lift truck
  . of the travelling crane (pallets).

4.2. <u>Casting in the ingot moulds</u>

4.2.1. <u>Positioning of the distributor</u>

- Cut the gas to the burners (order from the operator).

- Lift the burners and withdraw the nozzle heaters.

- Check operation of the stopper rod.

- Lift the distributor and pass control of the trolley to the casting station.

- Order the advance of the trolley and the positioning of the nozzles in the ingot mould. (large face and immersion).

- Connect argon line. Tighten the stopper rod fixing screw.

- Inform operator that casting is possible.

4.2.2. <u>Start of casting</u>

- On the orders of the operator, who is informed by the ladle pourer as to the level of steel in the distributor :
  . Opens the stopper rod to supply the ingot mould,
  . starts extraction at a reduced speed as soon as the level is reached in the ingot mould,
  . throws covering powder into the distributor,
  . covers the surface of the bath in the ingot mould with the powder (this powder is lubricating and prevents the oxidation of the steel). This operation is carried out throughout casting.

. increases the speed of extraction according to the directives of the operator,

. adjusts this speed to the flowrate of the nozzle. It is essential that the level is held constant in the ingot mould,

. continuously removes the lumps of slag forming on the surface of the bath and against the walls of the ingot mould,

. informs the oxy-acetylene cutter concerning oxygen burning so at to optimise cutting.

4.2.3. Sequential casting

4.2.3.1. Changing the ladle : on the instructions of the operator reduces the speed of extraction and the flowrate of the distributor until the ladle is changed.

4.2.3.2. Changing the distributor : this operation is carried out either on the directives of the foreman (sequence of 3 ladles) or on the initiative of the Line Foreman. If the latter finds, during sequential casting, that the nozzles are frequently clogged he will change the distributor.

Identical operations to those described under 4.1., but carried out in a more rapid manner and with the following special features :

. ensuring a constant and considerable layer of insulating powder on the meniscus of the ingot mould,

. when casting is recommenced a careful removal of slag is carried out so as to reduce the risks of piercing.

4.3. Operations in the event of incidents

These are of three orders :

. piercing,
. overflowing,
. obstructions in the nozzle.

4.3.1. Piercing : the principal causes are due :

- to excessively rapid extraction (insufficient cooling),
- to failure to remove a lump of slag (tearing of the skin),
- to a lack of lubrication,
- to incomplete solidication at the foot of the slab,
- to a failure of the leading head to disengage on leaving the stands,
- to separation of aluminium in the case of a release of O_2 (high local temperature).

The Line Foreman or the distributor caster will observe the incident by a sudden fall in the ingot mould. Stop extraction, shut the stopper rod. If it is impossible to continue casting on the line evacuate the distributor.

Position : CASTER, C.C.	Code 17 PRODUCTION

N.B. : After every piercing incident it is necessary to survey the line so as to remove any scraps which could hinder extraction. This survey is effected by the spray cabin. Every roller is checked, together with the spray ramps (test if necessary).

- Identical check during programmed shut-downs.

4.3.2. Overflowings are due :

- to an unexpected halt in extraction,
- to the impossibility of shutting off the nozzle. The molten steel leaves the ingot mould and spreads over the cover or even onto the floor,
- it is necessary to make an emergency disengagement of the distributor.

4.3.3. Obstructed nozzle

- Slag reduces the diameter of the nozzles, leading to a reduction in the flowrate.
- The corrective operations may consist of :
  . a reduction of the speed of extraction, within the permitted limits,
  . the shut-down of a line,
  . blowing argon,
  . clearing the nozzle with oxygen (clearing effected by the introduction of a tube into the nozzle after the latter has been removed; complete and careful de-slagging of the meniscus after casting is recommenced.

4.4. Cleaning operations

Apart from the casting, and under the responsibility of the foreman, the Line Foreman is responsible for ensuring the following, with the assistance of the available personnel (ladle caster, grade adjuster, distributor caster, casting assistant) .

. cleaning the work-places : casting floor
ladle treatment
stand-by table
stand-by ladle.

. changing the protections under the pivoter.

. removal of waste.

. supplies to the work-places.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : CASTER, C.C.			Code 17 PRODUCTION

