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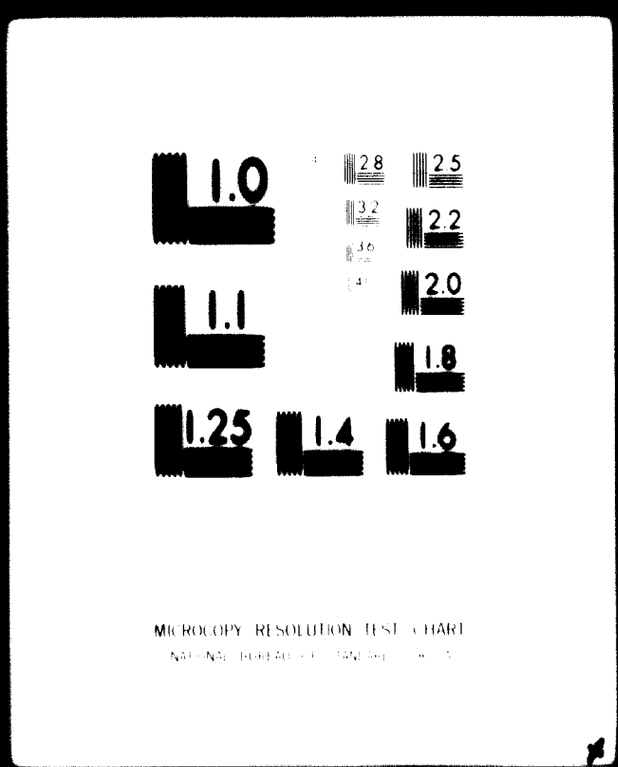

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Final Report

Organization & Management Survey
Zenica Mining & Metallurgical Combine
UNPD/SF Project Symbol YUG 11

October, 1971

BRUCE PAYNE & ASSOCIATES
INCORPORATED

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INTRODUCTION

Under the terms of UNIDO Contract 71/29 a survey of the Zenica Mining and Metallurgical Combine was conducted by the Bruce Payne & Associates' team in conjunction with counterpart personnel from the Yugoslav Centre for Industrial Organization and Development, the Zenica Kombinat and representatives of the United Nations Industrial Development Organization.

The general objectives of the Bruce Payne survey were threefold:

1. To identify management problems.
2. To suggest general solutions.
3. To develop the skills and expertise of the Centre personnel.

Because of the limited duration of the survey and its broad scope it is neither feasible nor desirable to include definitive solutions to specific problems identified in our report. Rather, the emphasis is on suggesting programs which Zenica should initiate to obtain more effective management by developing better information systems, better controls and better communications within the organization.

The Zenica Kombinat consists of ten producing locations (SOURs), plus headquarters and sales offices. During the course of the survey, field trips were made to nine of the ten producing locations as well as the Kombinat headquarters, and the Belgrade sales office. The only location not visited was the new mine at Radoven. The locations visited were selected as being completely representative of the total Kombinat by joint agreement with the representatives of Bruce Payne & Associates, Incorporated, the Centre, Zenica and UNIDO.

The specific locations visited by each team member are as follows:

Visited by Dulfer with Bures and Pasic:

1. Zenica
2. Bihac
3. Ljubia
4. Doboj
5. Mrkonjic Grad

Visited by Bower with Bodrazic, Kancir and Krdzalic:

1. Vares
2. Ilijas
3. Alipasin Most

Visited by DeVoss:

1. Zenica

Visited by Dzudza (Zenica Organization Group):

1. Novi Sad
2. Beograd (office)

Visited by Kancir (Centre - Marketing):

1. Bihac
2. Novi Sad

Throughout the survey emphasis was placed on training and instruction of counterpart personnel in consulting and management techniques. Presentations were made by each of the resident team members as follows:

Bower:	Systems Development, Computer Techniques and Marketing
Dulfer:	Industrial Engineering and Measurement and Control
DeVoss:	Maintenance Controls, Workloads, and Spare Parts Control
Shays:	Systems Methodology, IDEALS Concept

A work shop seminar for personnel from the Centre and Zenica was also held in Belgrade on June 28 to include Centre personnel who were not participating directly in the sub-project. Each of the BP&A representatives conducted sessions in the area of their specialty plus presentations by the Bruce Payne & Associates team director on organization, consulting techniques and methodology.

Excellent on-site cooperation was obtained from all project personnel. Language differences created very great problems with communicating and the understanding and translating of records and data available from the Kombinat. We estimate that the necessity of translating voluminous material reduced the amount that could be accomplished in the time available during the survey by approximately 50%. This factor must be seriously considered in planning future assignments of this nature.

I. SUMMARY OF MAJOR RECOMMENDATIONS

During the course of the survey conducted at Kombinat Zenica under the terms of UNIDO Contract 71/29 we were able, with the counter part teams, to identify and categorize many problems. The difficulties encountered involve practically all areas of the Kombinat and are in various forms. However, we believe that solutions involve four general areas.

A. Organization

The organization structure should be clarified in the areas of responsibility and accountability so that expertise at the Kombinat level is more directly available to the SOURs. This can be accomplished without loss of profit responsibility at the SOUR level which should continue to be reflected in workers personal income. Until this important policy question of centralization vs decentralization has been resolved it is impossible to clearly define responsibility and accountability and the relation of Kombinat staff to operating areas (SOURs).

There should be fewer deputy directors, and heads of sectors reporting directly to the General Manager. This can be accomplished by making a deputy director responsible for groups of functions in the commercial areas, similiar to those now responsible to the Technical Director.

Clearly defined lines of communication must be established from Directors to all areas of the Kombinat. Responsibility, and authority must be made clear for all levels of both line and staff management.

B. System and Sub Systems for Total Management Information

In order to support an effective organization, an adequate total information system is required. The system must provide each manager with the information he needs to make correct decisions without burying him under masses of data. More efficient systems for collecting data and distributing information must be developed to serve the needs of all levels of management.

C. Means

In order to achieve the above objectives it is necessary to establish an integrated systems effort at the Kombinat level. The means to achieve a good and effective organization supported by an information system are:

1. Develop a computer system and operating department. This group should initially establish priorities and begin applications design for the new computer. The objective should be to program, compile and test programs prior to delivery of the computer.

2. Develop a well trained systems function for the establishment of methods, measurement and control of the administrative and office work. This group should be trained in systems and methods work with emphasis on "on-the-job training" and should refine manual methods and establish standards of performance and staffing criteria for all clerical and administrative tasks.

3. Establish a strong industrial engineering function on the Kombinat level which would develop methods for production, maintenance and material handling. Technological standards should also be developed as a basis for planning, scheduling, measurement of operating efficiency and the determination of individual incomes. The objective of this department should be to increase the utilization of manpower to the extent that all new equipment can be operated without additional personnel.

II. ORGANIZATION STRUCTURE

A. General

The organization structure of Rudarsko-Metalurski Kombinat-Zenica has been charted and studied. In making these considerations, attention was focused on the needs of the Kombinat and the best way to satisfy these needs within the framework of the socio-economic system as it exists in Yugoslavia today. The cooperative teams had over 100 interviews and developed over 200 organization charts supporting the organizational conclusions and recommendations of this report.

The present organization of Zenica does not maximize the use of its resources in planning for future development, research and growth.

Our study is concerned solely with the structure of the organization in terms of reporting relationships and the definition of responsibility by activity and function. Because there is no present information system as such, details on communications media are not available and communications media will be defined along with the development of the information system.

We concur with the decision that Kombinat Zenica should be a unitary organization. The ten SOURs are in no way uniform nor can they operate in a completely independent manner. Some furnish raw materials exclusively, some make finished products using Zenica steel. There is a very great disparity in the size and sophistication of the units. For these reasons a corporate structure is essential in forming the Kombinat.

On the other hand, we also appreciate the value of preserving the SOURs as profit or cost centers to motivate workers and managers and to permit workers to share in accordance with their productivity. We feel that the relation between contribution and personal earnings should be strengthened. Since SOURs do not control their commercial activities, and since steel prices are controlled, profit may not be the best criteria of success at all SOURs. Fulfillment of plans and attainment of cost objectives may be preferable as measurements since revenues in some cases are beyond the control of SOUR management.

B. Line and Staff Functions

The most significant development in modern organization structures is the growing delineation between line and staff functions. The line organization at Zenica should serve to maintain descipline and stability and the staff at Zenica should serve to bring expert information. The growing technology of management in large organizations requires specialists in various fields such as quality personnel, scheduling, standards, systems, maintenance, and the technical aspects of production. No single individual can be expert in all areas and the staff provides specialization in diverse fields of expertise. The staff function is generally strictly advisory.

The separation of line and staff functions also tends to reinforce the principle of balance. For example, the responsibility for quality is separated from responsibility for quantity (production) so that there is no temptation to sacrifice quality. The responsibility for measurements should also be separated from those being measured so that objectivity and accuracy is maintained.

In the Kombinat all SOURs cannot maintain complete technical staff of high quality, yet there is a need to bring to each SOUR the best technical ability available in the Kombinat. We suggest that heads of staff functions at the Kombinat level should have authority and be accountable for staff in their fields of competence throughout each SOUR.

C. Zenica Kimbinat Organization

The principal problem with the existing organization structure of Zenica Kombinat, is the violation of the principle relating to span of control. This principle is concerned with the number of individuals who should report directly to a chief executive. Usually it is considered inadvisable for more than six to eight individuals to report directly to the General Manager. There are eighteen directors, heads of sectors and SOURs who report directly to the General Director. This multiplicity of individuals responsible to the General Director must result either in overburdening the Director or in his lack of control in many areas. (See Exhibit I.)

A second problem lies in the duplication of functional responsibility between the Kombinat and SOUR levels. Clear definition must be made, for example, between the head of the Metallurgical Sector Kombinat level and the head of SOUR Zenica and his chief of the metallurgical sector. There is an excess of individuals who operate in advisory capacities relative to the actual operating heads who have no clear authority and responsibility.

