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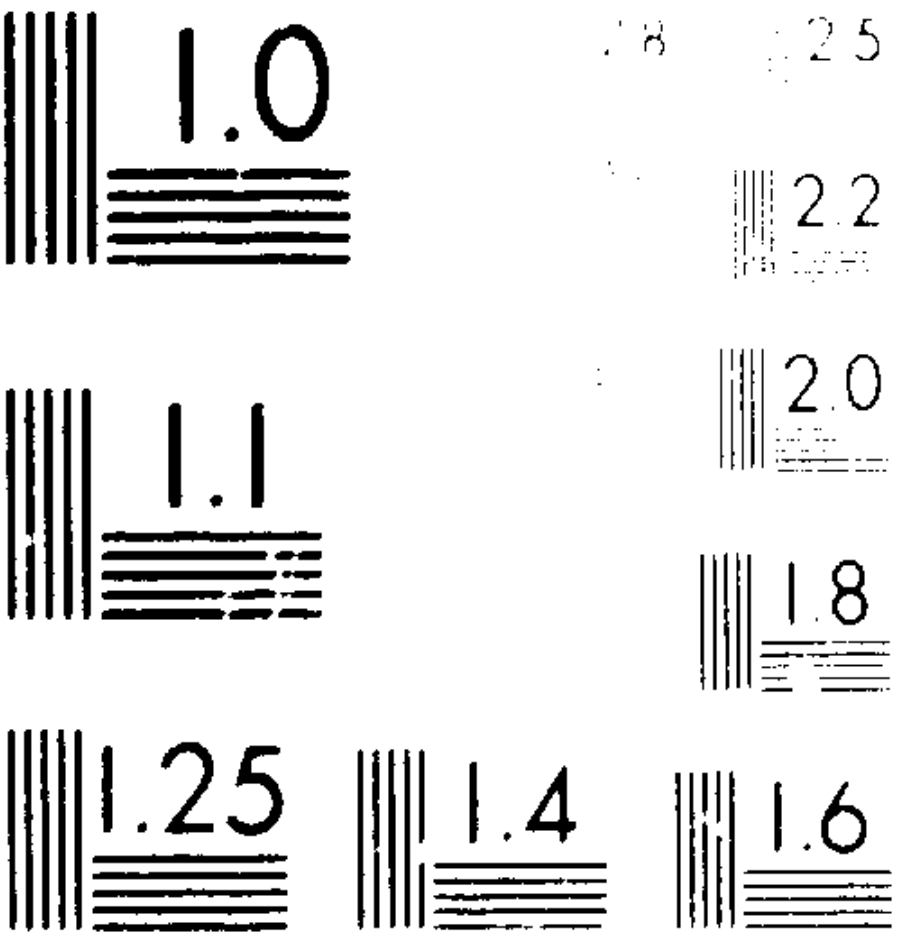
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INDUSTRIAL ADVISORY UNIT, PHASE II

DP/PDY/76/014

DEMOCRATIC YEMEN.

Technical report: Work-study applications in factories reporting to the Ministry of Industry *

Prepared for the Government of Democratic Yemen
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Giovanni Fankhauser, consultant in management, productivity and training

United Nations Industrial Development Organization
Vienna

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C O N T E N T S

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APPENDICES

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1 - SUMMARY

The Work Study programme discussed in this Report was carried out in early 1981 in P.D.R.Yemen (Aden Region). Originally planned as a continuous six month programme, it had to be subdivided for logistic reasons into two split-missions. The first one is discussed in the present Report; it was carried out by the author, who is hereinafter referred to as the "UNIDO Expert", or simply, the "Expert".

The general purpose of the programme was to bring Work-Study assistance to the forty-odd factories reporting to the Ministry of Industry. This being of necessity a long-term programme, the more immediate purpose was to make Government and industry acquainted with Work-Study philosophy and the techniques pertaining thereto.

This made it necessary to provide concrete evidence on some of the Work-Study aspects which could be of interest to the Yemeni economy, particularly as to the possibility of increasing the output of existing factories, while improving product quality and reducing accident risk. All this at a lower investment level than would be required by the classical approach, which concentrates on requesting additional production equipment, requiring additional factory space and additional skilled personnel. The latter aspect is particularly critical in developing countries.

Due to the limited duration of the total programme, and particularly of its first part, the Expert, assisted by Government Officials and by the Team-Leader of UNIDO's Industrial Advisory Unit, concentrated first of all on selecting possible practical projects : these had to combine a satisfactory success potential with the possibility of clearly understanding why and how success had come about. For this purpose the Expert first visited thirteen factories; his findings were then consigned to individual Audit Reports.

Based on these findings, Government selected seven of the factories visited for immediate or later Work-Study action, and

assigned to each one of them a priority number: first priority was assigned to the Aluminium Goods Factory in Maalla. It was, therefore, in that factory that the Expert, assisted by two Counterparts from the Ministry of Industry, started actual practical applications.

The findings from all the factories visited, as well as detailed results from the practical projects can be studied in the various Chapters of the Report and in the Appendix. It will suffice to state here that the first split-mission was successful and that it brought evidence about potential results from Work-Study application in Yemini industry. Practical projects indeed led to production increases in the range of 100 to 300% and more, in addition to improved product quality and safer working conditions.

In view of this, and knowing that Work-Study does not apply to industrial activities only, both P.D.R.Y. Government and UNIDO are interested in a continuation of the programme.

The Expert was asked to comment on the form and content of future UNIDO assistance in this field. He has, therefore, prepared a series of suggestions and recommendations which are to be found in Chapter 5 of this Report.

These recommendations refer first of all to the continuation of the actual practical projects according to the existing priority list. They also refer to training aspects which the Expert considers to be essential for balanced development of Work-Study action in P.D.R.Yemen. Some of this training can no doubt be imparted within the total programme time that is already envisaged for the next four years. Other training, however, will require additional man-months of specialised assistance. In the Expert's opinion this is essential to bring the "institution-building aspect" of UNIDO's assistance in the field of Work-Study to a sufficient level of impact and self-perpetuation.

However, assistance through transfer of knowledge requires not only additional participation by Experts but also the availability of a variety of equipment and material. This point is also discussed in some detail in this Report.

More information on all these aspects is to be found in the text of the Report and in the Appendices. Reference is also made there to frame-conditions which may theoretically impair the possible success of Work-Study applications, as well as efficient factory management in general. The Expert suggests, therefore, that an analysis be made as to whether factory management can be given more freedom of action; naturally within the limits set forth by the Board of Directors and as far as compatible with prevailing general rules.

Furthermore, the Expert suggests, among other things, that University curricula be submitted to a closer analysis with a view to finding new and faster ways of supplying industry with a sufficient number of specialists of adequate training level.

2 - INTRODUCTION

2-a) Brief review of industrial aspects in P.D.R.Y.

The People's Democratic Republic of Yemen (P.D.R.Y.) has at present some 40 manufacturing companies in actual operation which report to the Ministry of Industry; they are listed in APPENDIX I. Omitted from the list are non-manufacturing companies, such as the Public Electric Power Corporation and the Oil Refinery. Also omitted are those companies that report to other Ministries - such as the Fish Processing Plant in Maalla-Aden, which reports to the Ministry of Fisheries, and others.

The manufacturing companies reporting to the Ministry of Industry are broken down into three major groups (cf. APPENDIX I) :

- Public Sector (State owned) 18 factories
- Mixed Sector (majority stock held by State) 7 factories
- Private Sector (privately owned) 15 factories

The 25 factories in the Public and Mixed Sectors are responsible for the bulk of the total industrial output in P.D.R.Yemen. They also absorb more than 90% of the total industrial manpower (Management and Labour) in Democratic Yemen (cf. APPENDIX I). Furthermore they are totally supervised and guided by officials of the Ministry of Industry. It is understandable, therefore, that the productivity programme discussed in this report was limited at first to the said two groups of companies. Naturally, the know-how and experience gained through this programme will later flow into the Private Sector also.

An analysis of the industrial development in P.D.R. Yemen shows that the Ministry of Industry has been aware for a number of years of the need to increase the efficiency of

Yemeni industrial operations. It also shows that the Ministry has not relented in its efforts to introduce modern management methods, drawing from the experience of its own specialists and from the know-how offered by bilateral and by international aid, including that of UNIDO.

This endeavour led for example to declaring 1980 as "the year of healthy competition" for enhancing the productivity of all factories. This will also gradually lead to changes in the wage structure. Indeed, in the past wages were generally defined in fixed amounts per month, while in the future they are to be related to performance or to output.

Thus, all enterprises in P.D.R.Y. are required to submit proposals for piece-rate payment or other wage-incentive systems, and are currently engaged in determining suitable reference bases. In many cases so-called time standards will probably be used as a reference basis. Reliable time standards, however, require a close analysis of all conditions in the factory. Furthermore, they must be based on proper motion and time study, that is on Work Study.

In addition to this general productivity improvement programme for all Yemeni factories, the Ministry of Industry concentrated selective attention on seven factories. These were particularly interesting because their output did not fully meet demand. These companies, partly from the Public Sector and partly from the Mixed Sector, were (cf. APPENDIX I) :

(1) Aerated Water & Ice Factory
(2) Algundi Plastic Factory
(3) Aluminium Goods Factory
(4) Cigarette and Match Factory
(5) Foam and Metal Furniture Factory
(6) Paint Factory
(7) Textile Mill

These factories were declared to be "in competition" (and, in fact, they still are), meaning that they have been compared against their own performance in the past through evaluation of their overall performance. At the same time the Ministry of Industry introduced a non-financial wage-incentive system to reward meritorious management actions. This campaign has produced results and continues to be successful.

Nevertheless, and in spite of steady progress, a breach has remained in the efficiency of factory operations that can only be closed through Work Study. This had been recognised for some time by the present Team Leader of UNIDO's Industrial Advisory Unit, Mr. S.K. Desai, and has now led to the current programme. Its main lines are defined in the Job Description (cf. APPENDIX II).

What Work Study is, and how it can influence work efficiency and manufacturing costs, is described briefly in the following section.

2-b) Work Study : What it is and what it can do

Work Study is the general name covering all techniques utilized to increase production or to reduce labour cost, while leading to easier work and, therefore, to less fatigue for the operator. But Work Study also leads to greater work place safety, to improved product-quality, to simplified handling and storage and, often, to product simplification.

Work Study applies indiscriminately to all human work, including administrative and office work. In the present context, however, it refers essentially to industrial activities, both in the

fields of production and in maintenance and repair.

Work Study comprises essentially a methods' improvement aspect and a work-measuring aspect. The two are interrelated, each one utilizing a number of specific techniques to be applied selectively from case to case. These two aspects are also known under the names of "Methods Engineering" and "Time Study".

Work Study application leads ultimately to standardized work-methods and material handling. This is an essential condition for determining reliable time rates, that can be used for production planning and control purposes, as well as for controlling operators' performance, and ultimately, where desired, as a reference basis for the payment of wage incentives.

Contrary to Process or Manufacturing Engineering, Work Study does not concentrate on the choice of the manufacturing process or of the production equipment (machines and other items) that are needed to make a particular product; but on how such equipment should be used or improved to optimize results. This approach leads to a detailed analysis of all human activities related to a specific work place. This includes the detailed study of the operators' motions.

In many cases this also includes an analysis of the prevailing system, such as the organization structure, the forms, the factory layout, the material flow and other aspects. In turn this can also lead to changes being made in work places and in other items of production equipment, and in the system. These changes are often small in themselves, but can have a great bearing on productivity.