5. Evaluation of the requirements	Requirements ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	CAP Steelmaker level.		X			
5.1.2. Supplementary vocational knowledge	Experience acquired by training, for at least one year, in the position of ladle caster or distributor caster.			X		
5.1.3. Diversity of the techniques used	Casting/pouring technique. Ensuring sealing with refractory products. Must adjust the faces of the ingot mould. Uses a fork-lift truck. Is a recognised "Handling chief" in respect of travelling cranes.			X		
5.1.4. Type and complexit of the intellectual processing	Must adapt his response immediately as a function of the phenomenon observed: modifying the flowrate, adjusting the speed, halting extraction, evacuating the distributor. In the case of a variation of level in the ingot mould adjust the flowrate from the distributor. If despite everything the level still varies adjust the speed of extraction. If these two actions are found to be insufficient, halt the extraction or evacuate the distributor.			X		
5.1.5. Type and complexity of the physical actions	Must maintain a constant level in the ingot moulds. To do this, adjust : - either the nozzle flowrate, - or the speed of extraction of the slab.		X			
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : CASTER, C.C.			Code 17 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	The level of the molten steel in the ingot mould must remain constant. Incidents of piercing or irregular flowrate can occur at any moment during casting ...					X
5.2.2. Degree of contrast of the useful information	Sparks, dust due to the covering powder and visual fatigue all lead to difficulties in perceiving the height of the meniscus.					X
5.2.3. Response time	In the case of piercings or halting of extraction evacuate the distributor if the nozzle remains blocked in the open position. Overflowing : evacuate the personnel, reduce extraction, order the evacuation of the distributor, spray the foot of the billet					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : CASTER, C.C.			Code 17 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Procedures of casting into ingot moulds with varieties of levels in the operations. Varieties due to the type of sequences and to incidents. Regulation of the ingot mould			X		
5.3.2. Type of pilot information for others	Specifying to assistants the materials and the quantities necessary for the work-place. In the operations of regulating the ingot mould he directs the actions of his assistants. During casting, initiates the activity of his assistants. Informs the operator of casting incidents. Conditions the activity of the work stations: ladle caster - billet cutting. Directs the movements of crane driver when positioning - covers - materials. Initiates activity in refractories shop for supplies of materials (at distributor workshop level).		X			
5.3.3. Diversity of the functions piloted	Assistants. Ladle caster. Cleaning team. Oxy-acetylene cutter. Crane driver - Refractories (fork-lift truck driver)			X		
5.3.4. Position of the external controls	The operations are followed up by a quality controller. The speeds are recorded on a diagram. The actions undertaken have irreversible results on the progress of casting, particularly in regard to leading head incidents. The suitability of the regulation of the ingot mould will be seen during its use.		X			
5.3.5. Precision of imputation of consequences	Work carried out by the team.					X
5.3.6. Precision of directives	Operational modes : imposed by the operation of the installation, learnt by training on the job. In the case of incidents must adapt his response to the instructions received. Supplies his work-place when [illegible] of powder is insufficient.		X			
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : CASTER, C.C.			Code 17 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	13/25	52
Sub-Total Behaviour	15/15	100
Sub-Total Responsibilities/Powers	17/30	57
TOTAL		209

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : FOREMAN, CONTINUOUS CASTING MACHINE			Code 18 PRODUCTION

1) Objective :

To coordinate the activities of all the work stations on and around the Continuous Casting machine so as to ensure the regular operation of the "casting" function.

2) Summary of the functions

Under the responsibility and the authority of the Shift Foreman he is responsible for :

- initiating,
- synchronising, and
- controlling

the following operations :

1. - The preparation of the distributors (tundish) and the casting lines, ensuring the supplies of stocks of materials and parts, the removal of waste and the good order and cleanliness of the work-places.

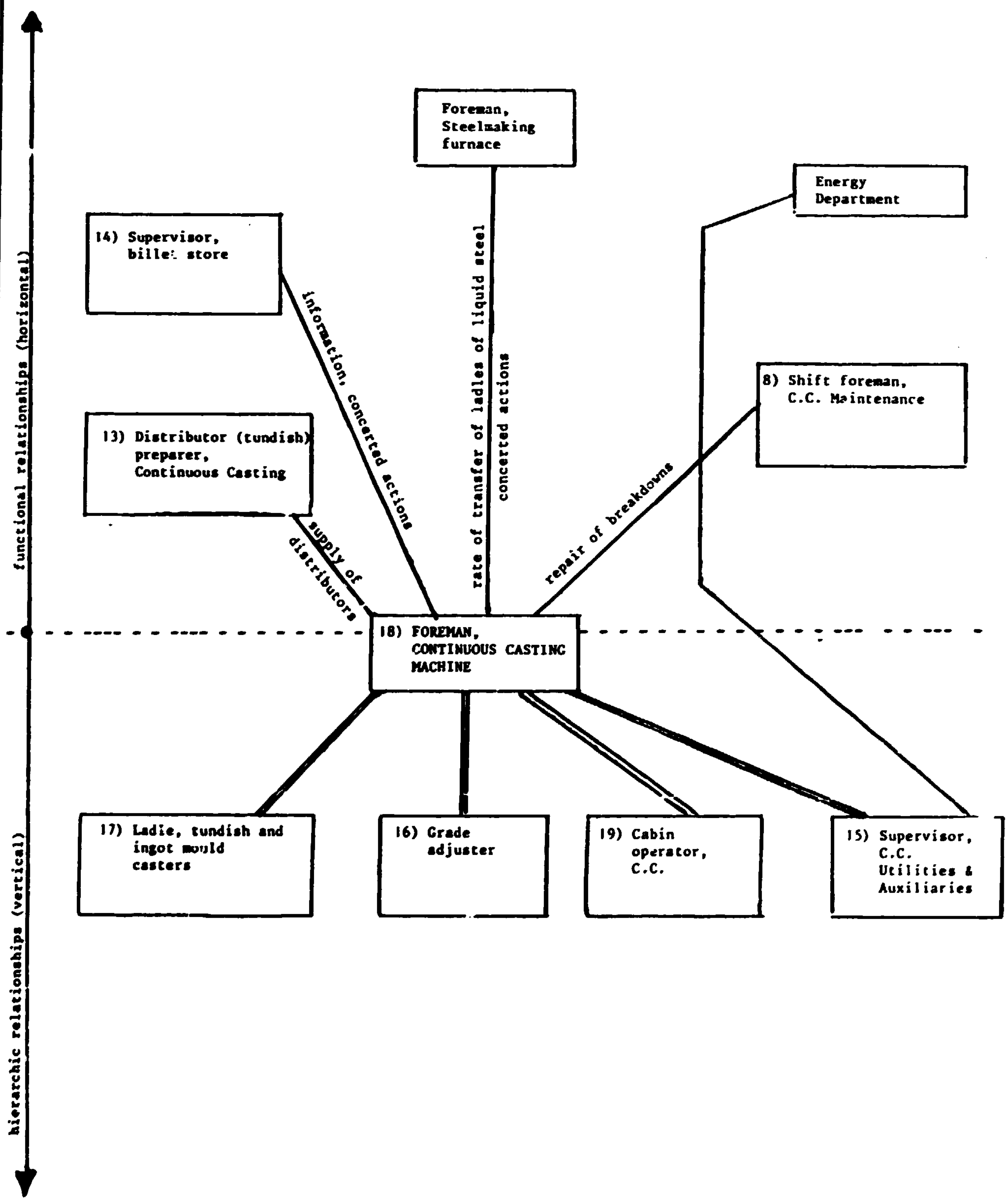
2. - The transfer of the steel ladles and treatment of the steel in the ladles.