We recommend that the two problems can be resolved by the expedient of using the level of organization between deputy directors and operating areas which are functional group heads. These functional group heads should be directly responsible for specific functions at each location. This would result in seven organization levels between the general director to the workers which does not appear excessive for an organization of the size and complexity of the Zenica Kombinat. The levels might be designated as follows:

1. General Director Zenica Kombinat
2. Technical Deputy Director
3. Metallurgical Group Head
4. Metallurgical Sector Head - Zenica
5. Open Hearth Superintendent
6. Shift Foreman
7. Charging Machine Operator

or

1. General Director Zenica Kombinat
2. Technical Deputy Director
3. Fabrication Group Head
4. SOUR Manager

5. Department Superintendent
6. Shift Foreman
7. Machine Operator

or

1. General Director
2. Deputy Director
3. Manager of the Organization Department
4. Manager of EDP Department
5. Deputy Manager of EDP Department
6. Chief of Division - Keypunch
7. Keypunch Operator

The same general organization structure should be established throughout the organization. For example, an electrical maintenance group head who reports to the technical director should be directly accountable for all electrical maintenance in the Kombinat. The persons in charge of maintenance at each location should be responsible to the maintenance group head in all matters related to their technical specialty. For administrative matters and for discipline, local personnel should continue to report to local SOUR or sector heads.

The principle of dual accountability in organization whereby staff personnel are responsible to the corporate level in technical matters and to the local manager in administrative matters, occurs frequently in industry whenever there is a need to provide expert knowledge and technical supervision to individuals who may work at locations far removed from corporate headquarters. The principle is sound because it allows local control administratively

while at the same time making the best technical advice and guidance available throughout the organization. This type of organization structure also reinforces the principle of balance and guarantees that local managers will operate within the framework of corporate objectives and regulations. (See Exhibit II.)

D. Conclusions

1. The concept of Zenica Kombinat as a unitary organization should be retained and reinforced. There should be greater emphasis on a functional type organization whereby Kombinat level group heads are responsible and accountable for all personnel (wherever located) who perform in a particular specialty.

2. The concept of profit responsibility in the SOURs as a motivational technique should also be retained and strengthened. The individual incomes of workers should be even more directly related to individual as well as SOUR productivity.

3. Groups of functions in the financial, commercial and administrative areas should report to a deputy director who in turn reports to the General Manager.

4. New tables of organization should be prepared based on a realignment of functions in accord with the principles of organization included in this section.

5. Position descriptions should be prepared which fully define the duties, responsibilities, authority and reporting relationships for all functions. These descriptions should be reviewed and approved by the incumbents and by the appropriate Workers Council.

6. The revised organization operating effectiveness will result in better utilization of specialized personnel. Ultimately this would be reflected in greater efficiency of production and reduced operating costs.

III. INDUSTRIAL ENGINEERING FUNCTION

A. General

One of the most notable developments in the steel industry in western countries in recent years, has been the growing importance and scope of the industrial engineering function. Not only has this activity been greatly expanded, it has also reported at higher and higher levels within the organization.

Observations and discussions with Zenica personnel reveal that there is no systematic approach to industrial engineering at Zenica. Where industrial engineering studies are made they have been fragmentary and without consistent effort or direction. We feel that there is a need within the Zenica Kombinat for a substantial industrial engineering effort adequately staffed with trained personnel and rendering services to all sectors of the organization.

Assignment of special industrial engineering studies to the "Institute" results in a project-oriented effort lacking continuity and follow through on implementation. What is needed is a program-oriented industrial engineering effort.

Effective, modern industrial engineering at Zenico should be organized to include the following services:

- Production Methods
- Maintenance Methods
- Work Measurement
- Production Standards
- Staffing Tables and Criteria
- Workload Calculations
- Plant Layout
- Feasibility Studies
- Cost Studies
- Job Evaluation
- Worker Motivation and Incentives

We recommend the organization of industrial engineering function at Zenico at the group level (see section on organization), with the chief industrial engineer reporting directly to the technical director.

The personnel for this group should, as far as possible, be drawn from within the Zenico organization by transfer from other departments. All personnel should be trained in modern work measurement techniques including time study and predetermined time systems such as MTM (Methods-Time Measurement). Also included in the training should be work simplification and analytical techniques such as process charting, man machine charts, line balancing, et cetera.

The department should consist of approximately forty members. All individuals should have engineering degrees, preferably in industrial engineering - but lacking this in mechanical, electrical or chemical engineering in that order of preference. The department might include four divisions specializing in service to rolling and fabrication, metallurgical sectors, maintenance and job evaluation.

Initial programs of the department should be to establish optimum production methods utilizing existing equipment, personnel resources and processes. Along with methods improvements, work measurement studies should be made so that production standards, controls and correct staffing can be achieved in all areas.

The implementation of methods improvements and controls and the resultant productivity increases would make available a pool of experienced personnel which would be absorbed by expansion plans in subsequent years. An immediate objective of the department should be to increase machine and worker productivity to the extent that the planned new production facilities can be operated without additional personnel. We believe that a 20% increase in productivity over a two-year period can be achieved and represents a reasonable goal in each area for which controls are established. The increase in productivity should make a significant improvement in profitability.

The need for an effective industrial engineering function was evident in many ways during the conduct of the study. Manager and technical personnel were familiar with technical and production data, but were lacking in knowledge of management techniques in the areas of scheduling and the measurement and control of productivity in production and maintenance areas.

D. Conclusions

1. Production plans and quotas are based on past performance and negotiation rather than true capacity as determined by engineering studies. The result is that plans are relatively easy to achieve and do not represent a uniformly high level of performance.

2. Productive efficiency varies widely between departments and EOWRs. Conditions were observed in some areas which indicate a large opportunity for more efficient production even though plans are being achieved.

3. Technical standards for production are required for a variety of purposes. These would include:

   - Measurement of efficiency of production on a daily basis
   - Preparation of plans for production
   - Accurate determination of costs
   - Worker motivation and incentives

4. Technical standards and controls are needed in maintenance to serve as a basis for planning and scheduling of preventive maintenance operations. They are also needed for machine loading and scheduling of maintenance repair shop operations.

5. Substantial improvements in the utilization of both men and equipment are possible through systematic study of each operation, the establishment of fair and equitable workloads, and optimum standards of production.

IV. PLANNING

A. General

Planning in the steel industry is necessarily of the long-range variety. Changes in product mix or the introduction of new products is a long and expensive process usually requiring the purchase and installation of major capital equipment.

Planning for Zenica Kombinat is for middle range to 1975 and long range 1985. These plans have been made and published as the "SLUZBENI GLASNIK". Annual plans are broken down into monthly plans for each sector and SOUR. Each area is then held responsible for fulfilling the plan.

Adherence to published plans at Zenica is very close with results invariably being within 2% of goals. This is because the plan is based largely on capacity and past performance, and there is little room for error provided that previous production rates are maintained.

Plans are formulated at the SOUR level under guide lines and methodology provided by the Kombinat economic sector. Final edition of the plan is sent back to sectors and SOURs for implementation.

In many cases the plans are based on negotiation between managers of SOURs, and are sometimes fixed at levels which will result in a predetermined earnings for workers, rather than upon an engineering basis.

B. Conclusions

1. The planning process is cumbersome and it requires six to twelve months for the planning cycle to be completed. It is unlikely that changes or innovations to meet conditions can be quickly reflected through the planning process.

2. Planning must be originated and coordinated at the Kombinat level. Plans should not be subject to negotiation or arbitrary decisions. Plans should reflect something other than past performance.

3. The basis for planning should be expanded to take into consideration marketing and economic factors as well as plant capacity and past performance. Consideration should be given to social and economic needs and within this framework product mix should be selected to yield maximum return on investment.

4. Production goals should be based on technological standards for utilization and efficiency in the operation of equipment.

rather than past history. Plans should reflect the same level of efficiency in all production units, so that attainment of goals reflects uniform application of skill and effort.

5. Production goals should include not only production, but also the required staffing to attain production with balanced workloads and effective utilization of personnel.

V. MARKETING

A. General

There is very little true marketing effort at Zenica, and apparently very little marketing expertise in the Kombinat. There is a tendency to regard the marketing organization as an expensive overhead item making a small overall contribution to Kombinat. This is not surprising in an environment where all products produced can be sold and where prices are established at the Common Market price for steel.

The objective of the marketing function at Zenica should be to identify new products, product mix, and channels of distribution which will produce the greatest economic return from the use of existing plant and equipment. Plant capacity should be utilized to yield the greatest possible return on investment consistent with national as well as company needs.

Greater profitability and growth can be achieved in conjunction with more effective marketing. To realize the objectives however, requires an accurate knowledge of costs, both actual and standard. We recommend that standard costs plus variance accounting procedures be developed and installed so that actual costs are accurately known. The questionable accuracy of existing cost figures make effective forecasting and planning difficult and uncertain.

Basic steel production is scheduled for substantial expansion in the immediate future. Production which is now 1,000,000 tons, will increase to 3,000,000 tons in 1975 and 5,000,000 tons by 1980. It is anticipated that 40% or 2,000,000 tons annually will be marketed in the form of finished steel products. Marketing this quantity of finished products will require careful study and planning if profitability levels are to be maintained.

In an industry which cannot react quickly to changes in the market place, it is imperative that marketing be made an integral part of long-range planning. Marketing considerations should also be used in the establishment of annual production schedules, and plans for expansion of facilities. At present there is not enough consideration given to marketing strategies at Zenica. New product planning is generally performed by technical people outside the marketing organization based upon what the Kombinat is physically capable of producing. Plant expansion is also greatly influenced by competence in technology rather than understanding of the evolution of the market place. Sales plans are generally developed by technical people and are based upon what the production groups consider they can produce. Yet, there are indications that some products are actually over-produced and then must be distributed in conjunction with other products that are easier to sell.

In order to exercise a greater influence in the planning function, the market research group needs to be expanded so that greater emphasis can be placed on this function and better service given to SOURs which produce finished products.

At present, 70% of production is marketed through distributors who charge 7% commission for their service. There is desire in the commercial sector to increase the proportion of products marketed directly to users to approximately 50%. This goal is based on the desire to gain greater control of distribution of products and in anticipation that small users today may use larger quantities in the future. (See Exhibit III).

The prices charged distributors are identical with those charged when supplying users directly. Thus, the benefactors of direct distribution in the short run are the users who will not have to pay the 7% commission. The revenues of the Zenica Kombinat will not be affected.

The distributors frequently arrange long term credit for local merchants, and also finance their own inventory stocks. On the other hand, they often arrange for direct shipments from Zenica to the local user and thus collect commissions without handling or warehousing the shipment.

The policy of moving towards a larger proportion of direct sales should be carefully reviewed to determine its effect on distribution costs, clerical and accounting costs and upon costs to carry larger inventories. The immediate increase in costs must be balanced against long term gains derived from closer ties between the Kombinat and the ultimate users of steel products.