The same detailed methods' analysis, when applied to a group of operations such as a production line, can lead to better factory

layout and to improved material flow; and consequently, to lower "work-in-process" inventories and less product damage. It is therefore gradually being recognized that the Work Study phase must precede the layout study.

But there is another very important aspect of Work Study that must be stressed : and that is its "low-investment approach" to production management problems. Thus, whenever there is a need for increased production at reduced labour cost (be it on a temporary or on a long-term basis) the problem should first be analyzed with Work Study. Indeed, the Work Study solution is usually much cheaper and faster to implement than simply buying additional production equipment and providing space, shelter, manpower and maintenance to keep it going.

2-c) Duration of the current programme

The duration of the current Work Study programme has been set at six months, as shown in the Job Description (cf. APPENDIX II). However, for logistic reasons, it had to be split into two consecutive parts :

- a first part, that lasted two and a half months and that has now come to an end. It was handled by the author of this Report, hereinafter referred to as the "UNIDO Expert", or simply as the "Expert".
- a second part, that will be spread over the remaining time and will build upon the findings of the first part. This second part is due to start shortly, and will be handled by another UNIDO expert.

Obviously, a total duration of six man-months is too short to make a lasting impact on the industry of a whole country.

This is indeed a programme-duration that is customary in industrial countries to bring about first results in just one single factory.

The aim of the present programme must, therefore, be to orient the Government of the P.D.R.Yemen on Work Study techniques and philosophy as well as on the positive consequences its application will have on Yemeni industry ; both with a view to better satisfying local market needs and to better resisting pressure from imported goods that are frequently cheaper and of higher quality. Import restrictions may indeed be lifted sometime in the future, if the Regional Common Market becomes a reality as is planned.

The present Work Study programme must, therefore, concentrate on selected projects of limited scope that can be completed, if not totally implemented, during the available time. This was particularly the yardstick used by the author of this Report, whose task it was to get the project started.

In spite of the many logistic difficulties met by the author and by his two counterparts from the Ministry of Industry, their work was very successful. Indeed, after initial auditing of 13 factories, they were able to concentrate particularly on one of them (Aluminium Goods Factory in Maalla-Aden).

The results achieved will be discussed in detail in another chapter. But it can already be said that Work Study was applied to five operations on four different work places. This led to production increases in the range of 100% to 300%, and to corresponding time savings from 50% to 75%. Such results are naturally exceptional. But further above-average results should be obtained during the second part of the current programme. They will bring additional evidence of the role that Work Study can play in the Yemeni economy.

With reference to the duration of the present programme, it should be stressed that Work Study must be applied intensely over a period of several years to have a lasting impact on a country-wide basis. At the same time, this will require the participation of a sufficient number of counterparts, both from the Ministry of Industry and from the factories themselves. In turn, this will require the assistance of UNIDO Experts that can be estimated in man-years.

(N.B. A seasoned Work Study expert can simultaneously supervise 2-4 projects, if each one of them is manned by 2-3 competent counterparts).

2-d) A Word of caution

The information contained in this Report, as well as the conclusions and recommendations drawn from it, could have been influenced to some extent by the individual interpretation of the UNIDO Expert. Should this be so, it would be a consequence of the limited duration of the mission which made it impossible to verify all the data and information gathered in depth. However, any deviation in relation to actual facts will be unimportant, be it from the point of view of quantity, or from the point of view of quality.

2-e) Acknowledgements

It is important to realise that the data and general information reproduced in this Report, as well as the results from the practical projects discussed here, are the product of team-work. Indeed the Expert received very substantial help from all interested parties throughout the duration of the Work Study programme. The names of some of the people who contributed to the success of the mission are listed below.

a) MEMBERS OF THE GOVERNMENT OF P.D.R.Y. AND OFFICIALS - Aden

MINISTRY OF PLANNING

1) Mr. Abdul Saeed Abadan
   Deputy Minister

MINISTRY OF INDUSTRY

1) Mr. Salem Basabrain
   Assistant Deputy Minister
   Director of Planning and Statistics

2) Mr. Fadhle Hasson Yehia
   Assistant Deputy Minister
   Director of Production

3) Mr. Taher Bin Yaha
   Deputy Director of Planning

4) Mr. Ahmad Al-Attar
   Chief Counterpart, Industrial Advisory Unit

5) Mr. Abdul Rehman Daiban
   Acting Director of Technical Section, Department of Production

6) Mr. Ahmed Faraj - Counterpart
   Economist
   Department of Production, Technical Section

7) Mr. Saggaf A.K. Al-Junaid - Counterpart
   Engineer
   Department of Planning

b) MEMBERS OF THE FACTORIES - P.D.R.Y.

AUDITED FACTORIES - First and Second Governorate

1) The Directors General and other members of the Management teams of all the 13 factories visited.

ALUMINIUM GOODS FACTORY - Maalla (Aden)
(where practical projects were carried out)

1) Mr. Ahmed Mohamed Ali
   Director General

2) Mr. Ibrahim Abdo Saeed
   Director of Production

3) Mr. Al-Hashla
   Chief of Administration

4) Mr. Ohmar
   Production Superintendent

c) MEMBERS OF UNIDO

1) Mr. P.F.Ryan - Vienna
Industrial Development Officer
Industrial Operations Division/Feasibility Studies Section
(in the absence of Mr. Behrens, Head)

2) Mr. S.K.Desai - Aden
Team Leader
Industrial Advisory Unit

d) MEMBERS OF THE UNITED NATIONS DEVELOPMENT PROGRAMME (U.N.D.P.) - Aden

1) Mr. R. Reifenrath
Resident Representative

2) The Officials from the Programming Section

3) The General Staff

The Expert wishes to express his gratitude for the help given to him during his mission by the people mentioned above, and by many others whose names are not listed. This also includes the workers from the Aluminium Goods Factory in Maalla, drivers and other helpers.

The Expert is specially indebted to Mr. S.K.Desai, Team Leader of the Industrial Advisory Unit, for his constant assistance in professional and logistic matters.

The Expert is also grateful to Mr. A. Aziz, the Industrial Economist of the Industrial Advisory Unit, for his permission to reproduce in the Appendix the information he had formerly compiled on factories in operation in P.D.R.Yemen, and corresponding employment figures.

The Expert wishes furthermore to thank his counterparts for their willingness to co-operate, even at times when the success of the practical projects was still far ahead and did not seem to be totally assured.

3 - FINDINGS

3-a) Breakdown of the activities of the Expert

It has already been said that the P.D.R.Yemen has some 40 factories in operation which report to the Ministry of Industry and which are broken down into three major groups: public sector, mixed sector and private sector (cf. APPENDIX I).

As previously mentioned, seven of these factories, some from the public and some from the mixed sector, were declared to be "in competition", i.e. their present performance was to be improved upon comparison with achievements in the past (cf. APPENDIX I). This implies that the Government pays special attention to their overall performance; in fact it introduced a special non-financial incentive to reward meritorious management actions. However, the Government is greatly interested in raising the productivity level of all factories in P.D.R. Yemen, hence the current Work Study project. The frame for this project is set by the "Job Description" that defines the main activities of the Expert (cf. APPENDIX II).

The first task of the Expert was to find suitable practical projects of limited duration, that could be completed during the time available for the total programme. Furthermore, these first projects had to be convincing in their results, and sufficiently clear in the logic of the improvement process, to show to interested parties what Work Study is and what it can do for Yemeni industry. The present programme can indeed be considered to be an ice-breaking programme for the future large-scale application of Work Study in P.D.R. Yemen.

This made it necessary for the Expert to visit first a number of factories to audit present conditions, assess the chances of success in general, and select a number of work places or operations that could be proposed to the Government for initial Work-Study applications. The Expert finally visited 13 factories situated in the Aden region (First and Second Governorates) that are listed in APPENDIX III.

For each factory visited the Expert wrote a short audit report; these are to be found at the end of the present report, for further reference (cf. APPENDICES VII-1 to VII-13). These reports, while still incomplete, were submitted to the Ministry of Industry in order to establish a list of priorities for Work-Study applications. This resulted in the selection of 7 factories, the names of which are reproduced in APPENDIX IV, in the same order as set forth by the Government.

As expected, the auditing phase proved to be an essential part of the whole programme, even though it had been rather time-consuming (partly due to logistic problems). Therefore, in order better to appreciate the amount of work involved in the auditing phase, by itself and in comparison to the other phases of the programme, it will be worthwhile to examine the breakdown of the main activities of the Expert during the whole development project, as reproduced in APPENDIX V.

A closer study of said Appendix shows the following breakdown for the 75 days of the official contract duration:

No.	GROUP OF ACTIVITIES Description	DURATION Days	%
1	Preliminaries (Europe & P.D.R.Y.)	5	6.7
2	Auditing of factories and determination of priorities for Work-Study applications (P.D.R.Y.)	23(*)	30.6(*)
3	Practical W.S. projects (P.D.R.Y.)	39	52.0
4	Closing phase (P.D.R.Y. & Europe)	8(**)	10.7(**)
	TOTAL	75(**)	100.0(**)

N.B. For more details consult APPENDIX V

*) Plus about 10 full days for completing the audit reports (spread out over three calendar weeks of evening and week-end work).

**) Plus about 60 full days to write the present report (outside and in addition to official contract duration).

The bulk of the activity of the Expert was, therefore, devoted to "Auditing" (30.6%) and to "Practical Work-Study Projects" (52.0%), overtime being additional. It is relevant to note how much time had to be invested in "Auditing" and related matters to build a safe base on which the result-bringing project phase could be started. This is valuable information in view of possible future development programmes of a similar nature.

3-b) General findings from the audited factories

3-b1) Introduction

The Expert visited 13 factories between 3rd February and 12th February 1981 (cf. APPENDIX III); each visit lasted a few hours. In some cases the visits had to be split in two or three parts, because a particular member of the Management Team was not available at the time of the first visit, or because there was a need for additional detailed information.

The main purpose of these visits was to find out whether there actually was a need for Work-Study in the individual factories, and whether there were suitable possibilities for limited initial projects in this field. Also to gather information on the wage-incentive system already in use, if any. However, the auditing was not limited to these points and covered, within the available time, the whole field of production as well as general aspects of the company.

It has already been mentioned that the audit reports are reproduced in APPENDICES VII-1 to VII-13. For easier analysis, all reports are standardized and represent the same basic pattern.

Clearly, the reader who wishes to obtain closer information about a particular factory must consult the corresponding audit report in the appendix. However, since all reports were prepared along the same lines, to allow for easy comparison, one might ask whether all 13 factories were characterized by a common general pattern that would allow for a common diagnosis and perhaps for a common healing process for all of them.

The answer is, unfortunately, no. Each factory has different problems that require different solutions. However, the audit showed that there was a series of shortcomings present in several factories, that could therefore be considered typical for industrial operations in Democratic Yemen, if not for all business operations. (It must be repeated here that the Expert visited 13 factories only, out of the 40-odd factories reporting to the Ministry of Industry; and that, furthermore, the latter figure does not cover all industrial operations in P.D.R.Yemen.)

A few of these typical shortcomings are discussed below. They are mere examples, and the list is not exhaustive.