3. - The continuous casting on the machine, according to the laid down programme, by intervening in the event of incidents to return the line into working order.

He intervenes physically in these operations whenever this is necessary. He has a teaching role in respect of the subordinate personnel for whom he is responsible.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

3) <u>Diagram of the relationships</u>



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

4. Details of the functions

4.1. Preparations

4.1.1. Preparation of the distributors

- The tasks are actually carried out by the Distributor Preparers.

- The machine foreman specifies the type of nozzle to be used and ensures that the preparation of the distributors made available for casting has been correctly carried out. The checks to be made relate to :

  . the surface condition of the stopper rods,
  . the mechanical state of the movements of the stopper rod,
  . the apparent state of the guniting, masonry and seating bricks,
  . the mounting of the nozzles,
  . the state of the covers,
  . etc.

- In the case of drawer-type distributors he checks the hydraulic system, the percentage of opening of the drawer, the presence of the rings, and checks the argon circuit. He follows up the stopper rods and draws up a request for intervention for those sent for repair.

- He has the distributor placed on the trolley, after checking the state of the condition of the scales (weighing the steel in the distributor).

- He ensures that the distributor is centred on the line, before casting or at the heating station with a gauge.

- He regulates the heating of the distributors as a function of the time before casting and the type of gas.
  Use of a pyrometer to measure the temperature.

4.1.2. Preparation of the casting lines

- The operations cited below are carried out by the line foremen, the distributor casters and the assistants. The machine foreman coordinates their activities and carries out the control operations.

  Example of ingot mould control :

  . state of the copper plates and the combs,
  . check on overall taper (thickness gauge to 1/100th) and individual tapers (gauge, sliding foot) If necessary adds shims to thickness,
  . verification of the spacing of the faces,
  . checks on the water pressures and flowrates (gauges).

  Example of control in Zone I :

  . detection of fissures in the grilles,
  . control of alignment of the ramps of jets,
  . control of flowrates,
  . verify sealing of the water boxes.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

In the same way he checks the alignment of the zone I ingot mould.

- The observations made during these various checks are noted on the documents. On the basis of the anomalies noted the foreman takes the necessary steps, in conjunction with the preparation workshop, to change an assembly.

- After the assemblies have been returned to the lines he checks the presence of the protective heads and the correct execution of the operations for "preparation of the leading head".

Note : Preparation of the casting lines is carried out after every casting, whether or not there has been a change of format, setting to format being complementary operations.

4.1.3. Supplies and cleaning of the work-place

- Ensure that the work-place is supplied with stocks as a function of the work programme.

- Order the materials necessary for these supplies from the General Services.

- Have carried out all the operations of cleaning, casting floor, ladle treatment, stand-by table, as a function of the availability of personnel and the state of the premises. Ensure the removal of the scraps in the pit.

4.2. Treatment in the ladles

4.2.1. Transfer of the ladles

- At the start of the shift he establishes a provisional order of operations for continuous casting as a function of the production programme.

- The work of preparing the work-place having been carried out he requests the metal from the production section (in the case of sequential casting he may ask the steelmaking section to hold back furnace operation so as to avoid any breaks in casting).

4.2.2. Treatment in the ladle

- Checks the level of the bath. In the event of excess drops to the pit from the overflow.

- Verifies that the analysis of the steelmaking sample is in accordance with the grade requested.

- Has the treatment operations carried out by the grade adjuster. giving his attention to the temperature of the bath (too high → scrap; too cold → exothermic powder) and on the analysis (injection of aluminium or carbon).
  Casting on the stand-by table : adds covering powder, casting outside temperature range : stirring the steel with the "dummy" are decisions taken in the event of incidents.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

4.3. Casting in the ingot mould

The machine foreman :

- initiates the activities of the following work-stations
  . ladle caster, assistant,
  . machine operator, distributor caster, assistant.
- coordinates the actions of the posts linked with the process :
  . bringing up the ladles on the pivoter,
  . casting in the distributor,
  . casting in the ingot mould,
  . changing the distributor for sequential casting.
- intervenes in the event of an incident (modifying the casting speeds, shutting down a line, modification of the spray curves, etc.), in the event of piercing gives directives for the return to order of the lines (cutting the slab with blow-lamp, cleaning, checking the stands and the spray frames).