B. Recommendations

1. Market research should be expanded so that better information is available as a basis for planning.

2. Market studies should be undertaken as a basis for decisions related to the patterns of distribution.

3. The decision to move in the direction of greater direct sales should be studied as to its effect on costs.

4. In Phase II the organization of market research should be identified as well as its authority and responsibility.

VI. BUSINESS SYSTEMS

A. General

During the course of the survey numerous interviews were conducted by the team with managers and supervisors of the Kombinat and throughout the various sectors and SOURs in order to trace the flow of information from one activity to another, and to management. In addition, several such flows were diagrammed for greater analysis.

There is a large volume of information available to management for the control and operation of the activities of the Kombinat. However, this information often is not available in time to take effective action; occasionally it is not accurate, and it is not organized effectively. There is a need for several similar reports to be consolidated and summarized.

It is recommended that more use be made of exception reporting whereby the managements' attention is focused on problems, rather than being required to examine very extensive data in order to discover problems.

There are many opportunities for automation of business applications to improve the quality and timeliness of information, and to provide management and operating departments with more complete more meaningful information for decision making.

There are also cases, however, where the use of the tabulating equipment constitutes a bottleneck for information which could be provided more quickly and at less expense on a manual basis. An example of this is in the receiving of materials where processing of invoices is delayed because receiving reports go to tabulating equipment for processing and internal record keeping rather than directly to those who must authorize payment.

There is a requirement to introduce greater quality control in the management of information. Presently errors which have found their way into reports are not easily recognized.

B. Organization

There is at present no organization unit within the Kombinat capable to develop and implement business systems of the magnitude needed. This should be considered in any study of the overall organization.

There is no staff qualified to undertake systems planning, design and implementation. This is a significant problem and can only be remedied by careful recruiting, selection and training of candidates for a new business information systems department.

The design and programing of computer systems should be separate from that for manual systems. When they are combined the tendency is to presuppose that all systems are computer systems.

Attention is focused on how to use the computer, rather than on determining the best way to solve the problem.

C. Current Data Processing

The Zenica DP activity is typical of tabulating shops with normal problems of limited capacity and capability. There are generally more services for this shop to perform than it can provide and as a result DP in the Kombinat today supplements manual systems with little invlovement by the departments it serves. DP systems today do not have much of an impact on the overall organization. The primary system now in operation is stock control and reordering. Failures and deficiencies created by this system greatly affect repair and maintenance effectiveness through spare parts and material shortages.

D. Future Electronic Data Processing Planning

The size and scope of the Kombinat justifies a modern third generation computer for data processing work. A correct decision was made to plan for expansion of systems into this area. However, as indicated above, there is presently no organization or staff qualified to undertake this work. In addition, there does not seem to be a well-documented program for developing a modern computer technology in the Kombinat. This is particularly important in view of the sophistication of the

equipment contemplated and the problems of writing computer programs in English-based languages. Development of this capability involves not only the training of the specialists who will provide the data processing services, but of the executives, managers, supervisors and workers in all areas who must frame the systems to be developed and then use them effectively.

Although the selection of the basic computer equipment is being decided, the question of equipment has not been studied fully. Further analysis must be given to the specific computer configuration and the uses SOURs outside Zenica will make of the computer and the method of transmission of data between SOURs and the computer.

E. Manual Systems

It is especially important that the Kombinat develop a capability for designing and implementing business systems which will not make use of the computer, since many systems will be too costly to "automate", or could be better handled on a manual basis. This manual systems capability is not fully available to all sectors and SOURs in the Kombinat today.

Each existing sub-system must be analyzed to determine the purpose in terms of the total system, what information must be provided and the best way to supply this information. This process may or may not involve use of computers.

In conjunction with the survey over 600 forms were identified as currently in use at the Zenica SOUR. In many cases the purpose of the forms is limited and much information is duplicated. Training in forms design and control should be a part of the overall systems effort in Phase II. There is ample opportunity for cost reduction, not only in the reduction in the number of forms, but in the application of exception reporting principles and modern computer technology.

F. Work Measurement

Costs and the timeliness of information could be improved through methods improvement and clerical work measurement. When greater use is made of automation, work measurement can provide the Kombinat with a means to accomplish a significant increase in keypunching volume with the same numbers of staff. At present the keypunch productivity is low and results in an unnecessary limitation to the amount of service the office can provide.

Scheduling is also a problem in keypunch as evidenced by the fact that overtime payments are invariably high during the first of the month, with little work available during the latter part of the month. With the increased keypunching load which will be the result of increased automation, information systems should be designed with keypunch work loads in mind so that a more even flow of work can be achieved. Failing in this, transfers of personnel to and from keypunch to handle peak and minimum load conditions is recommended.

G. Master Systems Planning

Although the proposal prepared for consideration of the new computer system lists the contemplated new application to be developed, no system of priorities has been established. This must be done if the new computer system is to begin returning its investment upon delivery.

In addition, there are no detailed plans of implementation for any of these applications. There is no Kombinat "Master Systems Plan", nor is there the mechanism established to maintain a coordinated systems effort over the prolonged period of implementation and conversion to the new computer.

H. Finance

The procedure for processing receiving reports for raw materials is cumbersome and results in a delay in the receipt of information by the Kombinat finance sector. This results in either making payments in good faith or in late payments to vendors. In 1970 the penalty for such late payments reached four million new dinars, of which one-half could be eliminated by more effective processing of receiving reports. In addition to delays there have been inaccuracies in some of the information upon which payments are based.

There is a similar delay in the receipt of payments by customers to the Kombinat. This situation can be improved through a system which would provide better analysis of customers' buying habits, credit ratings, et cetera.

The system for the calculation of earnings and labour costs is well worked out and has sufficient checks and balances. However, the volume of manual calculation is high at every level and this suggests that there is a significant opportunity in this area for automation.

Accounting at Zhotse is essentially a manual bookkeeping function which occupies the time of a large accounting staff. There is no modernised accounting technology in use and absolutely no utilisation of mechanised accounting aids such as bookkeeping machines, tabulating equipment or computers. It is recommended that the whole accounting system be reviewed in both form and function and a modern system based on computer technology be designed and installed.

Payroll activities suffer from the same lack of modern approach. While the payroll for the Zhotse SOUR is prepared with the aid of tabulating equipment, payrolls for all other SOURs are prepared on a completely manual basis. It is recommended that a modern computerised payroll system be installed to replace all manual calculations.

8. [redacted]

Transfer of in-process material is at planned cost so that accumulated actual costs are unavailable. There was little evidence that actual product costs were known. Final product costs are a mixture of planned and actual costs with little opportunity to analyze cost variances, to determine the actual profit for each product. While there is justification for not accumulating and transferring variances from one department to another, more factual information would be available if planned, actual and cost variances were accumulated simultaneously so that true contributions to profit are known.

Studies are now being conducted into the use of direct costing techniques. Direct costing has much to recommend it in the case of the Zenica Kombinat. Contributions to Kombinat overhead by each BOUR, and each product certainly are significant and meaningful and reflect the general philosophy of the organization. However, caution is advised in drawing too many conclusions based on contribution to Kombinat overhead in an environment of controlled prices and limited responsibility for marketing.

Regardless of the use of full absorption or direct costing techniques there is a need for more exact technological standards to serve as a basis for planned or standard cost.

Cost information used by top management of the SOUMs and Kombinat are generally not available until sixteen to twenty days after the close of the month. More effective control can be obtained by shortening this cycle and making information available on a more timely basis.

3. Commercial Sector

The procedure for obtaining imported materials and spare parts generally requires nine to twelve months from the initiation of the order to the receipt of the material. This cycle can be shortened through systems improvements and better procedures. At the same time other systems improvements should develop information so that the need for critical items can be anticipated and procedures initiated in time to meet requirements.

There are a number of reports that are not being produced which are needed by management for more effective decision making. Some of these reports are described in the work plans or charters of the Kombinat sectors and SOUMs. This situation exists because of a lack of capacity in the present data processing organization or a shortage of clerical staff to research and tabulate the information.

4. Economic Sector

The flow of information processed by the economic sector for the comparison of performance to plan involves many reviewing levels and requires a long analysis cycle. There is an opportunity to speed up this cycle through manual systems improvements at both the SOUM and Kombinat levels.

6. [redacted]

Very detailed reports are kept by hand on all phases of production. The problem is that this information is so voluminous and so detailed that it is of little value as control information. There is a need to consolidate this data and present it in a more accessible and timely form if it is to serve as a basis for decision making and control by management. Exception reporting provides an effective way of reducing the sheer volume of statistics for top management.

In 1970 the Combinat paid eighty-three million dinars in penalties for railroad demurrage. These were the result of failure to unload materials from rail cars and return them within the prescribed time. A system to keep track of incoming cars, guaranteeing their prompt unloading, and return to the railroad would eliminate this unnecessary expense. Bulk materials such as coal, ores, and limestone constitute the bulk of incoming rail shipments. To insure prompt unloading and storage, control schedules must be coordinated to reduce queing at unloading points, and the unloading itself must be studied to insure that methodology and applied effort are satisfactory. It is recommended that industrial engineering studies in the area receive high priority since the reduction in cost can be dramatic and immediate.

M. Conclusions

1. Although there is a wealth of data available throughout the organization, it is not in a form that is most useful to management. This deficiency results in excessive costs, delays and frequently in unnecessary penalty payments.

2. It is necessary to begin organization and planning immediately in anticipation of the receipt of the new computer. A master systems plan should be developed using the "IDEALS Concept". This plan should firstly determine what information is needed by management, secondly, how it can best be obtained, and finally, develop the detailed systems specifications. (See Exhibit IV).

3. It should not be presumed that the computer will be used in every case. Some data can be more easily gathered and distributed manually. Separate organizations are required for manual and computer systems development.

VII. MAINTENANCE

A. General

The maintenance function is a vital one for steel making and fabrication involving continuous use of heavy and expensive equipment. This importance is exemplified by the fact that there are 3,561 employees in maintenance at Zenica alone.

The effectiveness of maintenance operations is measured first by the results obtained as indicated by lost productive time and scrap or inferior products. Secondly, the cost of maintenance is, of course, a factor both of materials and spare parts, and a result of utilization of personnel.