3-b2) Inadequate marketing

Complaints about inadequate marketing are fairly general. If they are justified (the Expert had no opportunity to make a close analysis), then it might be worthwhile to look for basically new solutions. One solution could be to hand over the total responsibility for marketing and sales to factory management; this would also include the responsibility for success or failure.

This problem is mentioned here because marketing is the starting point for both product development and production planning. Marketing is therefore responsible to a great extent for the overall results of an industrial enterprise. Factories in P.D.R.Yemen will be no exception to this rule.

3-b3) Inadequate Maintenance and Repair

Efficient manufacturing operations in Yemeni factories are hampered by old production equipment that, in many cases, is also in poor condition. Furthermore, factories can find it difficult to carry out repair work, since their workshops are of insufficient capacity and, generally speaking, ill-equipped. Moreover, there is an acute lack of spare parts and of consumption material. And finally, there is also an acute lack of handtools, which is a heavy burden on maintenance operations. (The lack of adequate handtools also impairs material handling and storage, leading for example to the most primitive and time-consuming methods for opening shipment boxes.)

-- This is a field in which fast and thorough action is needed. It is not acceptable that expensive production equipment remains idle or under-utilized because of lack of minimum-cost items. One possible solution could be to hand over the whole handtool business (import and sales) to the private sector.

Thus, maintenance and repair are certainly crucial problems for Yemeni industry. The Expert is of the opinion, however, that these areas have drawn too great a share of Management's attention in the past, to the detriment of other production aspects of at least equal importance, such as Material Handling, Work Methods and Tool Design, Production Control, Quality Control and others. Therefore, Maintenance and Repair have unconsciously become an alibi for not recognizing those other problems that could put P.D.R.Yemen industry in an uncomfortable situation if import restrictions were to be lifted in the near future.

3-b4) Inefficient material handling and storage

Shelves, pallets and containers are almost totally absent. This makes storage of raw material, semi-finished and finished parts difficult. It also makes in-plant transportation difficult, leads to disorderly workplaces and to congested production departments. Moreover, it leads to increased damage risk, makes production control difficult and tends to increase work-in-process inventories.

This is one of the priority problems within the long-range Work-Study programme in P.D.R.Yemen; the more so since it has not yet been fully recognized as such. Indeed, so far, the above-listed short-comings were believed to be caused essentially by poor factory layout, which is only partly true.

3-b5) Poor work methods and insufficient quality-thinking

This problem had been recognized for some time by Mr. S.K.Desai, present Team Leader of UNIDO's Industrial Advisory Unit, and has led to the present Work-Study programme.

Work methods are indeed generally inefficient. In some cases this is due to inadequate training of the operators or to inadequate supervision. In most cases, however, it is due to poor utilization of available machines and equipment, as a consequence of lack of know-how.

Lack of know-how also results in the almost total absence of adequate auxiliary devices, like guides and stops, jigs and fixtures,

and others. This not only slows down production, but also leads to inconsistent dimension of the parts and, therefore, to poor dimensional quality. In turn, this causes additional work to make parts fit. It also makes modern assembly methods impossible.

In addition, the finish of the products is frequently unsatisfactory. This is clearly a consequence of lack of competition, resulting in insufficient quality-thinking. The quality-thinking also suffers from a lack of reference specifications, such as dimensional drawings and work-instruction sheets, and partly also from inadequate organizational solutions.

3-b6) Lack of time standards

There are no time standards based on time study in P.D.R. Yemen. Production planning and control, as well as wage-incentive payment (where applicable), must rely, therefore, on estimates, historical data or on information provided by equipment manufacturers. Available data are therefore of little value for efficient production management, and reliable time standards have yet to be developed. The present Work-Study programme is the first step towards this goal.

Hasty action, however, could be prejudicial. Time standards are valid only under given conditions such as: standardised transportation to/from the work place, raw material and semi-finished parts of consistent dimensions and quality, and other aspects. Changes in the reference conditions must reflect in the time standards, especially when they are used as a basis for wage-incentive payment (cf. APPENDIX VIII).

Time standards must, therefore, be "maintained", or they deteriorate sooner or later. Moreover, they must be administered properly, and naturally, they must have been determined correctly. This implies that the work-methods and the work places have first to be analyzed and standardised, and improved where necessary, and the operators trained in the new methods.

All these aspects require adequate organizational solutions that can also lead to changes in the organization chart. It is obvious that such changes would have to be built up on a careful analysis.

3-b7) High risk level for factory personnel

At present, accident risk is very high through lack of shields for belt-drives and moving machine parts; through lack of safety devices on shearing-machines and punch-presses (where installed, they are often short-circuited); through lack of screens to protect operators and other workers from flying chips and welding sparks; through non-wearing of goggles when sharpening cutting tools; through crowded factory floors that can lead to falls, or to injury through falling parts; through electrical distribution- and safety-panels that are not easily reached in case of emergency, since access is hindered by piles of material; and through other causes.

Obviously, accident prevention has not received the necessary attention in the past. One reason may be that individual accidents do not seem to have a great bearing on overall factory results. Another likely reason is that accident hazards are simply not recognized as such by supervisors and by the work force.

Still, the problem of safety cannot be neglected any longer, both for humanitarian reasons and out of the desire to maintain good relations between Management and labour, as well as to protect the factory against personnel losses that could deprive it of special experience or know-how. There are, therefore, several reasons why Management should pay close attention to this field.

In those factories that are or will be included in the current or future Work-Study programmes, accident hazard will be gradually eliminated, since Work-Study application always includes safety considerations. In the other factories Management should start an accident-prevention drive on its own, eliminating gradually all potential accident sources.

Health risks, on the other hand, seem to be in general on a lower level. This does not apply to welding operations, where there are no fume-exhaust installations to protect welders and co-workers. Nor are there any screens to protect co-workers from exposure to strong light which can lead to permanent eye damage.

Lack of fume-exhaust systems was also noted in connection with painting operations in general, as well as in factories utilizing chemical products, as in paint manufacturing and others. In other factories a similar problem existed in relation to dust.

Fumes and dust can give rise to insidious diseases. Management should take corrective action as soon as possible.

3-b8) Lack of technical staff

P.D.R.Yemen industry has a number of capable top- and medium-level managers and a work force that is, on the whole, dedicated and capable. Possibilities for improvement through participation in training courses certainly exist, just as the need for acquiring additional know-how. However, this holds also true, though to a lesser extent, for the managers and work force in industrialised countries.

The picture is totally different with regard to medium-level staff. Thus Yemeni industry suffers from a severe lack of specialists of all kinds, such as:

- assistants for chemical laboratories
- product designers
- tool designers (at first for auxiliary production equipment)
- draughtsmen (to assist designers)
- time-study men
- manufacturing specialists (to determine the manufacturing process and to prepare work-instruction sheets, etc.)
- and others.

In Yemeni industry such technical staff hardly exist. This makes it impossible for Management to get the most out of the existing production equipment and the available work force. This situation is typical of the early stages of industrial development, when factories are manned by a few managers, some foremen and many workers.

Yemeni industry has now reached the point where it must reduce the number of its workers, at least in percent of total manpower, and greatly increase its medium-level technical staff. This will allow each specialist to concentrate totally on a particular task until it is completed. At present, a few high-calibre engineers have to spread themselves thin on many problems, consequently often with modest results.

Unfortunately, this immediate need for additional medium-level technical staff is confronted with the reality of available talent. Yemeni schools simply would not seem to be in a position to "produce" them fast enough.

-- At present, general education is compulsory up to the age of 16. In further alternative steps, intermediate technical training (e.g. to draughtsman-level) is completed at the age of approximately 20, while full engineering training of University level is completed at approximately 25 years of age.

The present educational system is ambitious for a developing country but certainly in line with long-range needs. However, it may not be able to satisfy short-term needs quickly enough. The Expert suggests that it might be possible to introduce a transitory solution that might last a few years only and that would provide for an interruption in University training after completion of the second year. The "junior engineer" would then work for a period in industry as a designer, draughtsman or in another capacity. In this way he would help Yemeni industry, while gaining practical experience that would be valuable to him upon returning to University.

Additionally, or alternatively, the Expert suggests that, for quick availability of lower-level technical staff, talented workers from different factories should be trained to handle specialized functions, e.g., as technical draughtsmen or as laboratory technicians. Training would be imparted in intensive ad hoc courses, lasting from several weeks to some months, naturally full-time and excluding all other activities. Moreover, there should be some follow-up "on the job" to assist the trainees in their new work after they have returned to their factories.

If such a training programme is properly organized - and the Expert knows that it can be done - it will be successful and bring a great relief to Yemeni industry. Moreover, it will bring new professional satisfaction to those workers who, in their younger days, had decided to discontinue their education, but who would now like to have a greater challenge in their day-to-day work.

During the auditing phase and while carrying out the practical projects, the Expert came across workers that would seem to fit into this picture and who would probably be eager to co-operate.

3-b9) The language barrier

During the auditing and the practical phase the Expert met a rather high number of Yemenis who spoke no English, or very little. While this had no influence on the quality of the final results, it certainly reduced the effectiveness of communications.

In view of the importance today of English in international communications, especially in the industrial and scientific field and for technology transfers, and also in view of the exceptional geographical location of P.D.R.Yemen that seems predestined as a major link in international relations, the Expert would like to suggest that the knowledge of English be spread more intensively among the officials of the Ministry of Industry and among factory representatives.

While there are several methods of learning the English language, it may be worthwhile to mention the "total immersion" system, which is recommended when fast results are needed.

3-c) Specific findings from the audited factories

3-c1) Introduction

For detailed information on the factories visited the reader will refer to the audit reports in APPENDICES VII-1 to VII-13. In this section he will find additional information and comments on some factories and specific subjects.

3-c2) Tomato Paste Factory

a) Introduction

This factory has a series of problems that are dealt with in APPENDIX VII-13. These problems mainly concern handling and storage, as well as quality aspects. Additionally, there is a problem of excessive cost resulting from seasonal activity, since the supply of tomatoes is limited to four months per year, between December and March.

So far, the following steps have been taken to reduce overall labour cost:

- Diversifying production through the addition of a processing and packing line for canned vegetables.
- Utilizing production workers during low season for light maintenance operations, essentially cleaning.
- Manufacturing a part of the tins during the low season and storing them until high season.

These steps deserve some comments.

b) Product diversification

Product diversification has failed and corresponding equipment is to be dismantled. This is the result of inadequate marketing and the inability to master the technical process and raw materials supply (perhaps in combination with an inadequate choice of the production equipment).

The Expert is not in a position to comment on the marketing aspect. The second aspect is in keeping with the difficulties experienced in mastering the production of the tomato-paste line, which in turn is due to lack of qualified technical staff. Under such circumstances,

getting into an additional production line was equal to "escaping forward"; this is a philosophy which usually leads to failure.

c) Utilization of excess labour during low-season

Participation of the work force in light maintenance work during low season is praiseworthy and useful. However, the number of man-hours involved is not great enough to bring a sizable relief on total labour cost, which depends essentially on peak load during high season. The only really effective solution will therefore be to streamline operations in high season, so as to reduce the corresponding number of workers.

d) Manufacture of tins ahead of packing season

Manufacturing a sizable part of the tins during low season and keeping them in store until needed for packing the tomato paste in high season, is a good production-planning technique for reducing peak load and, therefore, total work force. Its disadvantage lies in the field of quality, since the tins, in spite of precautions, remain exposed to soiling during an extended period. Moreover, information on leakages due to poorly assembled tin bottoms would be fed back too late for corrective action. This production system has therefore to be reviewed.

e) Summary

Summing up the foregoing, the whole manufacturing process for tomato paste must be reviewed with the aim of manufacturing the tins at the time they are needed, while reducing labour cost. At the same time, this new method must satisfy all requirements of increased quality, simplified material handling and storage, as well as lower work-in-process inventories. Furthermore, the one-week storage for filled tins, introduced to control them for leakage when they come off the filling line and prior to packing them into shipment boxes, must be totally reorganized for lower cost and more efficiency. Chapter 5 contains specific recommendations on the application of work studies.