Note : A computer gives information to the operator and the machine foreman on the casting speeds and the spraying curves.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	a) BTS level. b) Iron and steel training of FAMECT type (Steelmaking option).				X	
5.1.2. Supplementary vocational knowledge	Steelmaking experience desirable (6 months) Training in post of Head of line operator (minimum 1 year)				X	
5.1.3. Diversity of the techniques used	Technique specific to continuous casting, linked with specific metallurgical techniques (treatment), refractories (distributor), mechanical (ingot mould regulation). Distinct procedure according to work station. Treatment in the ladle. Casting in the ladle and in the ingot mould.			X		
5.1.4. Type and complexity of the intellectual processing	Coordinates the activity of the various posts as a function of the importance of the sequence in hand, the temperature of the steel and the extraction possibilities (speed). As a function of delays must adopt waiting solutions in regard to the technical constraints (temperature of the bath, distributor, etc.).				X	
5.1.5. Type and complexity of the physical actions	Use of gauges, jigs, sliding calipers. Intervenes temporarily, in the case of incidents, in all operations.			X		
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	Intervenes in the event of incidents in all the posts falling under his authority. Must anticipate the possibilit'es of organisational incidents or physical accidents (safety)					X
5.2.2. Degree of contrast of the useful information	Has the same difficulties of perception as his subordinates, but in an episodic manner			X		
5.2.3. Response time	Rapid decisions with a view to avoiding shut-downs in production.					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	Distinct procedure according to the work station. Treatment in the ladle. Casting in the ladle and in the ingot mould.			X		
5.3.2. Type of pilot information for others	Coordinates the activities of his subordinates. In the event of incidents specifies the modifications made to the process : - change of distributor, - stand-by casting, - treatment in the ladle.			X		
5.3.3. Diversity of the functions piloted	9 subordinate posts 1 superior post (Shift Foreman, C.C.) 3 equal posts Relationships with steelmaking, General services, Maintenance services, Metallurgical and quality control, Safety.			X		
5.3.4. Position of the external controls	Adapts the instructions as a function of observations, the results being perceptible during the same shift.			X		
5.3.5. Precision of imputation of the consequences	Function of shift training directed towards the same objective.			X		
5.3.6. Precision of the directives	Adapts his actions to the incident situations, whether in the manufacturing process or at steelmaking level : Non-complying ladles of steel, lack of metal, piercing during casting, etc.				X	
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : FOREMAN, C.C. MACHINE			Code 18 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	18/25	72
Sub-Total Behaviour	13/15	87
Sub-Total Responsibilities/Powers	19/30	63
TOTAL		222

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : CABIN OPERATOR, CONTINUOUS CASTING			Code 19 PRODUCTION

1) Objective :

To initiate at the appropriate time, and to coordinate, all the activities which make it possible for the continuous casting to operate in compliance with the programmes and the rules of production.

2) Summary of the functions

Under the authority and responsibility of the C.C. machine(s) foreman, from whom he receives at the start of the shift the castings programme and the special instructions, he is the brain (intelligence and memory) and the nerve centre (transmission of orders) for the continuous casting production team, being in continuous dialogue with the continuous casting work stations and the peripheral production and services posts in order to receive information, to give instructions and to control execution of these instructions.

His principal tasks relate to :

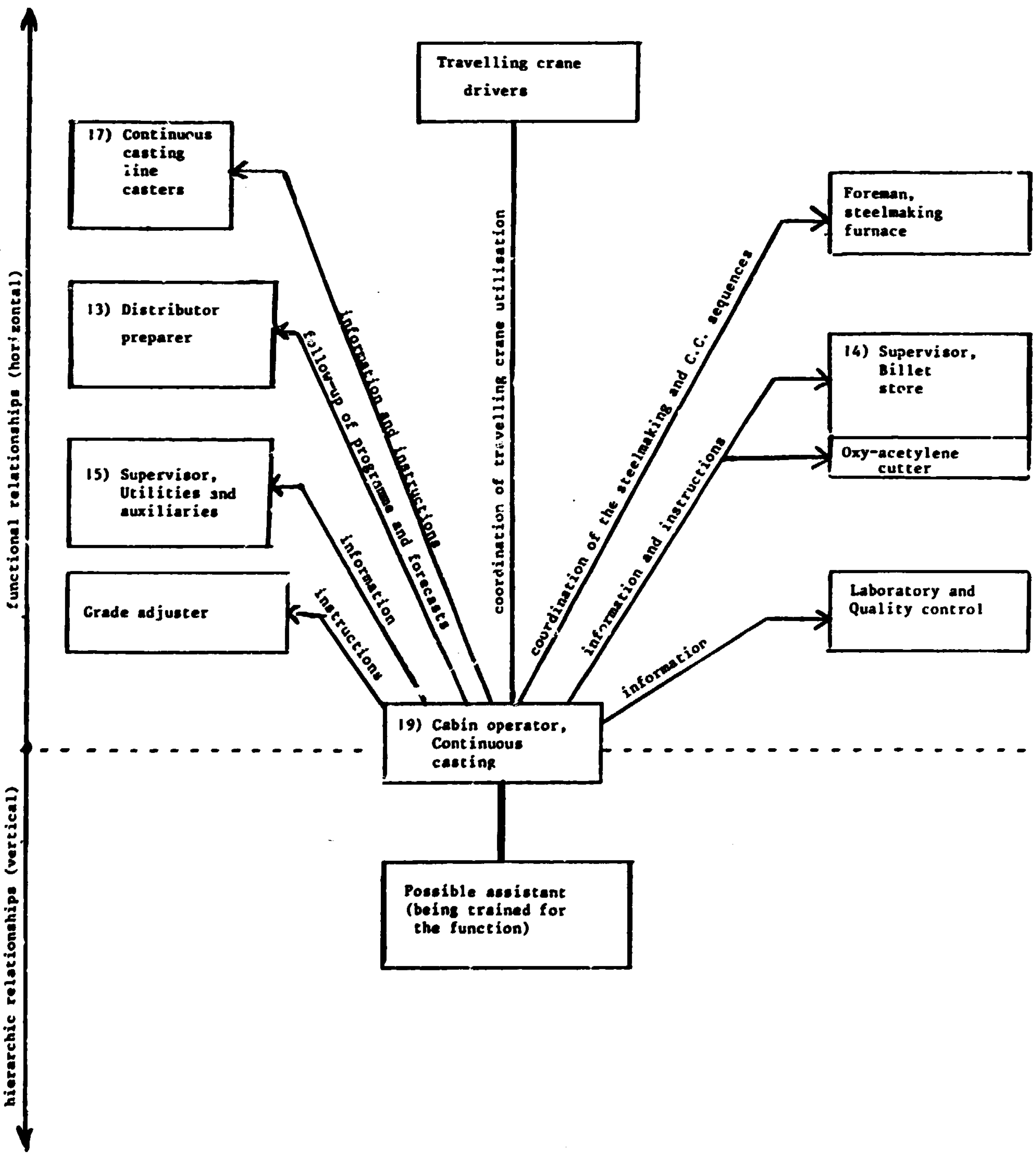
- the preparations for castings, and
- the conduct of sequential castings,

where his direct responsibility is engaged above all in the correct chronology of the "time signals" given to the executants.