The maintenance organization of Zenica Kombinat and at the Zenica steel plant were examined in detail. Interviews were conducted with those responsible for maintenance operators and observations were made both in the field and in the maintenance shops. While no interviews were made outside of Zenica, we believe these observations at Zenica were typical of the whole organization.

B. Effectiveness of Present Maintenance

The present maintenance effort suffers from a lack of hand tools, spare parts and lack of equipment in many areas, as well as poor methods. The transfer of workers from one area to another where they are needed occurs rarely. The number of workers assigned to each area

appears to be for the peak workload in a particular area without reference to similarly trained workers which may be idle or marginally employed in other areas.

The preventive maintenance program with accompanying planning and scheduling is relatively good. It is energetically administered and the plans are carried out insofar as they can be with limited availability of spare parts and materials. The main reason preventive maintenance has received this unusual emphasis and attention is the extremely long lead times for the ordering and delivery of spare parts and materials. For imported parts, nine months to a year or more is required while parts made in Yugoslavia seem to average about six months. This situation has led to the manufacture of 70% of the required parts internally.

1. Organization Problems

Considerable redundancy seems to exist in the assignment of maintenance personnel. The pattern seems to be that there is a watch standing group providing continuous surveillance of each portion of the mechanical or electrical equipment used in production, backed up by a non-watch standing maintenance group, back up by a repair shop group, all for the same equipment. The director of the Electric Shop stated that he loaned a few electricians to another department once last year, so such loans do take place on a very limited, informal basis. But lacking a device to

accurately measure the workload and planned requirements of each unit of the organization, effective control and efficiency to provide full utilization of available man-hours is not possible.

Considerable overtime is worked; for example, 12,000 hours in the Repair Department in May, and outside contractors are called for assistance with no organized effort to determine the availability of workers with equivalent skills being available for loan or temporary transfer in the other five departments of the Maintenance Division.

Another problem in the present organizational structure is a failure to organize along functional rather than area lines. It is generaly recognized that the functional organization is highly desirable and has the following advantages:

a. All workers performing the same basic duties are grouped together organizationally, if not physically. Thus, they share in a professional pride and a better performance of their duties results.

b. Due to a larger group of workers, more highly qualified professional management can be provided to give better supervision and closer attention to the details of the particular work being performed.

c. A career ladder is provided with promotional opportunity for the capable worker to rise to a level of responsibility.

d. In semi-professional work where a body of knowledge, principles, and policies exist, these can be made more available and enforced easier in a functional organization.

Organization along functional rather than area lines would lead to improvements in the following areas:

a. Purchasing

There are three separate groups involved in the purchasing for the Maintenance Department. The first is within the department purchasing non-standard parts within Yugoslavia. The other two are in the Kombinat: one is purchasing standard parts within Yugoslavia and the other purchases all parts and materials which must be imported. A consolidation of these functions would produce greater responsiveness to the problems of the department.

b. Personnel

Each of the six departments of maintenance has a separate personnel department performing personnel

record keeping and related duties for the employees of that department. Consolidation of this function with a maintenance director of personnel reporting directly to the Maintenance Division director would make the personnel function much more efficient and effective.

c. Historical Time Standard Application

Each of the six maintenance departments has a "Preparation of Work Section", where several people are engaged in application of time estimates to each work order. This standard is important since it determines the worker's pay for that job. There are thirty-one people in all doing this work with apparently only nominal supervision. This important function should also be consolidated organizationally in a staff officer who reports directly to the maintenance director. This organization will provide for a professional approach and reduce the possibilities of application of standard time values in violation of regulations and policies which apply.

d. Janitorial Services

Cleaning ladies are found in each little section, group or unit performing cleaning and janitorial services with very nominal supervision. One example of this situation

was a small power station with four watch standing electricians and two cleaning ladies. Obviously, their productivity is very low.

A janitorial department should be established in maintenance to provide these services for all other departments.

2. Spare Parts and Material Problems

The maintenance puchasing group consists of fourteen people, eight of which are buyers specializing in spare parts and four buyers for materials and other services. During the month of May, they processed 315 purchase orders for spare parts and 133 purchase orders for other materials.

Twice a week all new purchase orders are reviewed by a supervisor from the Mechanical Repair Shop to determine which parts can be made internally (make or buy decision). Those items which cannot be made here are purchased outside. This is about 50% of the orders received. The lead time on these orders is from three to nine months or more, but averages about six months. At present there are 1,310 orders outstanding and 156 orders past the delivery date and overdue.

The technical material group purchases standard spare parts available in Yugoslavia for all the ten SOURs of the Kombinat and is part of the Kombinat organization. The average time

from the placement of the order to the receipt of standard parts which appear in manufacturers' catalogues is three to six months. This group buys 70% of maintenance spare parts which are purchased, which is about 50,000 articles. At present, there are 230 overdue orders which constitute a critical backlog.

The Import Department of the Kombinat purchases imported parts and materials for all ten SOURs. Delivery times from the initiation of the order to the receipt of material have increased substantially so that they now average about eight months, with the quickest at least six months and many orders requiring more than a year. The major cause of delay in the delivery of imported material is in obtaining approval for import. This could possibly be reduced by getting blanket approval to import vital materials which would save an average of six months in processing each purchase. Once approval is obtained, the materials appear to be delivered in reasonable time.

A summary of the status of all purchase orders is as follows:

Category	Imported Parts	Standard Parts Ordered Locally	Non-Standard Parts Ordered Locally
On Order	900	550	1,310
Past Due Orders	262	230	156
Percent	29%	42%	12%

Parts past due average 23.4% of the orders, but the long lead times required create even greater operating problems.

The consolidation of purchasing for maintenance would result in a more uniform and professional administration. The importance of these problems is indicated by the fact that 20% of electric motors being repaired are delayed due to a lack of lacquered wire from abroad.

Another problem which aggravates the spare parts situation is a very time consuming document processing and paperwork flow which may take several months within the Kombinat organization. Much of this time is spent in Technical Services Department for preparation of drawings and related instructions.

The solution would be a firm "make or buy" decision by the Maintenance Department on each requisition within forty-eight hours of receipt by Purchasing, and a careful review of maintenance procedures to process requests and prepare required drawings more rapidly.

3. Transportation Problems in Maintenance

Transportation is a constant problem involving both personnel and materials. This means that with the exception of department heads, workers and supervisors must walk to job locations, often carrying heavy tools and equipment. The

Utilities Department has eighty people who must walk to job sites daily and some workers walk up to three miles at the beginning and end of each shift. This walking is completely unproductive and results in a worker being ready to sit down and rest and have his "breakfast" after merely getting to the job site.

The Transportation Division has responsibilitiy for all vehicles including twenty trucks used to transport materials and equipment within the Zenica SOUR. There are also five vans which seat eleven workers and two are assigned to Maintenance, one to Machine Repair Shop and one to Current Maintenance.

These vehicles are available only during the day shift. At night only three cars are available to the maintenance watch standing force in emergency cases. There is no radio control and all requests for dispatch are done by phone.

The workers are transported from the main gates to buildings of the SOUR at the beginning and end of each shift in six buses. The buses also make a round to the main buildings of the SOUR every half hour during the day. When asked why a schedule of every ten minutes is not maintained, it was stated that there is no need for such a service and that the buses would be empty.

4. [redacted]

During the tour of the physical facilities of the Maintenance Division, considerable evidence of lost time was observed in most departments. One exception was the shops of the Mechanical Repair Department where 12,000 hours of overtime was worked last month. In several other shops, half the staff appeared to have little or nothing to do. In one shop staffed by sixteen people, we were told that there was no work that day. Only four workers were present and the rest were elsewhere. In other cases, workers were diligently sweeping or cleaning at the time of our visit, doing what appeared to be make work projects which were largely unnecessary. The general impression was of a third to a half overstaffing in practically all shop areas except Mechanical Repair.

In the Electrical Shop while most workers appeared busy, the methods and tools being used were not effective. Armatures were being filed by hand and no mechanical grinders, or polishers were in use. Except for one electric drill, no hand power tools of any description were observed in any of the shops. Since the cost of such tools is low compared to the loss of worker effectiveness, their use should be greatly expanded. One example of inefficient methods was the hand filing of small right angle parts to remove a square corner to a depth of about 3/4 inch. Hand filing took well over an hour, while with

a motorized grinding wheel the same metal could be removed and the desired shape obtained in about three minutes.

5. Training and Recruitment Problems

With the exception of the Electric Shop each maintenance department director stated that he had a problem getting enough trained and qualified personnel to fill out his staffing table. Various apprenticeship training programs have been started but their output is not sufficient to meet requirements and workers are not sufficiently trained to perform more than "helper" duties. Another problem is with the supervision of the shops, because several highly skilled shop masters have emigrated to other countries.

The number of vacancies in the maintenance area at present (June 1, 1971) is as follows:

Technical Services Department	40
Department for Current Maintenance	100
Mechanical Repair Department	20
Electrical Repair Department	5
Utilities Department	41
Automated Equipment Department	14
Maintenance Total Vacancies	220

These vacancies are based on existing authorized organization tables which reflect the present degree of personnel utilization. Utilization is low at present because of a lack of measurement and control of maintenance work, the lack of good scheduling, and inflexibility on transferring personnel between areas.

However, an additional requirement for trained maintenance workers will develop within two and one-half years with the completion of the expansion program which will increase production from one to three million tons annually. This new capacity will require about 600 trained maintenance workers in addition to present requirements.

6. Standards for Maintenance

Historical standards are applied to every maintenance job order for scheduling work and for determining worker incentive pay. The one exception is certain machine tools where "technical" time values extracted from manufacturers manuals on speeds and feeds are used instead of historical standards.

While on the face of it the system appears adequate, the administration leaves much to be desired. In practice, standards and time are frequently adjusted to obtain a desired level of performance. In addition, the use of historical standards tends to perpetuate past performance and reduce incentive to improve methods and working habits.

9. Space Utilization

In many shops visited, the working spaces appear overcrowded. In some cases there does not seem to be enough space for the entire crew in the home shop without using space in Production Department buildings. In the Electric Shop space is at a premium with only a light crane to lift large electric motors. This means that overhaul and repair of large electric equipment such as generators must be done at the operating site. The Mechanical Repair area also seems to be overcrowded and noisy but less difficult to work in than the Electrical Shop. In some shops each worker is given only about two and one-half feet (three-quarter meters) of bench space with a vise in the middle. Such congestion slows down workers because other people are in the way.

C. [redacted]

1. Work order estimating, personnel and janitorial services should be consolidated and directed within a functional type organization.