First analysis during the auditing visit showed that this problem can be solved to a large extent through Work-Study application. It showed also that it could be advisable to introduce additional changes in the production process, such as :

- a quality control at the receiving end, possibly combined with a differentiated purchasing price according to tomato quality;
- a strengthened quality control at the beginning of the paste-making line in order to eliminate rotten tomatoes;
- and possibly also, a frozen-storage installation for fresh tomatoes or a tank for tomato paste to spread the packing operation over a longer calendar period.

The possibility of introducing a "waste-recovery process" for peels and seeds should also be analyzed.

3-c3) Aluminium Goods Factory

a) Introduction

This factory has a series of problems that are mainly related to work methods, material handling and storing, product quality, safety, the difficulty of buying spare parts (locally or abroad), as well as to maintenance and repair. These problems are already discussed in detail in APPENDIX VII-3; it is shown there that some of them are of rather an acute nature. Therefore, the fact that this factory makes a positive overall impression is due exclusively to the fact that it has a resourceful Management team down to shop floor level, and a good work force that keeps production going at a steady pace.

This factory headed the priority list prepared by the Ministry of Industry (cf. APPENDIX IV) for Work-Study applications and was, naturally, chosen for the first practical projects that were started on 23 February, 1981. The results will be discussed in the next chapter; it can be said here that they were very favourable.

In-depth analysis relating to the practical projects uncovered more problems than already known from the auditing phase. They are discussed below.

b) Assembly methods

Modern assembly methods, such as two-handed set-ups for simultaneous assembly of two parts, cannot be utilized because of inconsistent part dimensions. Closer analysis showed that this is not basically a problem of poor maintenance and repair of machines and tools (which aspect is simply additional), but is caused by:

- lack of tooling equipment, such as jigs and fixtures, stops and guides, etc.; and/or
- inadequate design of the tooling equipment.

The last point is particularly true of the dies for punching small parts, like hinges, latches and the like. The problem is particularly acute with parts provided with holes that could be used as reference for assembly operations. Indeed, the relative position of the punched hole can vary by a few millimeters between consecutive parts coming out of the same die, which should not happen.

The quick replacement of the present dies by new dies of modern design is therefore absolutely essential. In the opinion of the Expert, die-making is a high-technology field. The Expert recommends, therefore, that the new dies be purchased from first-class industrialised countries.

Furthermore, in time some of the handpresses for punching small parts will have to be replaced by modern machines. At such time, it could also be investigated as to whether punching from short strips should not be replaced by continuous punching from imported coils of aluminium tape.

An equally urgent problem is that related to the two shearing machines. They are not provided with holding bars for pressing down the aluminium sheet before the cutter blade comes into action. As a consequence, the edges of the cut strips are bent and this is unfavourable for subsequent punching operations.

-- Within the frame of the current Work Study programme one of the two shearing machines is now being equipped with a "home-made" holding bar.

Furthermore, the cutting quality is extremely poor. The edges of the cut strips are very irregular, which is bad for proper strip guidance in subsequent punching operations. Moreover, they are likely to cause injuries to the press operators. Shearing machine cutters must, therefore, be completely re-ground. (If done locally, then by the Agricultural Implements Factory.)

The poor quality is due to the fact that the two shearing machines are used indiscriminately for cutting relatively soft aluminium sheets and strips, as well as aluminium wire of a harder quality. This influences the condition of the cutter-blades and, therefore, also the "finish" and appearance of cut edges.

Cutting of large-size aluminium sheets causes, indeed, an even distribution of wear on the whole width of the cutter-blade, resulting in cuts of neat appearance. On the other hand, cutting to length of aluminium strips (=transversal cutting) will lead to locally concentrated wear of the cutter-blades (wear-spots). When strips are cut out of soft material, this wear will not be excessive and subsequent cutting of sheet-metal will still result in cuts of acceptably neat appearance.

The situation changes when cutting aluminium wire used to manufacture milk-can handles. This is a considerably harder material which leads to a high pressure on a limited part of the cutter-blade. This causes, therefore, a locally concentrated wear of the blades and leads eventually to blade damage through chipping off. When subsequently cutting aluminium sheets with chipped blades, this will result in cuts of poor appearance and even in strong burrs that are disturbing for further operations.

In the course of the practical projects it was, therefore, decided with Production Management that one of the shearing machines should be reconditioned and then only utilized for cutting soft material, while the other one should be reserved for cutting aluminium wire: at least until a special machine could be developed for this purpose.

-- It might then even be possible to combine this new machine with some of the other operations required to manufacture milk-can handles, and make it work more or less automatically.

While visiting the Foam and Metal Furniture Factory in Al-Durain, the Expert had had the opportunity to see a small multi-purpose machine that was used to process corner-irons for bedframes (cutting to length,

punching holes, etc.). It occurs to the Expert that such a machine, with perhaps some adaptation, might be ideally suited for cutting aluminium wire, too.

The Expert would, therefore, like to suggest "a posteriori" that his counterparts carry out a cutting test with alu-wire at the Foam and Metal Furniture Factory, when a suitable opportunity occurs. If successful, they could then investigate the possibility of acquiring such a machine for the Aluminium Goods Factory, thus freeing one of the two shearing machines for other purposes.

Reverting to the lack of consistency in part dimensions, it must be said that this problem is also present in the melting section. This concerns several small parts, like beaks and knobs for tea-pots, as well as some components of hinges. The cause for dimensional inconsistency can be twofold:

- duplicate moulds are not of identical dimensions; and/or
- mould components present too much clearance, partly through inadequate design and partly through wear.

The second aspect also leads to large casting burrs and, therefore, to a great amount of subsequent trimming, which is very costly.

The Expert was told, however, that there are plans for setting up a totally new melting section. For this reason casting and trimming operations do not seem to deserve priority attention in the frame of the current Work-Study programme.

c) Dimensional inconsistency of parts

Analysis of the dimensional inconsistencies discussed above made it desirable to compare actual dimensions with official reference data. This led to the surprising discovery that this factory has never used any drawings ("blueprints") in the thirty odd years of its existence. Therefore, there is no reference basis whatsoever for dimensions and acceptable deviations.

Thus, until now, everything was done, so to speak, in the artisan way. When a die was needed, the usual procedure was to give a rough sketch or a handmade sample to a local craftsman. He then took the responsibility for building the die, naturally according to his own interpretation of dimensional accuracy and adequate die design. That results could not be in line with internationally accepted standards, has already been shown. Obviously, reliable dimensional drawings of the parts are indispensable for ordering dies and other manufacturing equipment as well.

Moreover, the lack of part drawings also means that it will not be possible, in due time, to install a formal quality control system, because the reference basis is missing. It will not be possible either to build and utilize simple "Go/Not-Go" gauges.

Furthermore, drawings are also the source of reference information for material procurement and, therefore, for inventory control in relation to production planning. They are also the starting point for work instructions (process sheets, manufacturing times, etc.). This aspect will be felt acutely when more sophisticated or more complex products are added to the manufacturing programme.

It should be clear by now that the Aluminium Goods Factory is in bad need of drawings, both of components and of assemblies. And that it needs, therefore, one or more draughtsmen to prepare these drawings in a reasonably short time, ideally in one or two years.

This means that the corresponding drawing programme has to start as soon as possible to be effective. But it also brings up again the problem of the availability of reliable draughtsmen; and, therefore, the priority need for accelerated large-scale training of medium-level technical staff.

d) Production figures

Production figures are difficult to obtain. Up to last year, those which were available showed total weight of parts produced per month or per year; but, unfortunately, these were not broken down according to the different sizes of parts. It is, therefore, practically impossible to determine accurately the number of parts of each type and size manufactured in 1980. Early 1981 production figures are available in number of parts, but again they are not broken down according to size.

This makes production planning and control in the classical sense difficult. It can also impair the correct working of a wage-incentive system. Furthermore, it makes it difficult, if not impossible, to carry out feasibility studies for new equipment that may be needed to improve the manufacturing process. This was substantiated within the frame-work of the current Work-Study programme. Moreover, it led to a very considerable loss of time for the Expert and his two counterparts.

e) Anodizing installation

A few years ago a complete anodizing installation was bought to colour selected products and give them more sales appeal; also, a new building was erected on the factory premises to house the new equipment. However, the new production line has remained idle ever since, plagued by numerous technical problems. Obviously, the corresponding investment has not brought the expected results.

Aspects related to this project have already been thoroughly analysed by the Industrial Advisory Unit. First by Mr. A. Aziz, Industrial Economist, and later by Mr. K.P. Mahalingham, Plant-Engineering specialist. Their findings are contained in reports that were submitted to Management and to the Ministry of Industry.

It is not the Expert's intention to bring up again this problem as such. He merely feels that this problem, and others, could probably have benn solved in a shorter time had it received permanent professional attention by medium-level technical specialists, having their office in the new building and headed by an engineer from the Ministry or from the factory.

This again brings up the problem of lack of technical personnel and the need to speed up their training, at least for the medium-level group. If this goal cannot be achieved sufficiently rapidly, the Government could then be faced with the necessity for alternative actions, such as :

- reduce industrial growth rate and concentrate on a limited number of selected factories that would be adequately staffed and that would be brought into top operational conditions;
- hire specialists from industrialised countries;
- go into joint ventures with foreign companies that would supply know-how and make available an adequate number of technical staff.

3-c4) Foam and Metal Furniture Factory

The various problems of this factory are discussed in some detail in APPENDIX VII-7. One of them refers to the lack of space in the

present premises that forces the factory to move to a new location. The new building is already planned and construction work should start in about one year.

The Expert shares the general opinion that the present premises are limited and that the plant layout is poor, especially with regard to storage space. He is of the opinion, however, that the main problems should be solved before moving, since the mere fact of moving operations from one building to another does not improve them; just as a patient does not recover if the treatment is limited to transferring him to another hospital.

Thus, it must be stressed once more that a new layout should be developed "around" improved work methods and "around" improved material handling and storage to accommodate them. The reverse procedure that develops the layout and then squeezes improved operations into already fixed walls, necessarily leads to amputated results.

The unique opportunity offered by the construction of a new building for the Foam and Metal Furniture Factory should, therefore, be seized to prove beyond doubt that plant layout is not a purpose in itself, but just a design system for efficient accommodation of optimised solutions. Plant-layout development must, therefore, come after a Work-Study applications programme.

With this approach the return on investment will be much higher than with the usual approach, and operations will run more smoothly, once production has started. The new Foam and Metal Furniture Factory can bring conclusive evidence of this fact.

3-c5) Wage-Incentive Systems utilized in the visited factories

The Expert included this point in his investigation because a recent law requires all factories in P.D.R.Yemen to introduce wage-incentive payment, and because this point is also referred to in the "Job Description" (cf. APPENDIX II).