He trains qualified personnel in the function of carrying out "control rounds".

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

4. Details of the functions

4.1. Preparations for castings

4.1.1. Preliminary operations

- Receives the production programmes. The latter specify the grade required and the format of the billets.
- Initiates, if necessary, the change in the format of the ingot moulds (distributor caster) and of the leading head.
- Pre-sets the water pressure and flowrate on the control desk as a function of the speed of extraction required by the format. Informs the lines supervisor concerning the choice of the water circuits.
- Obtains information from the various production stations regarding any technical impossibilities in casting or extraction: repairs, breakdowns, lack of supplies of materials, remaking of the leading heads not carried out, etc.
- Orders from the steelmaking unit (operator) one or more ladles, specifying the grade of steel.

N.B. : The same grade of steel and the same format makes sequential casting possible (two or more ladles).

- Checks the availability of the stand-by casting.
- The steelmaking operator will specify the commencement of steelmaking in the furnace and will confirm the end of this operation.
- Takes note of the results of the analysis of the steel (print-out).
- Verifies conformity with the characteristics required. If these do not fall within the tolerances allowed by the ranges the steelmaking unit is to be asked to carry out a re-adjustment. If this is found to be impossible the ladle is to be refused (after agreement of the Shift Foreman).

4.1.2. Initiation of the activities of the following work stations, and for the designated operations (not given in chronological order) :

Casting crane

When the ladle is received the operator asks the crane driver to carry out the weighing operation after having entered the casting number on his "weighbridge desk", with the tare, the estimate of the slag and the number of ladles. This information is sent through from steelmaking. The gross and net weights are displayed. From these the operator calculates the length of the billet by line (weight per metre, according to format).

Cutting the billets

In the absence of indications to the contrary the length of the billets to be removed is given by the cabin operator from the total length of the billet and the rules for the optimisation of cutting (table).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

Continuous casting platform operative

Receives the signal for transfer of the trolley and the signal for the removal of the ladle to the pivoter.

- According to the temperature, the aluminium content as known by the analyses at Steelmaking level and then at ladle treatment level, the operator decides on :
  - . the weight of additional aluminium necessary, and the corresponding length of ribbon.
  - . the weight of scrap to be added to obtain the required temperature (temperature too high).
  - . the duration of argon mixing.
- He transmits these results to the platform operative who is responsible for their execution, together with taking the temperatures and the supplementary samples.

Leading head preparer :

Initiates the heating of the heads and their introduction into the lines (operator signal).

Distributor caster :

Pre-heats nozzle and distributor.

Ladle caster :

Ensures the positioning of the ladles, simple casting or sequential casting.

4.2. Tasks carried out during casting (in sequence or not)

With the ladle positioned over the distributor the operator requests confirmation of casting from all the posts, then gives "authorisation to cast" to the ladle caster. The latter starts casting into the ingot mould, via the operator, as soon as the required level is reached in the distributor.

- Informs the distributor caster as to the desired extraction speeds (defined by the hierarchy).
- Supervises the water pressures and flowrates (speed variations, incidents). Adjusts them as a function of the speed of extraction. Speed reduced (or increased) by the distributor caster or by himself (according to the temperature of the bath or the difficulties experienced during the oxy-acetylene cutting).
- At the end of the shift, and at the end of casting, passes the information back to the various continuous casting work stations and re assumes control from his desk.

N.B. : All through the casting, sequential or otherwise, he informs all stations of incidents and synchronises their actions by way of his intercom link. In sequential casting he takes care to ensure continuity in casting (the length forecast by way of the linear speed indicates the length of time available to carry out the ladle treatment operations. Modifies the speed as a consequence of this).

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

In the event of incidents

- To effect emergency shut-downs, insofar as this has not been done by the distributor caster.
- Subsequently proceed to the operations for removing the hot billet.
- As a result of a sequence which has been shortened in respect to the forecast production, fix the new planning for cutting the billets.

4.3. Report on castings

- Establish one report per ladle. In this report on the quantities of steel - slag - aluminium - scrap.

  The times : start of each operation, variations in speed, water flowrates, temperatures, any incidents arising on the line : clogged nozzle, difficulties in separating the leading head, etc.
- Show by a diagram, on a shift report, the various operations against time. Note the incidents.