2. Spare parts and materials purchasing is very slow, in some cases requiring a year or more. Purchasing needs reorganization, systems need streamlining, the reorder formula needs adjustment, and follow-up methods need improvement.

3. Internal transport is not organized to meet the needs of maintenance. There is considerable time lost walking to and from maintenance jobs carrying tools and equipment.

4. Greater organizational flexibility is needed to transfer trained personnel between departments to fill the greatest need. Overtime can be reduced or eliminated and personnel utilization greatly increased.

5. Manual shop methods are generally inefficient. Production can be greatly increased by use of small hand power tools and better work methods.

6. The maintenance organization is redundant with apparent overlapping functions in the shop areas.

7. A great deal of idle time now occurs in maintenance shops and other groups which can be reduced and better controlled by proper systems and techniques.

8. The present historical time standards are inaccurate. Improved standard data techniques can provide accurate time values as a basis for effective control.

9. There is a serious lack of trained personnel in many areas. Use of engineered time standards as a training tool can develop trained workers in a shorter period of time than other training methods.

10. Maintenance shops lack adequate space. Greater productivity per worker will reduce congestion and pressures on the limited space available.

VIII. PRODUCTION

A. Open Hearth

The most important production area is the open hearth furnaces where steel is produced. This department was most frequently cited as a problem area. The specific problems mentioned were off-specification heats, and an uneven flow of steel to the rolling and forging operations.

The uneven flow of production from the open hearth is the result of occasionally having several furnaces out of production for repair and rebuild at the same time. There is an annual plan for rebuilding furnaces but the plan does not seem to have been strictly followed. When furnaces are not rebuilt at the scheduled intervals more than one furnace may be shut down at the same time. This irregular out of phase condition of open hearth rebuilds and repairs is the basic cause of the uneven flow of steel production.

Based on the average campaign length for the last five campaigns for each furnace, the elapsed time between rebuilds averaged approximately 4,000 hours. This is excessive and would contribute to low productivity and accentuate the uneven flow of production. However, as a result of advice from Siemens-Martin, the length of the campaign appears to have been drastically reduced to slightly over 2,100 hours during the first half of 1971. This has resulted in higher productivity and should result in a more stable production rate.

The calculation of the optimum campaign length is closely associated with the length of the rebuilding period. While rebuilds are not carried out by Zenica personnel, their duration has a vital effect upon production. In the recent past, rebuilds have required fifteen to twenty-five days which is 360 to 600 hours each. The 1971 schedule calling for more frequent rebuilds allows considerably less time. However, there is no indication yet that rebuilds are being accomplished in the scheduled intervals. On the contrary, the time appears the same as formerly.

Since the duration of the rebuild is so important a factor in overall steel production, the rebuild itself should be carefully studied and coordinated so that it can be accomplished in the absolute minimum time. The complete rebuild of a Siemens-Martin 180-ton open hearth has been accomplished at the Brazilian National Steel Company in Volta Redonda in less than 100 hours, not counting warm-up time. This excellent performance was obtained by using PERT net work analysis of each phase of the rebuild, careful measurement of all work and the preparation of phase diagrams detailing the numbers of men to be employed on each activity at each point in the cycle. There is a possibility at Zenica of increasing production by more than 50,000 tons per year through shorter rebuild times.

The rebuild should be carefully studied and planned to determine the exact numbers of each maintenance craft and the sequence of work to accomplish each rebuild in one hundred hours or less. If the contracting company is unable to accomplish this, serious consideration should be given to having Zenica maintenance personnel undertake rebuilds themselves.

B. Rolling Mills

The productivity in the blooming mill is closely related to the even flow of steel from the open hearth. During low production periods, charging cold ingot results in delays waiting for ingots to attain correct rolling temperatures. Our survey shows that appreciable delays are caused by this factor, which would be corrected to some extent by better open hearth scheduling.

The shape of ingots was recently altered to obtain better blooming mill productivity. However, the expected increase did not occur. There is a need to study the whole question of soaking pit operations, rolling methods and shear operations to develop improvements to actually realize the potential increased capacity. There are variations in rolling methods and delays from a variety of causes which could be eliminated through careful planning and control.

More than 10% of productive time on the heavy section rolling mill is lost through roll changes. Roll changes can be accomplished in an average of less than one hour when two sets of stands are used. This permits new rolls to be installed and adjusted while production continues on the alternate set. This not only results in more production time, but also in better utilization of both production and set-up personnel. There is evidence that on the average 5-7% of productive time can be regained through using this technique.

Observations at the various producing locations disclosed great variations in the efficiency of production between the various plants in the Kombinat. There is every indication that technical studies and better controls could result in substantial increases in output with consequent reduction in cost.

IX. MATERIALS HANDLING/TRANSPORT (Internal)

We consider materials handling in basic steel production to be an integral part of the production process. The operation of cranes and railway equipment must be coordinated and scheduled in synchronization with production equipment. There is opportunity to increase efficiency in the use of materials handling equipment.

In addition, maintenance of cranes and rolling stock present constant problems. Examples were noted where production was seriously delayed because of electric motor failures on cranes which were required for production. These considerations are discussed in further detail under the section on maintenance.

Reduced costs and more effective transport can be achieved through the application of industrial engineering techniques to the transport of materials. Trucks should be scheduled in accordance with priorities to meet production requirements and obtain optimum utilization of equipment. Where rigid schedules are impractical, the use of radio dispatching equipment should be considered for locomotives, trucks and cars.

The use of conveyors to replace trucks is being considered at Dobej, the limestone quarry, and at Bihac. These represent advances in materials handling techniques but care must be taken specially at Bihac to see that the proposed system is adequate for the planned increase.

Mail service especially within SOUR Zenica is a problem. There is no regularly scheduled inter-department mail service. This results in considerable delays in transmitting information between departments. The increased use of passenger cars carrying personnel and inter-office mail within SOURs is an important requirement and should be seriously considered.

X. QUALITY CONTROL

Consideration of the organizational factors related to quality control are discussed in the section on organization. We have observed the need for more uniform quality control procedures in the SOURs. This need is evidenced by the fact that some SOURs are using quite sophisticated sampling procedures, while in other locations 100% inspection is the rule. By making the head of the quality control sector responsible and accountable for all quality control procedures, improvement in effectiveness and consequently cost reductions should result.

At present 30% of all open hearth heats are off-specification, with the principal reason being incorrect carbon content. The reasons for this lack of control are difficult to understand since present open hearth practice using high hot metal charges should minimize uncertainties caused by variations in scrap charge. The only possible conclusions are that there is indifference as to quality or that quantity of output is emphasized to the exclusion and detriment of quality.

Most off-specification heats appear to be in heats destined for rails where the carbon content is critical. When rail heats do not conform to specification they are "diverted" to other less critical uses such as structural sections, merchant bars or concrete bars. If the high percent of off-specification heats is caused by the desire to maintain high output, then rail heats should be scheduled early in each month so that diverted heats can be applied against production requirements for other, less stringent, qualities of steel.

Closer adherence to specifications, without loss of output is possible when workers are motivated in this direction. Individual earnings of workers can and should be made to reflect the quality as well as quantity of output.

We recommend that the Quality Control Sector at the Kombinat level be responsible for all inspections, testing and quality analysis procedures. The Quality Control personnel at each SOUR would be under administrative control at the SOUR but would be responsible technically in matters of test procedures and quality standards directly to the Kombinat.

III. PROGRAMS FOR IMPLEMENTATION

A. General

The development of programs for the solution of the problems identified in Phase I should be carried out in conjunction with a team of consultants from the Yugoslav Centre for Industrial Organization and Development and Bruce Payne & Associates, Incorporated. The initial emphasis should be on the training and development of client and Centre personnel, and upon planning and scheduling final implementation to be accomplished. Phases II and III must be carried out simultaneously as a practical matter since training and implementation will frequently overlap and on-the-job training or guided application of technological concepts should be an important part of the implementation projects.

We suggest that teams of consultants from BP&A and the Centre be assigned to work in separate areas of specialization. The three areas of specialization would be:

1. Manual Systems

2. Computer Systems and Programming

3. Industrial Engineering/Organization

B. [illegible]

The organization structure should be completely realigned along lines suggested in the body of our report.

Realignment should provide for better communication of information as well as facilitating the application of the best possible expertise to each functional area.

The duties and responsibilities of every position must be clearly documented so that every individual knows precisely the scope and limits of his authority and accountability. This will facilitate decisive action by those concerned who can act and carry out programs confident of their own authority and responsibility.

We estimate that the design of the organization, complete in every detail, and the documentation of duties and responsibilities of each position, will require one year to complete for a team of Zenica personnel working under guidance and direction of the BP&A consultant team. We feel that, once principles and procedures are completely understood, Zenica personnel can proceed to implement the reorganization without special consulting assistance.

C. Computer Systems and Programming

The new computer which is planned for 1973 should be the central core of business systems. Methods and procedures of gathering

and processing data make up the Management Information System. As indicated in the body of our report, it is important to begin now for the installation of the new computer.

A group should be recruited and trained for this important work under the Organization Department. A total of twenty systems designers and programmers should be recruited and trained in systems design and programming for third generation computers.

This group should develop a master systems plan, and establish priorities for the development and programming of systems. When the computer is finally delivered programs should have been written, compiled and tested so that operations can begin immediately. If compiling and testing of programs is delayed until after the computer is delivered much valuable time and expense will be lost getting started.

The final decision on computer configuration and peripheral equipment can only be made when master systems planning has been accomplished. An important factor in this area would be counseling Zenica management on computer acquisition.

The objectives of this program can be stated as follows:

1. Training of Centre personnel to develop the capability to lead similar programs.

2. Training of Zonico personnel in systems design.

3. Training of Zonico personnel in programming, including COBOL.

4. Development of a master systems plan for Zonico Kombinat

5. Design of specific systems for computer application.

6. Programming and test of computer programs.

7. Development and installation of systems for scheduling and controlling computer projects.

Since computer technology and programming is to a large extent based on the English language, all members of this department should either speak English or receive intensive training in English.

Approximately half the group should receive basic training in programming including COBOL. This will probably involve going to special schools either in Europe, England or the United States. The duration of the training could involve as much as three to four months.