The information gathered on this subject during the plant visits was quite interesting, but it would not be worthwhile reproducing

it here in detail. It is interesting to know, however, that each factory has total freedom in the choice of an adequate wage-incentive system to suit prevailing conditions that may vary with the size of the factory, the type of products or other factors. Consequently, the Expert met with a variety of wage-incentive systems.

The situation can be summed up as follows:

- One factory is in the process of introducing a wage-incentive system for all workers based on time standards (Aluminium Goods Factory).

- One factory has a non-financial incentive system that allows the workers to leave the factory premises after completing their task, or to reduce the number of hours of presence in case of low work load (Agricultural Implements Factory).

- One factory will not introduce a wage incentive system so long as its workers refuse, though indirectly, to perform other work during machine time, such as deburring the parts made during the previous machine cycle (Algundi Plastic Factory).

- One factory pays wage incentives to a few workers that are chosen periodically by their co-workers in open assemblies, based on a personal and essentially subjective appreciation by the group (Tomato Paste Factory).

- One factory employs a differentiated wage-incentive system that offers a very high bonus to a small group of workers who handle unpleasant and dirty work (*), and a low bonus to the other workers (Tannery).
  *) The compensation for dirty work would be better built into the base wage and not into the incentive.

- A few factories have sophisticated wage-incentive systems based on actual total production (usually per department), versus installed production capacity, with bonus payment starting at a given utilization level, e.g., 70%, determined by Management (Textile Mill and others). Utilization assessment is absent and should be made into an important criterion.

It is also interesting to know that the bonus, in case of financial incentives, is calculated throughout on a per-month basis and is paid out usually in the first week or ten days of the following month, i.e. separately from the base wage that is paid at the end of each month.

An essential characteristic of good wage-incentive systems is that they are correctly designed and administered, and fair. This presumes, among other things, that the bonus paid is consistent with the effort expended by the workers. The Expert had no time to check "bonus-versus-output" statistics and other aspects related to the application of the wage-incentive systems met in the different factories. He is, therefore, not in a position to comment on the intrinsic value of these systems. Closer analysis, however, will be carried out in those factories that will be participating in the Work-Study programme.

To close this section, a general comment is offered for the benefit of those factories that are still in the process of introducing a wage-incentive system, especially if based on time standards. It is good practice to introduce first the performance-control system and to "break it in" during one or two years in order to test all its aspects and to eliminate possible errors. Actual payment of a bonus should start then only. This will avoid errors in the performance-control system or in the time standards, which would have a negative effect on the wage-incentive system and make it unacceptable to the workers (cf. APPENDIX VIII, Point C).

4 - ACHIEVEMENTS

4-a) Audit phase

The present work study programme made it necessary to carry out an audit phase that highlighted 13 factories: 9 of them came from the Public Sector and 4 from the Mixed Sector (cf. APPENDIX III).

The audit was carried out with the purpose of finding limited projects suitable for initial Work-Study application, and subsequently to select one factory in which, despite the short time available, the productivity-improvement programme could be started with some chance of success.

The auditing process is already described in Chapter 2 ("Findings"). It will suffice to mention that the audit was not limited to the Work-Study angle but could explore a variety of factory problems. This in turn led to the uncovering of an array of interesting facts, some of them surprising.

The Expert found it therefore, useful and necessary to prepare a short Audit Report for each of the factories visited, as reproduced at the end of the present Report (cf. APPENDICES VII-1 to VII-13). No doubt, these Audit Reports will be of value to anyone who will deal with the audited factories in the future. The preparation of the Audit Reports must, therefore be considered as one of the major achievements of the present Work-Study programme.

4-b) Orientation effect

When confronted with the need to increase production, the usual reaction of a factory manager is to request additional manufacturing equipment, and more workers. The thought that Work Study might be a valuable alternative will usually come second and then only when budget limitations force the manager to look for a cheaper solution. It is indeed more comfortable (and results are easier to anticipate) when concentrating simply on the acquisition of additional equipment.

-- Obviously, in those cases where there is an immediate need for a large production increase, the acquisition of additional production equipment is unavoidable. In many cases, however, the Work-Study solution makes it possible to bridge the production gap until the time when the market pressure becomes very strong. Corresponding investments can then be postponed to more favourable times.

This attitude is typical of industrial countries, where Work Study has been successfully applied for over half a century. Undoubtedly, it will be even more pronounced in developing countries where managers, on the whole, have not yet been exposed to Work-Study philosophy.

In recognition of this fact, the Expert did not concentrate exclusively on getting practical results. He therefore devoted much of his time, both during the auditing visits and during the practical phase, to explaining to the factory representatives and to his counterparts from the Ministry of Industry why he proceeded in a particular way and why certain things had to be done. In other words, the Expert taught the people he was connected with how to look at operations through "Work-Study glasses".

This required a continous effort on the part of the Expert, and was very time-consuming. However, it was a good long-term investment, since the people concerned began to look at operations in a different way. --- No doubt, it would be more accurate to say that this orientation effort brought "first" results. A continued and intensive orientation and demonstration effort will indeed have to be deployed on a national level to bring about indelible marks.

Now the first step has been made, interest has been awakened. Some representatives from Government and from industry have started to recognize what Work Study is and what it can do for Yemeni industry, and are now keen to see results on a broader scale. Therefore, seen from the orientation angle alone, the audit phase was successful and must be counted among the achievements of the present Work-Study programme.

4-c) Practical results

Practical projects were carried out at the Aluminium Goods Factory in Maalla (Aden). They concerned a number of diversified operations and were very successful. Results are listed in condensed form in APPENDIX II. They are discussed below in more detail.

PROJECT No.1: Manufacturing of handles of different sizes for milk-cans from alu-wire of different diameters.

This project was completed and is ready for implementation through the factory's Maintenance and Repair Department (probably assisted by the Revolutionary Workshop). --- This project concerns three operations carried out on three different workplaces. --- With the improved method the number of operations is reduced to two; they are carried out on two workplaces. Results from the improved method (average values for all handle sizes) are as follows:

a) Time saving:	approx. 50 %
b) Production increase:	approx. 100 %

The above results are based on the following total time standard per handle (average value for the different sizes):

- present method:	approx. 0.016 h (= 0.96 min.)
- new method:	approx. 0.008 h (= 0.48 min.)

N.B.: Production forecast for 1981 corresponds to about 40'000 handles of various sizes.

PROJECT No.2: Cutting alu-sheets (approx. 1220 x 610 mm) into strips of different widths to be utilized in punch-press operations.

This project was completed and is ready for implementation through the factory's Maintenance and Repair Department (probably assisted by the Revolutionary Workshop). --- This project concerns two operations carried out on one workplace. --- With the improved method the number of operations is reduced to one. Results from the improved method (average values for all strip-widths) are as follows:

a) Time savings:	approx. 75 %
b) Production increase:	approx. 300 %

The above results are based on the following total time standard per sheet cut into strips (average value for the different strip-widths):

- present method:	approx. 0.120 h (= 7.2 min.)
- new method:	approx. 0.030 h (= 1.8 min.)

N.B.: Production forecast for 1981 corresponds to about 1'250 alu-sheets. cut into strips of various sizes.

* * *

Important: At present, the alu-sheets are cut transversely, resulting in strips of 610 mm length. This procedure has been maintained with the new method, since the present working conditions related to the subsequent punching operations (due to design of the dies, and consequently also to their orientation in the punch-presses) would make it difficult to work with longer strips.

However, when new dies are available, this limitation will be eliminated. The alu-sheets can then be cut longitudinally resulting in strips of 1220 mm length. This will have the following consequences:

1) A very considerable additional time saving and production increase for the shearing-machine operations (the number of cuts per sheet will be reduced by half).

2) A considerable time saving and production increase on the subsequent punch-press operations.

3) A considerable reduction in material waste in the subsequent punch-press operations.

N.B.: Due to the limited width of the "red" shearing machine that is utilized for cutting the sheets into strips, it may be necessary to cut first 1-2 strips transversely and only then proceed with the longitudinal cuts, or else the operation will have to be transferred to the broader "grey" shearing machine after reconditioning of same.

PROJECT No.3: Cutting imported alu-strips (approx. 1500 x 15 mm) into short pieces to be used for manufacturing handle-brackets for tiffin-carriers ("Burtons").

This project concerns one operation. --- The project was well under way and the main lines for the improved method were already defined. Because of lack of time it then had to be abandoned. Still, results from the improved method can be roughly anticipated as follows:

a) Time saving: 80 %
b) Production increase: 400 %

It would be premature to go into more detail. It is hoped, however, that the project can be resumed at a later date.

N.B. Production forecast for 1981 could not be checked. However, the corresponding operation is performed fairly frequently by one operator.

PROJECT No.4: Assembly of hinges for teapots and latches for tiffin-carriers.

This project concerns an assembly operation of two parts (hinges or latches). --- Initial analysis showed that the individual parts were totally unsuitable for modern assembly methods. Consequently the project was abandoned. The parts indeed presented numerous defects, such as bends and strong burrs, in addition to a total lack of dimensional fidelity (the position of punched holes, e.g., could vary by a few millimeters from one part to another). --- Nevertheless, a very rough time study was made of the present method and first ideas for the improved method were also analysed. Results from the projected improved method can, therefore, be anticipated as follows (order of magnitude):

a) Time saving:	approx. 50 %
b) Production increase:	approx. 100 %

It would be premature to go into more detail. It is hoped, however, that the project can be resumed at a later date.

N.B. The production forecast for 1981 could not be checked, but production figures must be high, since the corresponding operation is performed almost continually by one or two workers.

In spite of the fact that it had to be abandoned, this project was a major achievement. The technical project analysis indeed led to the discovery of two major problems that had remained undetected for a number of years: i.e., the fact that (a) this factory does not utilize part drawings, thus making any serious quality control impossible; and the fact that (b) it utilizes antiquated and partly primitive dies that are totally unsuitable for mass-production purposes.

Thanks to this project two top-priority problems of the Aluminium Goods Factory are thus clearly defined and the Management is now in a position to take corrective action. The urgency of corresponding decisions by Management cannot be sufficiently emphasized. Indeed, what had been acceptable under artisan-type conditions, is gradually becoming a stream of inefficiency, that must be stopped as soon as possible.

--d) Some economic considerations about practical results

In summary, and referring exclusively to those practical projects that could be completed, it must be said that results were exceptionally good, since usual values from Work-Study projects lie in the bracket of 20-30 % production increase. Nevertheless, further exceptional results can no doubt be expected from the second part of the present programme, as well as from other Work-Study programmes that may be organised in the future.

How do these results look in terms of savings in direct labour cost?
An approximate calculation produces the following data:

a) Project No. 1 (Manufacturing of handles for milk cans):
Total labour-cost savings per year amount to approximately 150 % of the total monthly direct labour-cost for one operator (or approximately 12.5 % of the total direct labour-cost per year for one operator).

b) Project No. 2 (Cutting alu-sheets into strips):
Total labour-cost savings per year amount to approximately 70 % of the total monthly direct labour-cost for one operator (or approximately 5.8 % of the total direct labour-cost per year of one operator).

At first sight these savings appear to be relatively modest, especially if expressed in terms of the wages that are currently paid in P.D.R. Yemen. On the other hand, these savings would be considerably higher if indirect labour and overheads were taken into consideration. Moreover, savings are in direct relation to the number of parts produced per year, and will increase in direct proportion to increasing production.