N.B. : If the cabin is provided with a computer defining the cooling curves, optimising the cutting lengths, specifying the values for treatment in the ladle and retaining in its memory all the manufacturing rules and instructions, this will facilitate the material tasks of the cabin operator whilst in no way diminishing the level of professionalism required for his function, which is a key function.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.1. Know-how						
5.1.1. Basic general and technical knowledge	Secondary education - BAC level			X		
5.1.2. Supplementary vocational knowledge	Experience in all the posts involved in continuous casting : 6 months Training in the post : 8 months			X		
5.1.3. Diversity of the techniques used	Iron and steel techniques : continuous casting - operating regulating panel - use of a computer. Administrative : casting and shift reports, variations of the procedures due to the diversity of the possible incidents with their consequences on the preparation of the sequences, casting and the general planning of the operations.			X		
5.1.4. Type and complexity of the intellectual processing	As a function of the instructions and the objectives of the production he must evaluate the operational information so as to draw up the necessary adjustments : quantity of aluminium and scrap, speed of extraction as a function of incidents or of the necessity to ensure continuity in sequential casting.				X	
5.1.5. Type and complexity of the physical actions	Switching : adjustment of flowrates by handwheels. Manual dexterity on control desks and keypads.		X			
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	Supervision of the flowrates, pressures and temperatures of the cooling water. An incident may occur at any moment during casting. In regard to the indicating equipment and the actions of the executants there is an analogy with the control tower of an airport.					X
5.2.2. Degree of contrast of the useful information	Perception of the information on a synoptic panel, on a dial, a diagram or a listing (paper or VDU). Permanent intercom. High level of alertness demanded in the appreciation of very diverse types of data.			X		
5.2.3. Response time	Emergency shut-downs on incidents if any reaction on the part of the caster is impossible. In the event of an anomaly in the cooling of the billet he must react instantaneously (shut-down, adjustment)					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 9/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers						
5.3.1. Diversity of the activities	a) Conceptual : establishment of the detailed chronology and the technical instructions for all the activities in Continuous Casting and at the periphery. b) Initiation and control of execution on behalf of his hierarchic superior, the C.C. Machine(s) Foreman.			X		
5.3.2. Type of pilot information for others	Platform operative : quantity of supplementary additions, calculated from the composition of the bath or of the temperature. Ladle caster : speed of extraction (modify the rules as a function of incidents during oxy-acetylene cutting; determine the length of the cut as a function of the total theoretical length. Supervisor of utilities : regulation of the cooling water.			X		
5.3.3. Diversity of the functions piloted	- C.C. platform operators (line foremen). - Ladle and distributor (tundish) casters. - Billet cutter. - Steelmaking Platform. - Casting crane. - Leading head and distributor preparers. - Supervisors of electricity and fluids. - Grade adjuster.				X	
5.3.4. Position of the external controls	The non-coordinated initiation of the activities of the posts within the process would create a discontinuity in sequential castings. This would only appear in the processing of the product.				X	
5.3.5. Precision of imputation of the consequences	He must, as a function of the instructions and the production objectives, evaluate the operational information so as to draw up the necessary adjustments : quantities of aluminium or scrap, speed of extraction as a function of incidents or of the necessity to ensure continuity in sequential casting.		X			
5.3.6. Precision of the directives	Programme : fixed overall by the Shift Foreman, leaving liberty to establish the allocation of a batch (by concerted action with the steelmaking unit). Initiation of the fixed operations. Adjustment of the speeds of extraction as a function of the problems encountered (incidents during casting or when cutting the billets).			X		
SUB-TOTAL Responsibilities/Powers						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : CABIN OPERATOR, C.C.			Code 19 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	15/25	60
Sub-Total Behaviour	13/15	87
Sub-Total Responsibilities/Powers	19/30	63
TOTAL		210

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 1/10
Position : SHIFT FOREMAN, CONTINUOUS CASTING			Code 20 PRODUCTION

1) Objective :

To ensure that the production, as laid down in the programmes, is achieved by coordinating the activities of his subordinates, providing them with technical and/or physical support according to the nature of the incident.

2) Summary of the functions

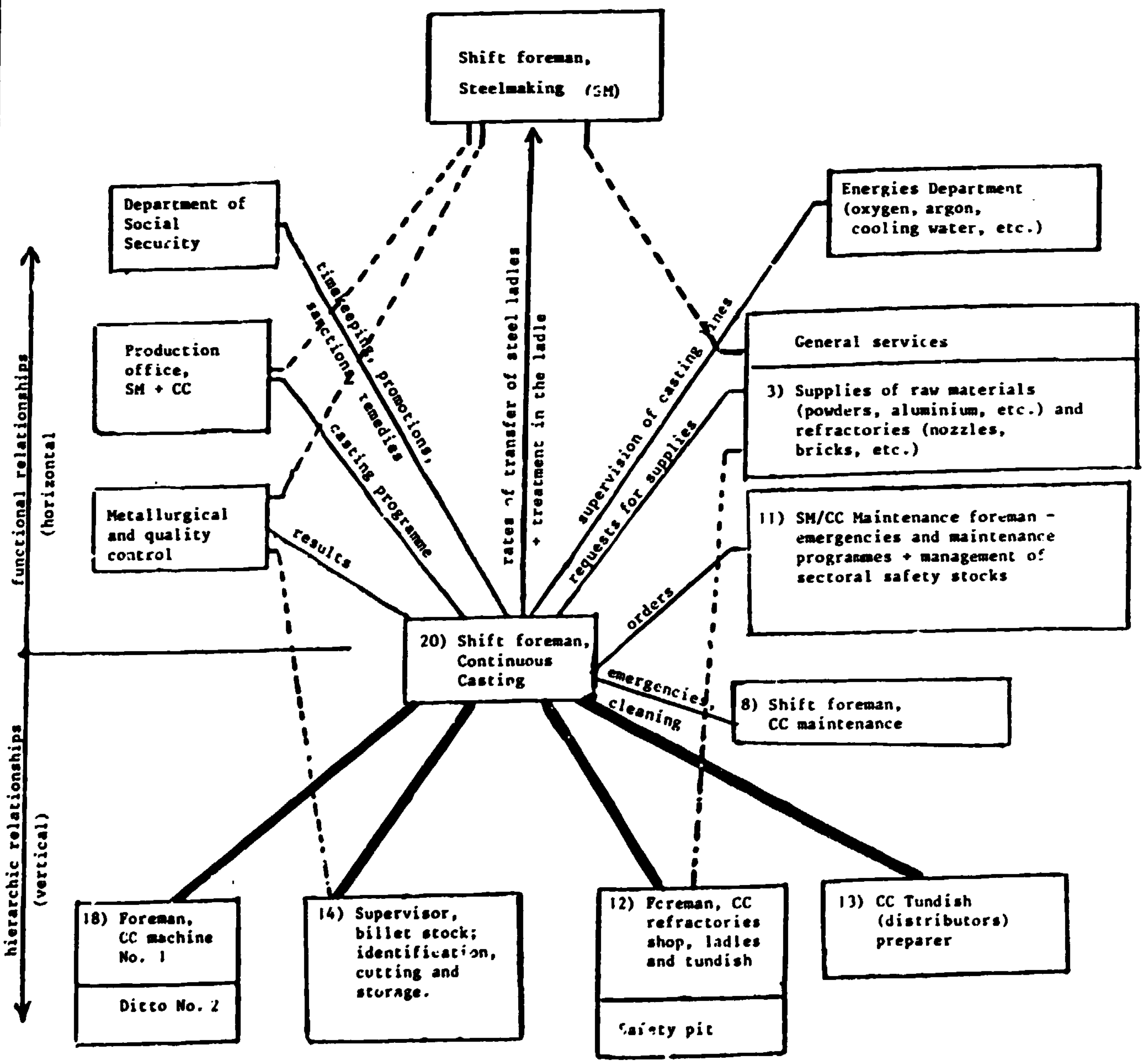
a) To initiate and to follow-up the operations involved in the production, identification and storage of the billets produced from the ladles of liquid steel (direct responsibility).