The group which does not receive programming instruction should proceed with the development of the master systems plan and the design of specific systems. One BP&A consultant should work in conjunction with two Centre consultants on this phase of the program. The training in systems design should be given by the BP&A consultant and would consist on three weeks of initial classroom instruction followed by approximately five months of on-the-job training. At the end of this period there should be sufficient expertise developed in client and Centre personnel to enable them to continue without further specialized consulting assistance.

D. Manual Systems

The development of manual systems should be completely separate from the development of computerized systems and programming. Some procedures cannot be justified for computerization and should be continued on a manual basis. Improvements and refinement of manual systems should be an important part of the overall systems effort.

Systems design should consider the computer as a tool to be used when it represents the most effective way to process data. Systems should not be designed on the presupposition of the use of the computer. The first step is the evaluation of the needs of the system in terms of outputs. Real needs must be determined having consideration for exception reporting not mere accumulation of data.

Having identified the needs and the inputs, the most effective way of processing the data must be determined, taking into consideration the cost and time frame within which the information is required. If this involves the use of the computer, the specifications can be transferred to the computer systems area for design and programming.

Closely related to the development of manual systems should be the measurement and control of clerical and administrative activities. The use of work measurement for clerical activities will enable management to determine the clerical staff required and to balance workloads between individual employees and between sections. The application of work measurement would involve the recruitment and training of a group of methods analysts in work simplification and work measurement techniques. We suggest training for approximately fifteen such analysts who would develop and install methods, staffing criteria and controls for clerical and administrative activities.

As in the computer systems area the objectives of the manual systems and control program should be directed to both training and implementation. Specifically the objectives should be:

1. Training of Centre personnel to direct similar assignments,

2. Training of Zenica personnel in systems design and work measurement,

3. Development and implementation of improved manual systems,

4. Establishment of staffing criteria for clerical and administrative operations,

5. Establishment of controls for the effectiveness of clerical and administrative personnel.

Two Centre consultants should be assigned to this program in conjunction with a BP&A specialized consultant in systems and clerical work measurement. The initial training in systems for the whole group should be the same as that received by the computer systems group. This would involve three weeks of classroom instruction.

At the completion of the systems training, the entire group should receive training in clerical work measurement and the development of systems of control. This would involve an additional four weeks of classroom instruction.

During the initial implementation phase the group should receive guided application and on-the-job training in systems development and clerical work measurement. The period of guided application should be at least ten and possibly twelve months depending on progress and the degree of competence developed by Zenica and Centre personnel.

E. Industrial Engineering

The development of a strong industrial engineering department is essential to the establishment of measures and controls necessary to improve productivity and the utilization of workers and equipment. The prime objective of the industrial engineering department should be to make it possible to man all new equipment incident to the expansion plans without additional personnel.

We suggest that a group of forty industrial engineers be trained in modern management techniques, including work measurement and predetermined time systems such as MTM. Coincident with training, a master plan should be developed for the organization of the department and the areas of specialization required. Time tables should be developed showing the sequence of departments to be studied and the manpower required for each study. The schedule should be coordinated with expansion plans so that personnel will be available as new equipment is installed.

The objectives of the industrial engineering program should be as follows:

1. Train Centre consultants to be able to direct similar programs.

2. Train Zenica industrial engineers in methodology and techniques of modern management and control.

3. Develop engineered production standards for all production and maintenance operations including transport and materials handling.

4. Establish measures and controls of productive efficiency in all above areas.

5. Establish correct staffing in each of the above areas.

6. Develop motivational techniques for workers whereby individual productivity is more directly related to individual income.

We suggest that four Centre consultants work on this program in conjunction with one BP&A consultant. Initial training would be in methods analysis and work measurement and would consist of at least four weeks of classroom instruction. Following the formal instructions systematic study should be initiated in all areas of production and maintenance. Each Centre consultant would work in conjunction with ten Zenica engineers under the direction of one BP&A consultant. Each group should be responsible for a specific area such as the metallurgical section, fabrication section, maintenance and possibly job evaluation.

The initial engagement of the BP&A consultant should be for a period of at least twelve months. Evaluation of results and the degree of competence developed by Centre and Zenica personnel will then dictate future consulting assistance.

F. Summary of Consulting Requirements

Program	Zenica Personnel	No. of Consultants Centre	No. of Consultants IPEA	Consulting Man-Months Centre	Consulting Man-Months IPEA	Consulting Start Date	Finish Date
Computer Systems & Programming	20	2	1	12	6	10/1/71	3/30/72
Manual Systems & Controls	15	2	1	20	10	9/1/71	6/30/72
Industrial Engineering	40	4	1	48	12	9/1/71	8/30/72
	75	8	3	80	28		

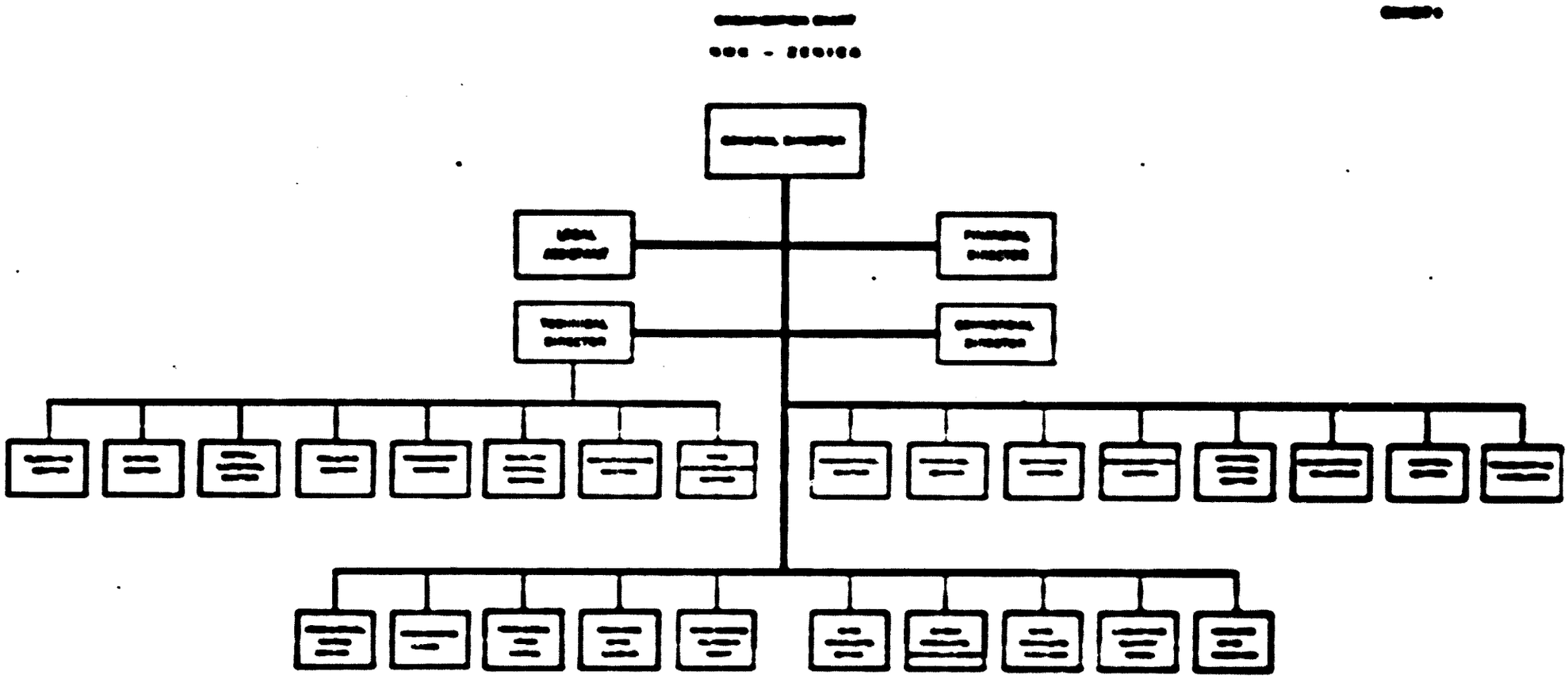
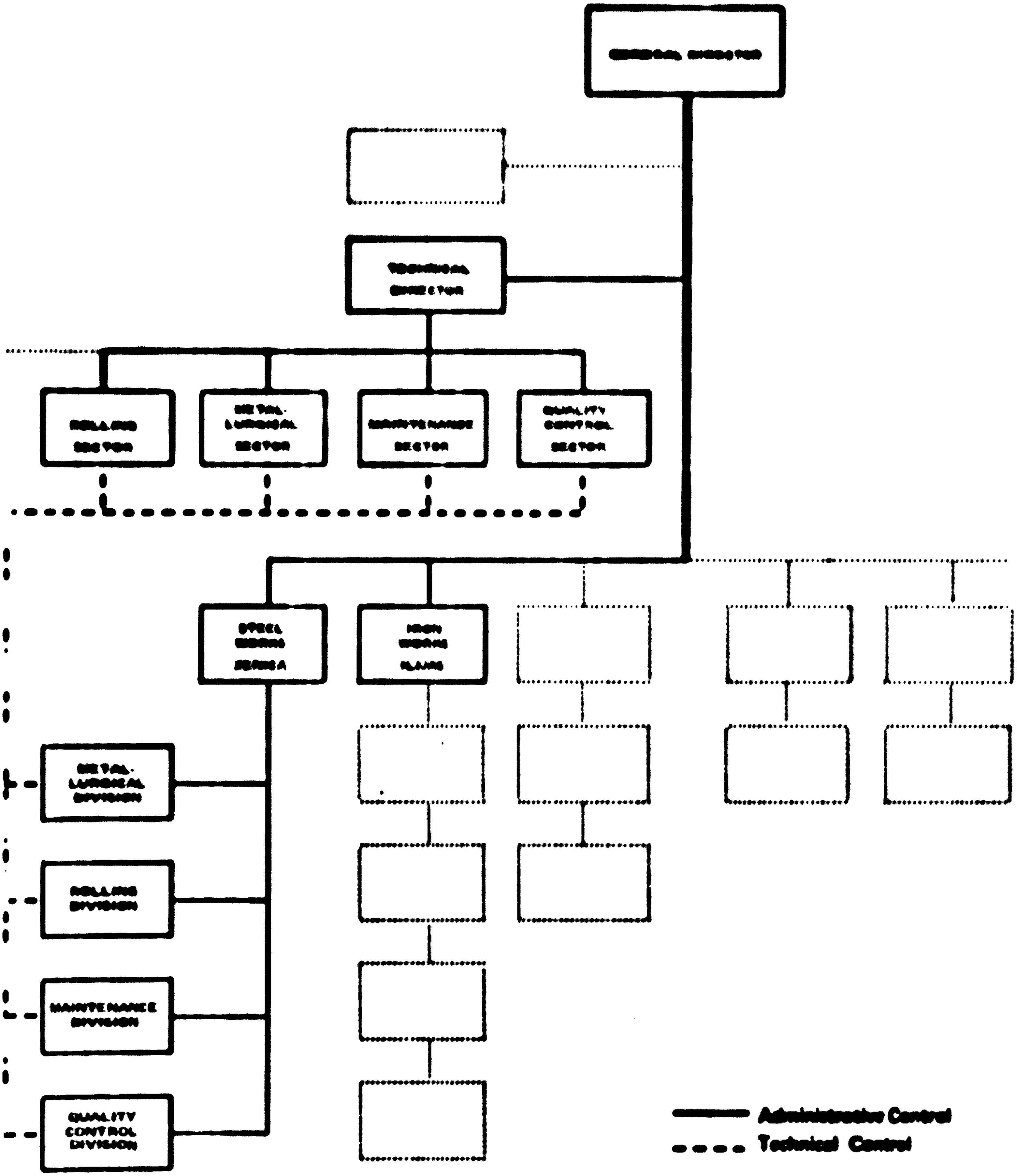