In any case the appreciation of the results will be totally different when referring to the savings in investments that would be necessary to buy the additional production equipment needed with the classical solution to achieve just a fraction of the increase in production capacity offered by the Work-Study solution. --- In the case of both Project No. 1 and Project No. 2, investment savings will indeed amount to many hundred if not several thousand Yemeni Dinars, not to speak of the space required to house the new equipment, space which would simply not be available.

Seen from this point of view, the first part of the current Work-Study programme has been extraordinarily successful. --- The foregoing does not even take into consideration a number of sizable corollary savings resulting from improved quality, a lower waste rate, lower energy consumption and others.

4-e) An evaluation of the quality of the time standards, as related to the practical results

The time standards obtained during the Work-Study applications carried out at the Aluminium Goods Factory (cf. Section 4-c) were based on actual time study in the case of the present methods and on estimates in the case of the new methods.

In the case of Projects No. 1 and 2, both time studies and estimates were accurate. Nevertheless, the time standards for the new methods will have to be reviewed by time study as well, once the improved equipment is available. --- In the case of Projects No. 3 and 4, on the other hand, time studies and estimates were of a provisional nature due to the limited time available to work on them. Of course, accurate time values will be determined in due course when work on these projects is resumed.

In all cases, listed time standards are based on the internationally accepted concept of "normal performance" that makes it possible for the motivated worker to exceed standard production on a continuous basis by 10-20 % and sometimes more.

For the benefit of those readers who may not be totally familiar with time-study principles, a description of the corresponding time-study system can be found in APPENDIX VIII. This Appendix also briefly explains some of the major implications related to the introduction of time study in factory operations. For those interested in the subject the reading of this Appendix is recommended.

APPENDIX VIII also refers in some detail to the "Allowances", i.e., to that fraction of the time standard that accounts for short time losses due to contingency delays. It is shown there, that allowances in the case of light to medium-heavy industry are usually in the range of 10-15 % of the "normal time" (cf. APPENDIX VIII); but the Expert found it advisable to utilize a 20 % allowance in the case of the Aluminium Goods Factory to account for the present difficulties in the production process. The above value is provisional and will have to be verified in the course of the extended Work-Study programme.

The setting of time standards also implies "rating the performance level" of the operator who is being time-studied. This means that his performance level is compared with the normal performance (100 %) of an imaginary "normal" operator, with whom the time-study man is completely familiar. This comparison will result in a rating figure that is higher than 100 % in the case of the fast worker, and is lower than 100 % in the case of the slow worker. Such values correspond to an internationally accepted concept of performance.

During the audit phase of the present Work-Study programme the performance level of the workers in the visited factories was rated in general. Corresponding findings for each factory are listed under Point IV-1 in each Audit Report (cf.APPENDICES VII-1 to VII-13). The interested reader may refer to them.

In summary, it is relevant to point out that the number of Yemeni workers who are accustomed to working at a "higher-than-normal" performance level is fairly high. Of course, it varies from factory to factory and seems to be highest in the Aluminium Goods Factory. Such performance levels show that equipment which has been improved through Work-Study will be satisfactorily utilized with a further increase in output, provided that the organization of the production process will also have been suitably adapted.

5 - RECOMMENDATIONS

5-a) Introduction

The recommendations and suggestions made in this Chapter are already partly known from the preceding Chapters of this Report. They are based on the information gathered in the audited factories and on the work performed in one of them. Other recommendations refer essentially to future Work-Study programmes, planned to start next year.

Recommendations in this Chapter are grouped by subject. The Report Sections in which they were first formulated, where applicable, are shown in brackets for reference purposes.

5-b) Specific recommendations concerning the factories with which the Expert was in contact

5-b1) Specific recommendations concerning the Tomato Paste Factory

Recommendations about the Tomato Paste Factory are too numerous and too detailed for condensed reproduction here; the reader will therefore refer to Report-Section 3-c2 and to APPENDIX VII-13. An exception is made with regard to two points that may have a greater bearing on decisions and actions to be taken during the Work-Study programme to be carried out at this factory. Thus:

First main-recommendation

An organic chemist, or possibly a laboratory technician, should be hired as soon as possible to start systematic analysis of the product all through the manufacturing process. The chemical laboratory must be equipped correspondingly with suitable installations and instruments. --- If necessary, UNIDO-assistance or bilateral aid should be requested to put this recommendation into practice as soon as possible.

Second main-recommendation

The problem of waste-recovery related to seeds and peels must be thoroughly analyzed as soon as possible. Recommendations and actions resulting from this analysis may, indeed, have a greater bearing on de-

cisions and actions to be taken during the comprehensive Work-Study programme that will be carried out in this factory. They could also greatly affect plant-layout in general. --- If necessary, UNIDO-assistance or bilateral aid should be requested to put this recommendation into practice as soon as possible.

Independently from the conclusions and actions resulting from the above recommendations, practical application in the framework of the next Work-Study programme should concentrate at first on the manufacture of tins, because (a) it offers great labour-saving possibilites, and (b) it determines major choices in the manufacturing process, as well as in inspection, material handling and storage. --- Moreover, this part of the project is, to a large extent, independent from conclusions and actions that may result from the two recommendations made above.

5-b2) Specific recommendations concerning the Aluminium Goods Factory

Recommendations concerning the Aluminium Goods Factory are too numerous and too detailed for condensed reproduction here; the reader will therefore refer to Report-Section 3-3c and to APPENDIX VII-3. However, it will be useful to emphasize once more the need for urgent improvement of some production aspects, such as:

a) Material handling and storage must be improved through the introduction of shelves, pallets, containers and the like, to improve material-flow and production control.

b) Dies for punch presses must be replaced by first-class imported dies of modern design.

c) Shearing machines must be provided with holding-bars to press down the sheet-metal before the cutter-blade goes into action and, naturally, during the actual cutting time (*).

   -- Moreover, these machines must be reconditioned. This applies especially to the cutter-blade and to the counter-blade that must be totally reground on a "tool and cutter"-grinding machine or similar.

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*) See footnote on next page

d) Drawings of all parts (components and assemblies) must be prepared for reference purposes and quality control.

e) All work places must be improved (*).

f) Auxiliary manufacturing devices, such as jigs, fixtures, stops, guides and the like, must be developed to increase output and to improve quality and safety (*).

g) Production figures, both for forecasts and from actual production, must be stated in number of parts (this system was already started in early 1981). They must also be broken down by part size and specifications.

   -- This system should also be introduced for stored raw material, where applicable. Thus, e.g., available quantity of alu-wire of a particular diameter should be shown in weight and in length of wire.

h) Safety measures must be taken to eliminate, or at least reduce, accident hazards that are very high throughout the factory (*).

i) Technical staff must be increased to devote systematic attention to the above problems and to other non-listed needs.

5-b3) Specific recommendations concerning the Foam and Metal Furniture Factory

Some recommendations concerning the Foam and Metal Furniture Factory were spelled out in APPENDIX VII-7. But for one recommendation, they are not reproduced in the Report-Section dealing with this factory (3-c4), and the reader will have to refer to the Appendix. However, the recommendation referred to in Report-Section 3-c4 is briefly discussed here: it concerns the moving of the factory to a new location.

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*) Improvement on this point was already started in the course of the present Work-Study programme. It must be continued during future extensions of same.

It is emphasized once more that the Foam and Metal Furniture Factory should not move into new buildings before completion of the Work-Study project that will be initiated by UNIDO-Expert No.2, as discussed with the Officials of the Ministry of Industry. --- Furthermore, architects' work must be based on a factory-layout resulting from Work Study. Architects' drawings that may already exist for the new building must therefore be adapted in due course to the conditions set by Work Study.

Furthermore, health-protection measures should be taken rapidly by Management. They concern a better evacuation of the chemical fumes in the foam-making section, and the evacuation of welding fumes. They also concern the protection of fellow-workers from exposure to strong light from electric welding, by screens or by other means. This last point would also be improved in the course of the Work-Study programme, provided there are no unforeseen delays.

5-b4) Specific recommendations concerning the other audited factories

A recapitulation of the recommendations with regard to the remaining ten factories would exceed the limit set for this Report. However, the interested reader can consult them in the Audit Reports, as listed below; corresponding Appendix Numbers are shown in brackets.

- Agricultural Implements (VII-1)
- Algundi Plastic (VII-2)
- Carpentry Corporation (VII-4)
- Cigarettes and Match Factory (VII-5)
- Flour Mill (VII-6)
- Milk and Dairy Factory (VII-8)
- Paint Factory (VII-9)
- Revolutionary Workshop (VII-10)
- Tannery (VII-11)
- Textile Mill (VII-12)

5-c) General recommendations concerning the factories with which the Expert was in contact

5-c1) General recommendations concerning health and safety hazards

In those factories in which early Work-Study application is not to be expected, Management will be responsible for eliminating, or at least reducing, health and accident hazards. Corresponding action must be started quickly, in spite of the investment that may be necessary, since such hazards can impair physical well-being and work-efficiency.

Risk causes will not be the same in all factories and corrective action may vary from case to case. The following list gives some of the most urgent safety measures needed. It is recommended that Factory Management uses it as a guideline for a comprehensive risk-reduction campaign (cf. Report Section 3-b7).

a) Shield off belt-drives and moving machine parts.

b) Introduce safety devices into punch-presses, shearing machines and others, to prevent the machine from being operated when removed or short-circuited.

c) Install screens around critical machines and welding places to protect fellow-workers from flying chips, sparks and strong light from electric welding.

d) Install transparent screens and/or supply goggles and compel operators to wear them near grinders for sharpening tools and near other critical machines, to protect operators from flying chips.

e) Have workers thoroughly clean their work place, including surrounding space and floor, at the end of each shift. This will eliminate the habit of tolerating parts that linger about and that can dart off when stepped upon or get caught by a moving machine part or that can cause injury when falling from the worktable.

f) For similar reasons material storage and transportation to/from work places must be made safe (and at the same time efficient)

through utilization of pallets or containers for all material and parts, and through installation of adequate shelves in the storerooms where loaded containers and pallets are kept.

g) For these same reasons containers must be of adequate design, and must never be too full, to allow for safe piling.

h) Remove all material and obstacles around electrical safety devices and distribution panels to ensure permanent and immediate access in case of emergency.

Others.

5-c2) General recommendations concerning handtools and spare parts

Maintenance and Repair Work, as well as Material Handling, are impaired by lack of handtools (cf. Report Section 3-b3). Valuable and expensive production equipment remains, therefore, under-utilized because of lack of low-cost items. It is recommended that fast action be taken to assure that a variety of handtools, even of the more specialized types, be readily available in P.D.R.Yemen.

In spite of their great importance for industrial operations, handtools are insignificant in themselves and will hardly motivate Government and Management thinking. In view of this, and of the limited amount of foreign exchange involved, one might wish to analyze the possibility of handing over the whole handtool-business (import and sales) to the Private Sector. --- This also because of the specialized knowledge required for proper handtool selection. Furthermore because of the usually small order-lots that require much administrative work, and at the same time considerable flexibility, which is more common to smaller organizations.

The situation with spare parts and small industrial equipment is quite similar. There, too, a steady and diversified availability should be assured through a similar solution as for handtools (perhaps with an upper limit in foreign exchange value), or through simplification and acceleration of import and distribution procedures, or other means.