b) Administrative work and personnel management (direct responsibility).

c) To ensure the continuity of the continuous casting operations from one post to another and also upstream (steelmaking) and downstream (rolling): indirect responsibility.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 2/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

3) Diagram of the relationships



UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 3/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

4. Details of the functions

4.1. To initiate and to follow-up the billet manufacturing operations from the ladles of liquid steel, and to identify and store the billets.

4.1.1. Obtaining information

- To note the information, observations and incidents recorded during the previous shifts as notes in the shift log. To discuss these with the outgoing shift foreman.
- to obtain information on the forecast castings for the shift. Programme drawn up by the head of production, specifying the grade of steel, the number of castings and the format and length of the slabs.
- to request his subordinates to warn him of any anomalies noted on the line ... of a breakdown in supplies (powders, aluminium, scrap, nozzles, etc.). If there is any doubt as to the state of the lines the foreman is to arrange for a simulated casting (all phases being complied with: introduction, speed, cooling).
- to ensure that the refractories department has a sufficient number of distributors and ladles (in the case where continuous casting does not have priority).
- to verify the presence of stand-by ingot moulds (conventional type).

4.1.2. Initiating the activities

- Indicate to the caster the castings to be carried out (according to HP programme). The latter will then start up the manufacturing process and the preliminary operations :
  - . requesting ladles from the steelmaking section,
  - . introducing the leading heads after heating,
  - . transferring the ladles,
  - . treating the steel in the ladles,
  - . casting.

The foreman will assist with and check all these operations and will intervene in the event of incidents or in resolving a technical difficulty.

Examples of the problems encountered at work station levels :

Operator :

The charge approaches the limits of the ranges, temperature, composition of the bath. Return of a ladle to the steelmaking section or to the stand-by casting, after treatment in the ladle (temperature too low ... Adaptation of casting speeds to the technical problems encountered or to incidents).

Treatment in the ladle :

Difficulty in the introduction of aluminium or stirring with argon.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 4/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

Ladle caster :

Rotation of pivoter defective, fixing of the nozzles to the drawer difficult, closing of the nozzle drawer impossible, etc.

Caster distributor :

Difficulty in maintaining a constant level. Overflowing, piercing, evacuation of distributor during incident.

Line surveillance :

Lack of pressure on a stand (shut-down of installation or casting), lack of cooling of rollers, etc.

Preparation of head :

Difficulties in preparation (inserting - drying).

Oxidation :

In the case of a blowtorch incident slow down the line with possible manual cut-off. Control of lengths (annotated programme).

Billet stock :

Stock area overloaded. Difficulties in clearing the billets.

N.B. : in the case of sequential casting, necessitating the use of two distributors successively, the foreman will specify and order the procedures.

- in the event of piercing of a line to organise the operations for releasing the slabs, changing the ingot moulds and zone I if necessary.
- changes in format are placed under his responsibility: alignment and conicity, which implies rigorous control on his part.
- verifying the presence of the materials necessary for the castings, and ensuring supplies.
- carrying out the operations of cleaning the workshops.
- reporting to his superiors any incidents encountered and, where necessary, submitting proposals for modifications, either technical or relating to work stations.

4.2. Administrative work and personnel management

4.2.1. Functions relating to work management

- responsible for personnel timekeeping,
- planning holidays in his team,

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 5/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

- granting compensatory time off in such a way as not to create disruption in the department;
- training personnel for work stations. Informing them as to the technical rudiments and training them in safety;
- notifying them of the safety rules, and supervising their application;
- suggesting possible promotions to their superiors, with plans for supplementary training;
- proposing sanctions.