EXHIBIT [illegible]

ORGANIZATIONAL DUAL ACCOUNTABILITY



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4. Soaking pit productivity was carefully recorded and records were kept of the time each heat was charged, the time it was available for rolling and the time actually rolled. Records were also available of the time for soaking pit repairs and furnace down time.

5. Analysis of soaking pit productivity showed a fairly constant incidence of furnace repairs. Crane delays were also constant and resulted from the fact that when crane A was unloading a pit at the North end of the yard, crane B could not load a pit in the same general area without causing interference. There were no abnormal delay factors affecting soaking pit operations.

6. The analysis of soaking times for various heats showed a different story. Some heats were ready for rolling within 90 minutes; others required as much as 240 minutes to attain the correct temperature.

7. Soaking pit productivity in tons per hour is greatly influenced by soaking time. When soaking pit productivity was correlated with rolling mill productivity the two were found to be identical.

8. Investigation of the reasons for the low productivity of the soaking pits which seemed closely related to rolling mill productivity, showed that the heats of long duration were caused by two factors. By far, the most common cause as determined by fuel consumption graphs was the charging of cold ingots from inventories maintained in the yard. A secondary cause of long soaking time was delays due to scheduling mill down time. The difference in the two delays was readily discernible from fuel consumption records.

CHARACTERISTICS OF MANAGEMENT INFORMATION SYSTEMS

A. **INFORMS** if it changes the probability of management decision.

B. **INSTRUCTS** if it recommends a management decision.

C. **INITIATES** if it has put its recommendation into effect.

OBJECTIVES OF MANAGEMENT INFORMATION SYSTEMS

A. **INITIATE** where decisions can be made so that particular events can be always handled the same way.

B. **INSTRUCT** where it cannot initiate.

C. **INFORM** where it cannot instruct.

CASE STUDY - NUMBER ONE

PROBLEM: Rolling Mill Production Rates

The production of blooms at the rolling mill showed wide daily fluctuations as well as prolonged periods of low and high production. It was desired to produce on a nearly uniform daily basis so that in-process inventories were fairly constant. The wide fluctuations in blooming mill productivity with corresponding increase and decrease in bloom yard inventories caused delays in subsequent rolling operations and excessive materials handling costs. Management wanted to correct these situations and eliminate excess costs.

Available Data

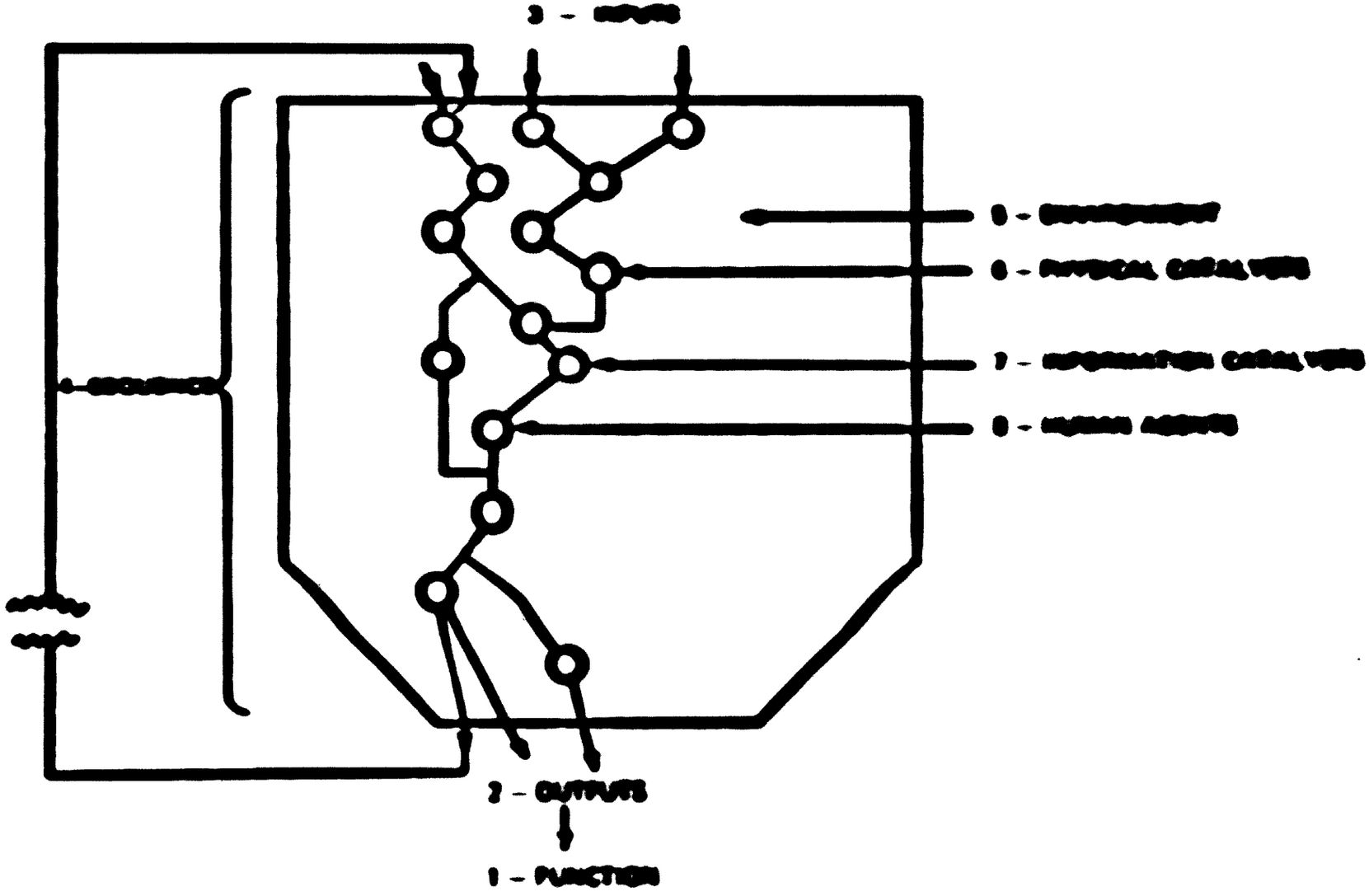
1. Reporting techniques were initiated in the blooming mill to obtain carefully detailed records of the daily productivity with particular emphasis on the causes of production delays.

2. The records showed a fairly consistent incidence of delays for mechanical and electrical repairs in addition to regularly scheduled inspection and repair periods. The magnitude of these delays averaged between 5% and 7%. There was little or no correlation between periods of high and low total productivity and the quantity of unscheduled maintenance.

3. The major cause of non-productive down time was in waiting for hot ingots to roll. There was a distinct correlation between the incidence of these delays and daily productivity. It was evident that daily productivity was greatly influenced by the output of rollable material from the soaking pits.

[illegible]

MODEL OF ANY SYSTEM



9. Further investigation was made as to why charging cold ingots occurred at irregular intervals during the year. It was found that cold ingots were used when open hearth production was low. The inventory of ingots in the storage area was increased during periods of high open hearth productivity, and decreased when productivity was low.

10. Comparison of the production of the rolling mills, the soaking pits with open hearth showed distinct correlation between productivity in these three areas.

Conclusions

Develop and discuss possible solutions to the problem of rolling mill productivity. Some possibilities would be:

1. Work overtime during periods of low productivity.

2. Install more soaking pits.

3. Get additional cranes.

4. Improve railroad scheduling.

5. Improve maintenance scheduling.

6. Schedule maintenance for periods of low open hearth productivity.

7. Reschedule open hearth maintenance to produce more even flow of steel production.

CASE STUDY - NUMBER TWO

PROBLEM: Penalties for late invoice payment

The large steel company regularly pays penalties for late payment of invoices of 4,000,000 dinars per year. The management feels that this is an added cost which should be eliminated.

Available Data

1. The procedures for purchasing materials and payment of invoices are as follows:

   a. A purchase order is placed to buy material from a local vendor. The order specifies the quantity and quality of material and the terms of payment.

   b. Copies of the purchase order are sent to the vendor and to the SOUR purchasing section.

   c. When the material arrives at the plant receiving department the inspection department is notified to inspect the material to see that the quality received conforms to the purchase contract. A receiving report is prepared for the quality and quantity of material. This usually takes up to twenty days.

d. The receiving report is forwarded to the raw materials bookkeeping section where the prices are extended for the unit price and quantity received. This requires two to eight days.

e. The receiving report is then forwarded to the SOUR purchasing section where it is compared with the original purchasing order for quantities and unit prices and posted to financial inventory records. If all is in order a payment authorization is forwarded to the clearing department. This requires six days on the average.

f. The clearing department checks the authorization and determines whether the vendor has payments due to the company. If all is in order the papers are approved and forwarded to accounts payable.

g. The accounts payable section sends the payment order to the bank which then pays the supplier. This requires one additional day.

h. General ledger entries are also prepared in the clearing section and forwarded to bookkeeping. This takes six days.

i. Central bookkeeping processes the general ledger and forwards the the supplies department, which processes and forwards it to the machine posting section. This requires one day in each department or a total of two days.

j. The total time from the receipt of material until the vendor receives payment is from thirty to thirty-six days and frequently longer if the cash position is not favorable. The result is that many suppliers invoke penalty clauses in their contracts which is the reason for the large volume of penalty payments.