5-c3) General recommendations concerning marketing

Complaints about inadequate marketing were fairly general (cf. Report Section 3-b2). Since marketing is the starting point for product development, capacity planning and production planning, findings and decisions referring to marketing can directly affect the overall efficiency of an industrial operation. From the point of view of capacity planning, marketing will also have a bearing on Work-Study programmes.

Therefore, assuming that complaints about marketing are justified and not simply an unconscious alibi to cover up management deficiencies, changes in the total marketing set-up should be introduced rapidly. One solution could be to hand over the total responsibility for marketing to the Management of each individual factory. Management of each factory would then be also fully responsible for the success or failure of it operations. This would give a new sense of responsibility, while giving a new impulse to Yemeni economy.

It is therefore recommended that the present marketing approach in P.D.R.Yemen industry be submitted as quickly as possible to a critical analysis.

5-c4) General recommendations concerning Time Standards and Wage-Incentive Systems

One factory (Tannery) pays an "above average" incentive to a group of workers who operate under more difficult conditions (cf. Report Section 3-c5). This fact is of general interest, since it helps to clarify a misunderstanding about the relative role of wage incentive and base wage.

A wage incentive is, indeed, a strictly motivating factor for inducing workers to raise their performance level to standard, or even higher than standard, whereas compensation for difficult work is part of the base wage. The latter may therefore vary within the same factory or within the same Department with the type of work, as shown by "Job Evaluation."

Job Evaluation is a technique for determining the correct wage or salary level for each type of work. It is therefore recommended that it

e used for P.D.R.Yemen industry as well, if this is not already the case. --- It is furthermore recommended that in the wage-incentive systems that may be developed in the future in other factories, compensation for difficult work should be included in the base wage and not in the incentive.

Finally, wage-incentive systems can be based on different parameters. If time standards are used as a parameter, one of the two following conditions must be fulfilled:

- the time standards must be accurate; they must have been thoroughly tested prior to utilization for incentive-payment purposes and they must be properly maintained (cf. Report Sections 3-b6 and 3-c5, and APPENDIX VIII); or

- the wage-incentive system must be designed in such a way that it can "absorb" inaccurate time standards. (The wage-incentive system will then be "less accurate" in the sense that changes in the performance level will not fully reflect in the amount of the incentive paid. Also, preference might be given to Group Incentives.)

It is strongly recommended that these aspects be kept in mind when new wage-incentive systems are designed for P.D.R.Yemen industry, to protect both time standards and wage incentives from gradual deterioration.

5-c5) <u>General recommendations concerning the spread of technical and language knowledge</u>

Factory operations in P.D.R.Yemen are impaired by a lack of medium-level technical staff, such as designers and draughtsmen for products and auxiliary manufacturing devices, time-study men and manufacturing-process planners, chemical-laboratory technicians, others (cf. Report Section 3-b8).

It is recommended that this problem be solved as quickly as possible to assure a balanced growth of Yemeni industry. A possible course of action would be to introduce a "Junior Degree" in University training at the end of the second year, at least in the Engineering and Chemistry curricula. This would allow the "undergraduates" to work for a

a period in industry before returning to University to complete their studies.

An additional step would be to organize training courses in specific techniques, e.g., for draughtmen, chemical-laboratory technicians and others. These courses would provide intensive accelerated training during several weeks or months, preferably on a full-time basis. Such training could be organized on a factory basis ("in-plant") or for a whole branch of industry; this choice would naturally influence course content and duration.

Such training would be imparted first of all to talented young workers and to other lower-level personnel that emerge through general attitude and eagerness to participate in new things. However, other categories of participants should not be excluded, both in order to offer the possibility of professional recycling and of talent search.

Industrial efficiency today, however, also depends widely on technology transfer. This applies to developing countries and to industrialized countries as well. English has become the internationally accepted language in this field. It is therefore recommended that the knowledge of this language be spread quickly and intensively through adaptation of the school programmes and through specialized courses.

To this purpose, it would be advisable to rely on training assistance from the UK. Advanced training in an English-speaking country could also be recommended, especially if it can be combined with specialized technical training.

5-d) Specific recommendations concerning future Work-Study programmes

5-d1) "Institution building" versus "direct support"

The Work-Study programme discussed in this Report served the purpose of making P.D.R.Yemen Government and industry acquainted with the possibilities offered by Work Study in the field of productivity improvement, especially in view of increasing production capacity with limited investments only.

This orientation purpose, naturally, had to be based on actual results. This is why the Expert did not dwell on the preparation of later long-range results, but concentrated on projects that could be more or less completed within the available time.

The Expert had then to make a further choice: either limiting the productivity-improvement effort to one project only, i.e., just one work place or one simple operation and finishing it in all its details; or studying simultaneously several operations, accepting the possibility that detail work might not be totally completed at the end of the programme. --- The Expert decided in favour of the second solution, since favourable results from one work place alone could have been considered to be fortuitous and not representative.

This choice resulted in a great amount of work for the Expert and his two counterparts. It also implied that, for lack of time, the different techniques utilized by the Expert from case to case could not be explained in all their details to the counterparts, as would be desirable in a long-lasting programme. The present programme was, therefore, more of a "direct support" type than of the "institution building" type. It has already been explained why this had to be so.

The Expert is aware that the long-range aim of UNIDO assistance is in general of the institution building type. This also applies to the Work-Study programme. However, there is a peculiarity about Work Study that cannot be ignored. Indeed, Work Study is not a purely intellectual "science," like chemistry or mathematics. The only possible way to learn it is, therefore, through participation in practical projects under the guidance and total project responsibility of an experienced Work-Study specialist.

-- Naturally, mastery of a considerable amount of theoretical knowledge is also essential. When not available, this knowledge must be acquired prior to participating in the Work-Study programme, or in alternation with practical project phases.

Consequently, the institution building aspect of future Work-Study programmes for P.D.R.Yemen must necessarily build up on the realization of a number of practical projects of the direct support type, with participation of counterparts from Government and industry.

-- Considering that Work Study applies to all types of activities, including, e.g., administrative work, counterparts from Government need not be limited to the Ministry of Industry only, once the programme has attained its cruising speed.

This extended period of initial direct support assistance will, naturally, require the availability of corresponding supervisory expertise. It can be assumed that UNIDO will be in a position to provide the needed Experts' man-months in sufficient number.

5-d2) Number of counterparts

Direct support assistance and especially long-range assistance of the institution building type, require the full-time participation of a greater number of counterparts from Government and from industry. It is assumed that Government and industry can meet this problem. (N.B.: Counterparts' full-time participation was not sufficiently ensured during the present Work-Study programme, reducing its efficiency.)

A greater number of counterparts is necessary for several reasons, two of which are listed below.

a) Talent search and promotion

As proven by experience, some counterparts will not produce satisfactory results for lack of aptitude or motivation or because they are not able to sustain hard work during extended periods of time.
--- Other counterparts, on the other hand, in spite of excellent results or as a consequence thereof, will grow out of the programme to assume new responsibilities in Government and industry. They

may even be called upon to disseminate Work-Study knowledge and application in P.D.R.Yemen, initially under the supervision or guidance of the Expert.

Occasional drop-out of counterparts has, therefore, to be expected during the whole programme duration. Corrective action must be planned from the very beginning to maintain a fairly constant level of programme efficiency.

b) Impact on Yemeni economy

It has already been said in this Report that a seasoned Work-Study specialist can run and efficiently supervise 2 to 4 parallel projects, if each one is manned by 2 to 3 talented counterparts (cf. Report Section 2-c).

This means that a well-run Work-Study programme can absorb 4 to 12 counterparts from Government and industry and gradually bring them to a satisfactory level of professional maturity, while producing actual results on the factory level. The pedagogic optimum can be said to be around 8 to 10 counterparts, distributed initially over three projects. With growing experience, the number of parallel projects can sometimes be increased to four.

Obviously a long-lasting impact of Work Study on Yemeni economy can only be felt, if applications do not remain on a limited level. It is therefore recommended that the maximum pedagogically acceptable number of counterparts be assigned to a future Work-Study programme for best utilization of the Expert's supervisory capacity.

Best programme efficiency, of course, will be achieved if all parallel projects are carried out in the same factory, or at least in geographically grouped factories. Furthermore, it is preferable that the different parallel projects do not all start at the same time, so as to allow for a higher degree of initial supervision for each of them. It is recommended that these aspects be taken into consideration.

5-d3) Structure of future Work-Study programmes and related training needs

It is known that P.D.R.Yemen's Government is interested in extending the present Work-Study programme into the coming years. It is also known from the "Draft Project Document" for the pericd covering the years 1982 to 1985 that UNIDO is planning to offer further Work-Study assistance during four consecutive years starting in January 1982. Accordingly, UNIDO would ensure Experts' availability during five months per year on a split-mission basis. Such a plan would be very fortunate for Yemeni industry and for Yemeni economy in general. It is, therefore, highly desirable that it will be realized.

The Expert has already pointed out that the long-range institution building aim in Work Study has to go through a longer phase of direct support. He also pointed out that practical application of Work Study requires mastery of a considerable amount of theoretical knowledge that has to be acquired prior to participating in the Work-Study programme, or in alternation with practical project phases (cf. Report Section 5-d1). It will be useful to add a few words on this subject.

Based on the experience with two counterparts (an economist and an engineer) the Expert believes that existing Work-Study knowledge is inadequate, or at least fragmentary, and that in all cases it will at least need "brushing-up". The Expert is therefore of the opinion that short ad-hoc courses should be organized in each calendar year, for as long as the need exists, at the start of each practical phase and/or alternating, within each phase, with the practical projects.

-- Courses should be run full-day and on a continuous basis for maximum efficiency.

Programming and duration of the courses should remain flexible, and fit actual needs as they develop in the framework of the Work-Study programme. These courses will serve a specific purpose and will be essentially practical. Theoretical classroom training will thus be completed by guided exercises in the factories; results obtained will be included in the practical projects carried out in the same factories, or added to the analysis data needed for the projects.

Short training courses will be run directly by the Work-Study Expert. He will also develop corresponding training material of adequate content (presentation might be of minimum-acceptable level to reduce preparation time). Time for preparing training material and for actually running short courses would be taken directly from the corresponding phase of the Work-Study programme. This will reduce somewhat the time available for practical work in the factories, but still not reduce overall programme efficiency.

On the other hand, training courses of medium length and, especially, long courses - as well as preparation of corresponding training material - should be scheduled outside and in addition to the Work-Study programme. Otherwise there would be too little time left for practical work and actual results. The Expert does not feel, however, that this should lead to programming or financing difficulties, since the "Draft Project Document" for 1982-1985 anticipates a large number of man-months per year (6 to 12) for short term experts. No doubt, a part of it could be split off for this purpose.

-- These special courses of medium and long duration could be run by the Work-Study Expert. If he is not available, other specialists of an international level would have to be called in.

To conclude these considerations, just a few examples on course duration to illustrate the time that may be involved in training.

a) Short courses

Duration of such courses will vary between one to two days and about one week, not including preparation of training courses. Possible course subjects would be:

- process charts
- multiple-activity charts
- basic principles of methods engineering
- balancing of production lines
- basic principles of plant layout
- economic considerations on Work-Study projects
- (wage-incentive systems)
- others.

b) Courses of medium duration

Duration of such courses will vary from one to three weeks or more, not including preparation of training material. Possible course subjects would be:

- Work Sampling ("Ratio Delay")
- time study
- construction of time-standard catalogues
- others.

c) Long courses

Duration of such courses will vary between four to six weeks and two to three months, not including preparation of training material. A possible course subject could be:

- MTM
- others.