4.2.2. - <u>Functions relating to administrative work</u>

- Drawing up the shift report: reports on activities, with observations;
- reporting in the "ladles logbook" the numbers and the reasons why these ladles were returned to the steelmaking section;
- drawing up :

a) the reports on incidents (piercing, overflows, etc.),

b) statements on physical accidents (specifying the circumstances after a preliminary enquiry),

c) "withdrawals from stock" notes (general services),

d) "personnel leaving" notes,

e) requests for interventions by the maintenance services (repairs or modifications to the equipment) and from the transport services (orders for trucks).

Reporting, in the log, the orders in hand (follow-up by Foreman).

4.3. <u>Ensuring the continuity of the continuous casting operations from one shift to another and also between upstream</u> (steelmaking sections) <u>and downstream</u> (rolling mills) as indirect responsibility.

4.3.1. Awareness of being the meeting point between the production activities (steel production) and the metal converting activities (steel forming), operating according to different rates and programming norms.

4.3.2. Anticipating, by means of exchanging information with the Shift Foreman in charge of steelmaking and the Shift Foreman in charge of rolling, the possibilities of push-pull operation, and making provision for suitable measures for avoiding this.

4.3.3. Analysing the progress of previous shift(s) and indicating, for the following shift(s), the scenarios for possible incidents, with the proposed remedies.

4.3.4. Requesting, where necessary, decisions from the Head of Department Engineer(s) by giving succinct, but precise and exact, indications, correctly evaluated in regard to their importance.

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 6/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

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UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 7/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

5. Evaluation of the requirements 5.1. Know-how	Requirement ratings	1	2	3	4	5
5.1.1. Basic general and technical knowledge	a) BTS in metallurgy b) Iron and steel training of the FAMECK type, steelmaking specialisation			X		
5.1.2. Supplementary vocational knowledge	Experience in a steelmaking post desirable. Experience in any continuous casting post, and more particularly an operational function. Experience spread over several years. Elements of accounting.					X
5.1.3. Diversity of the techniques used	Specific technique of continuous casting, calling at the same time on knowledge of steel casting, rolling (slab extraction), engineering (oxy-acetylene cutting, ingot regulation), stock management and control and personnel management. Control and intervention in various technical posts (ladle treatment, casting, line supervision, oxy-acetylene cutting, slab store). Varied situations during incidents and an essential understanding of steel-making problems.				X	
5.1.4. Type and complexity of intellectual processing	Must organise, as a function of the production programme, the work of the team whilst taking into account the personnel present, the availability of the distributors and ladles, the steelmaking possibilities and the temperature and quality of the bath. Must coordinate the various actions as a function of incidents and the general operation of the line.					X
5.1.5. Type and complexity of the physical actions	Administrative work. Intervenes temporarily in the event of an incident, in all the functions, in all the operations, but more particularly in the control of the lines (control panels).			X		
SUB-TOTAL Know-how						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 8/10
Position : SHIFT FOREMAN, C.C.			Code 17 PRODUCTION

5. Evaluation of the requirements	Requirement ratings	1	2	3	4	5
5.2. Behaviour						
5.2.1. Degree of vigilance	To intervene in the event of an incident, in all work stations on the line, and particularly at the lzdle and the casting distributor positions (risks of piercing, of overflowing).				X	
5.2.2. Degree of contrast of the useful information	Has the same difficulties in perception as his subordinates, but in an episodic manner (slag discrimination, levels in the ingot moulds, etc.).			X		
5.2.3. Response time	Must decide rapidly on the actions to be undertaken in order to avoid : prolonging shutting-down of production - dangerous situations (risk of piercing).					X
SUB-TOTAL Behaviour						

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS					Page 9/10
Position : SHIFT FOREMAN, C.C.							Code 20 PRODUCTION
5. Evaluation of the requirements		Requirement ratings	1	2	3	4	5
5.3. Responsibilities/Powers							
5.3.1. Diversity of the activities		Checks and intervenes in the various technical posts (treatment in the ladle, casting, supervising the lines, oxy-acetylene cutting, slab store). Various situations during incidents with essential understanding of steel-making problems. Management and training of the production personnel.				X	
5.3.2 Type of pilot information for others		Coordinates the activity of subordinates as a function of the work programme on incidents, informing the posts concerned as to the modifications to be made to the process : cooling - pressure - speed of casting and removal - stand-by casting, etc. After analysis ordering ladles from the steelmaking section. Ordering materials from general services. Informing regarding modifications made to the programme.				X	
5.3.3. Diversity of functions piloted		12 subordinate posts. 1 higher post (engineer) and 3 equal posts. Relationships with steelmaking, metallurgical control and quality control, sectoral and general maintenance, supplies, social affairs and safety, rolling mills.				X	
5.3.4. Position of the external controls		Modifications of instructions integrated into the process. The results obtained by the agent and his team can only be compared with the objectives established for the medium term (some months)					X
5.3.5. Precision of imputation of consequences		Function as foreman in various posts located in the same process but which depend closely on different departments for their realisation (steelmaking - refractories)				X	
5.3.6. Precision of directives		Must realise the manufacturing forecasts. To do this must adapt his actions to the situations regarding incidents, whether in the process of manufacture or at steelmaking level: non-conforming ladles, shortage of metal, pierced ladles or ingot moulds. Defective pressure or cooling etc.				X	
SUB-TOTAL Responsibilities/Powers							

UNIDO No. 3/84	CHAP. II	EVALUATION OF THE KEY FUNCTIONS	Page 10/10
Position : SHIFT FOREMAN, C.C.			Code 20 PRODUCTION

6. Summary of the requirement ratings

	Points	%
Sub-Total Know-how	20/25	80
Sub-Total Behaviour	12/15	80
Sub-Total Responsibilities/Powers	25/30	83
TOTAL		243