Conclusion

In considering possible solutions, disregard any delay due to shortage of cash. Concentrate on ways to speed up the system.

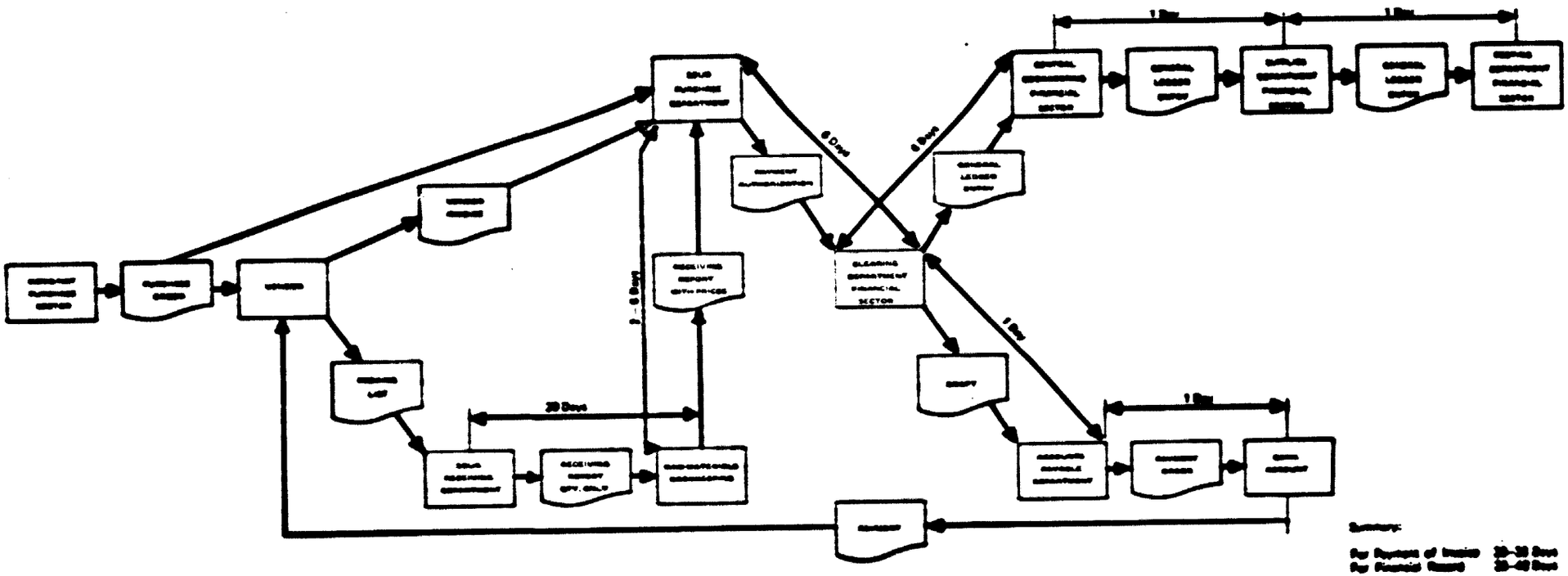
Possible approaches may include:

1. Use of computer more extensively.

2. Work more overtime.

3. Make additional copies of receiving reports.

4. Eliminate some of the departments now participating in the process.



CASE STUDY - NUMBER THREE

PROBLEM: Maintenance for Rolling Mills

A large steel company wishes to keep all costs to a minimum. Since the cost of maintenance labor is a very large item employing 3,560 employees, it offers opportunities for cost control. Furthermore, there is a shortage of skilled maintenance workers. There are vacancies for 282 skilled workers and new equipment will still further increase the need for new employees.

Available Data

1. The distribution of total maintenance personnel is shown in Table I. The current maintenance division is the largest single area.

2. The breakdown of the current maintenance division is shown in Table II. There are a total of 74 persons in documentation, preparation of work orders and record keeping, 791 are in mechanical maintenance and 449 in electrical maintenance.

3. The rolling mills are selected for further study since together they constitute the largest single maintenance group. The further breakdown of personnel is shown on Table III.

4. The old and new rolling mills are not located together and are separated by a distance of approximately four kilometers. The sites are connected by railroad tracks, and by paved roads.

5. The labor pool is composed of individuals who can perform a variety of maintenance tasks including mechanics, welders, plumbers, truck drivers, etc.

6. Observations of maintenance personnel in the rolling mills show that there is at least 30-40% idle time. This is occasioned by the fact that with the exception of the labor pool, personnel are assigned to a particular mill.

Conclusions

Suggestions for possible solutions for discussion are:

1. Work more overtime during emergency shut downs.

2. Improve transportation facilities so that men can be more easily transported between mills for emergency work.

3. Assign fewer men to fixed locations and enlarge the labor pools.

4. Measure the routine work carefully and assign men on the basis of a full day's work.

5. Maintain a highly mobile flexible crew to serve in emergencies.

6. Measure and schedule preventive maintenance so that full work loads are maintained at all times.

TABLE 1

MAINTENANCE ORGANIZATION

Technical Services Section	235
Current Maintenance	1,314
Mechanical Repair Section	670
Electrical Repair Section	406
Energy Production	664
Instrument Repair	181
Spare Parts Control	16
Other	67
Total	3,560

TABLE II

CURRENT MAINTENANCE DIVISION

	Documentation	Mechanical	Electrical	Total
Coke Plant	10	67	33	110
Sintering Plant	-	83	48	131
Blast Furnace	19	164	74	257
Open Hearth	12	172	63	247
Rolling Mills (New)	12	117	108	237
Rolling Mills (Old)	10	92	85	187
Forge	11	96	38	145
	74	791	449	1,314

TABLE III

CURRENT MAINTENANCE - ROLLING MILLS

	New Mill	Old Mill	Total
Documentation	12	10	22
Mechanical Lead Men	4	4	8
Mechanics Blooming Mill	17	12	29
Lubricators Blooming Mill	4	4	8
Mechanics Rod Mill	19	14	33
Lubricators Rod Mill	7	4	11
Crane Maintenance	11	8	19
Labor Pool	55	46	101
Sub-Total	117	92	209
Electrical Lead Men	4	4	8
Electricians Blooming Mill	24	19	43
Electricians Rod Mill	30	23	53
Electricians Wire Mill	17	13	30
Crane Maintenance	9	7	16
Labor Pool	24	19	43
Sub-Total	108	85	193
GRAND TOTAL	237	187	424

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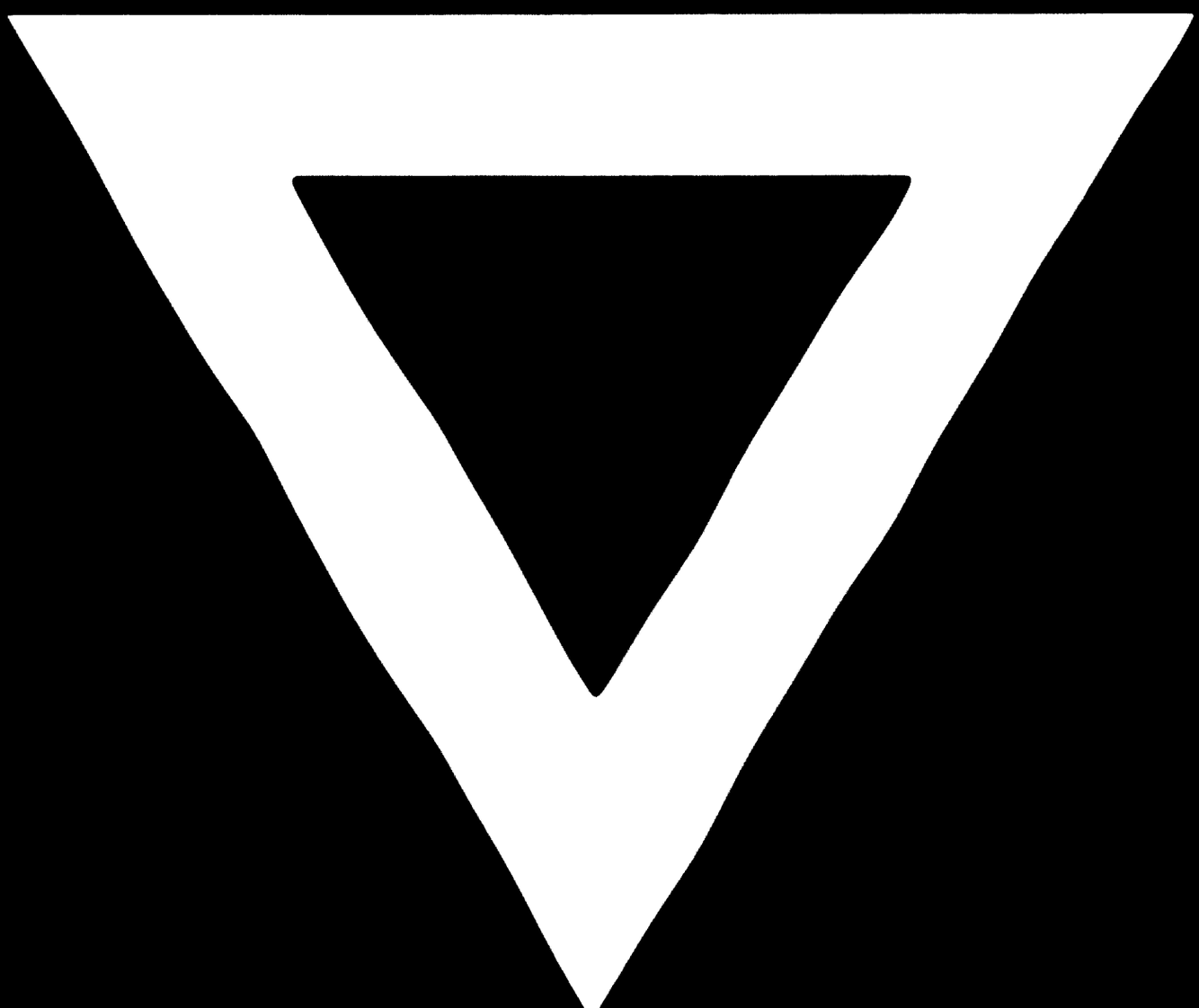

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