N.B.: MTM, or Methods-Time Measurement, is a so-called "predetermined time system" that is gradually replacing classical motion study by Gilbreth, since it is much faster, in addition to having other advantages. With the gradually increasing Work-Study maturity of the counterparts, training in MTM will become a necessity.

It is important to note that training duration as shown here for the three types of courses (short; medium-length; long) includes a sufficient number of classroom exercises to assure the trainees a pre-operational proficiency level. Full operational level will be reached after extended guided practical application in the factories.

It might be useful to remember here that practical Work-Study projects will be carried out in the factories listed in APPENDIX IV and in the same order of priorities. Should the Government find it necessary to introduce changes in this list, it is then recommended that the Work-Study Expert be consulted for advice.

Referring finally to the split-mission character of the Expert's participation in the total programme, it is useful to mention that during the absences of the Expert from P.D.R.Yemen, the counterparts will continue to work on the practical projects. For this they will rely

on guidelines that the Expert will have prepared for them.

-- This is based on the assumption that the projects are not interrupted during the Expert's absence, due to other urgent tasks of the counterparts or because they receive advanced training abroad in the framework of fellowships (cf. next Report Section).

At the beginning of the new programme phase the counterparts will submit their work to the Expert for criticism and advice. In the meantime, however, they will have had to take decisions on their own if they wanted their projects to continue. Temporary absence of the Expert from P.D.R.Yemen will, therefore, contribute to more independence of judgment and to faster growing professional maturity of the counterparts.

However, one point has to be stressed. The task of the counterparts will be made easier during the absence of the Expert if the Government Officials and the factory representatives they deal with, have been exposed to Work-Study thinking. It is therefore recommended that in due course the Expert be offered the opportunity to run short orientation seminars on the subject. One-day seminars might serve the purpose.

5-d4) Fellowships abroad

To give more depth to training and to develop judgment in Work-Study matters, it would be desirable to give to at least some of the counterparts the possibility of completing their Work-Study background through specialized stays in industrialized countries. If English-speaking countries were chosen for this purpose, then advanced technical training would be combined with improved language proficiency.

The Expert is of the opinion that this goal could best be achieved through fellowships and would like to recommend that organizational and logistic matters be handled by UNIDO. He would also like to recommend that the financing of the fellowships be assured through UNIDO-managed funds and not through the IPF-Country Programme, so that the whole structure would be more flexible. More especially with the aim of satisfying training needs at short notice, once they have been recognized and defined.

Furthermore, the Expert believes that fellowship beneficiaries should already have received basic training in P.D.R.Yemen, where possible through specialized courses in the framework of the extended Work-Study programme. They will then already possess a technical vocabulary and a general view on the subject that will make their stay abroad both more efficient for Yemeni industry and more rewarding for themselves.

-- An exception to this would have to be made for highly specialized subject matter for which it would not be convenient to organize basic courses in P.D.R.Yemen, if only because of the limited number of trainees.

Finally, the Expert wishes to stress the point that fellowships need not be restricted to formal training purposes. It is indeed conceivable and even highly desirable, that a counterpart would use his fellowship to work for a few months as an industrial trainee in a manufacturing company. The counterpart could, e.g., participate in the activities of a manufacturing department or in a tool design or other Work-Study section and in this way get a true feeling for modern factory organization, factory problems and problem solving.

From the point of view of scheduling, no difficulties are to be expected due to the split-mission character of the future Work-Study programme. Every year there will be, indeed, six months left for convenient scheduling of fellowships after deduction of the five months during which the Expert will be in P.D.R.Yemen and of one month for vacation; unless this time is needed for additional Work-Study courses.

5-d5) Methods Workshop and related aspects

Within the framework of the practical projects, ideas for improved work methods must frequently be tested prior to introducing final changes in the production equipment. This will ensure that a given project has been studied from all angles, including ergonomics, to avoid wrong investments. Tests will be carried out with the help of full-size models built by the counterparts from auxiliary material, such as soft wood, sheet metal, cardboard and other consumption material. An adequate supply of such material and of fasteners, such as bolts, screws, rivets and nails, must be available.

Suitable handtools for work in wood and metal and for soldering and brazing, as well as portable power-tools, are also needed. Furthermore, some simple machine-tools will be essential: e.g., a drilling machine, a band-saw and a small grinder for sharpening cutting tools. --- A small milling machine, a small lathe, welding equipment and portable power-tools would be of advantage. This also holds true for machines for sheet-metal work, such as shearing and bending machines. Benches, vices and an anvil will naturally be essential. This equipment must be in good condition but need not be new.

Of course, the usual workshop installations must also be provided, such as electric power (220 Volts AC and possibly 380 Volts) and running water. Compressed air and gas (the latter in cylinders) would be highly desirable.

In factories that are engaged in metal work, such equipment may be available in the production departments or in Maintenance and Repair, but will not always be available for the Work-Study team. In other factories such equipment will hardly exist. Ideally, each factory engaged in a Work-Study programme should, therefore, have a "Methods Workshop", i.e., a small workshop especially created for the Work-Study team.

Should this exceed immediate investment possibilities, an intermediate solution would then be to create a well-equipped "Central Methods Workshop", complete with a sizable stock of consumption material as mentioned above. This workshop should be conveniently located, e.g., in Maalla or on the premises of the Ministry of Industry. The Work-Study team could then use it to build its models and to carry out some of its tests. At the same time, it could borrow portable power-tools, handtools and consumption materials from it for those tests that must be carried out in the factories themselves.

-- Some equipment might also be borrowed from the Central Methods Workshop to equip temporarily a provisional methods workshop in one of the factories.

Depending on the size of the Central Methods Workshop and on the type of available equipment, a full-time attendant may have to be assigned to it. He would maintain workshop and equipment in good condition and

could also help with the building of models. This person should have, if possible, workshop experience as a mechanic, machine fitter or machine-tool operator.

Naturally, the Central Methods Workshop should also provide adequate office space and equipment. Particularly, it should offer storing opportunities for files, etc., as well as tables for tests and general project purposes (one table with drawing equipment would be of advantage). --- A good quality and reliable photostatic copier (with sufficient supply of suitable paper) would greatly speed up the realization of the Work-Study projects and would, therefore, be of great advantage.

-- Over the years, the Expert has had satisfactory experience with plain paper copiers by Xerox and by Canon. Locally available maintenance being of greatest importance, however, the Expert would also like to point out that a small chemical paper copier by Olympia works at present fairly satisfactorily in the World Food Programme offices of the U.N.D.P. in Aden.

Ideally, office space and equipment should be available from the very beginning. Investment limit, however, may force procedure to be in stages. In this case, preference should be given to the actual workshop aspects of the Central Methods Workshop.

It is recommended that the Ministry of Industry take fast action towards the creation of a Central Methods Workshop. Since the investment aspect might hinder Government's corresponding freedom of action, the Expert would like to recommend that U.N.D.P.-financing be taken into consideration for this part of the project. This possibility should be analyzed by U.N.D.P. representatives with the assistance of the Team Leader of the Industrial Advisory Unit.

To close this Report Section, just a short comment on training aspects related to Methods Workshops in general.

It is becoming customary in industrialized countries to train new operators in separate training centres before assigning them to their final work in a production department. This also applies to "old" operators who are being retrained with a view to a transfer to another

workplace, or to learn to perform detailed motions resulting from a methods' change. With companies having their own methods workshop, operators' training and retraining takes place more and more frequently in the said workshop, especially in the case of methods' changes.

A Central Workshop, on the other hand, offers another possibility. Through the addition of a classroom with adequate lecturing equipment, it can develop into a Training Centre for Work Study and for Productivity in general. Theoretical training could then alternate with practical exercises under "semi-factory" conditions, offering participants in this way a better preparation for problem solving under actual factory conditions. --- Such a possibility could be kept in mind for future developments in the Work-Study programme in P.D.R.Yemen.

5-d6) Professional Work-Study equipment

a) Introduction

Work-Study application comprises an analytical and a creative phase. The first phase gathers the data defining the existing situation and allowing the measurement of results; the second leads to the actual improvement.

The two phases require that the Work-Study group can work under acceptable comfort conditions. This implies the availability of office space and equipment, but at least of sufficiently large tables, chairs and filing furniture, as well as small office equipment, such as staplers and the like. Furthermore, it implies the supply of adequate stationery and, finally, the supply of consumption material for building models, as already discussed. All this falls under the responsibility of the factory in which the Work-Study project is carried out.

Additionally to the above standard requirements, the two Work-Study phases require the availability of specialized professional equipment as listed in the following Sub-Sections. The listing is broken down in equipment which is used very frequently and which should therefore be included in the standard outfit of every counterpart and of other persons engaged in Work Study. --- Other equipment items, on the other

hand, are less frequently used. It will therefore suffice to have available one of each item per project, or possibly for the whole Work-Study programme.

b) Standard equipment needed for each counterpart

Each counterpart as well as other persons participating intensively in a Work-Study project, should receive the following material:

1) 1 x "Decimal-hour" stop watch (essential)
With this type of stop watch the dial is divided into 100 parts, and it takes the large hand 36 seconds to make one full turn (there must also be a short hand to count the number of turns made by the large hand). --- This type of stop watch shows the elapsed time directly in hours, i.e., in the time unit most frequently used for labour-cost calculations.
The stop watch must be started, stopped and restarted through stem-action. Returning of stopped or moving hands to zero-position must be controlled by pressing down of a lateral push-button and not by shifting of a slide. --- NB: Stop watches made by Lemania can be recommended, as they are accurate and reliable, Heuer being a good second choice.

2) 1 x Time-Study observation board (essential)
Board must be complete with holding device for stop watch, and with spring clip for time-study forms.

3) 1 x Electronic pocket calculator (essential)
Any simple standard model is acceptable, provided it carries out "constant factor" operations. --- NB: An easy to handle and reliable calculator is, e.g., Casio HL-101 model; it can be recommended, but other good makes are acceptable.

4) 1 x Flexible 2-meter steel tape (essential)
The flexible tape must be divided in centimeters. The tape must be easy to handle and rust protected. --- NB: Any good make is acceptable.

5) 1 x Portable 25 kg weight scale (essential)
This is a spring-and-hook type scale as used, e.g., to weigh full sacks. Effective rust protection must be assured. --- Rebüre scales can be recommended among other good makes.

c) Standard equipment needed for each parallel project or for the whole Work-Study programme

1) n x "Decimal minute" stop watch (essential)

With this type of stop watch the dial is divided into 100 parts and it takes the large hand 60 seconds to make one full turn (there must also be a short hand to count the number of turns made by the large hand). --- This kind of stop watch is easier to read than decimal-hour stop watches and is, therefore, better suited for occasional helpers who are less familiar with handling a stop watch, especially with regard to long-cycle operations, as usual in maintenance and repair. This stop watch must also be controlled through stem-action and pressing of lateral button, as already discussed in connection with the decimal hour stop watch.

Needed quantity (= n): There should be one such stop watch per parallel project, but at least two for the whole Work-Study programme. --- NB: For this model too, stop watches by Lemania and by Heuer can be recommended.

2) n x "Engineer's" 25 m (preferably 50 m) measuring tape (essential)

The tape must be subdivided in meters and centimeters. This is a reel- and crank-type model for layout work. Tape will preferably be made out of textile or plastic, since flexible steel tapes of such length get easily damaged and rusted.

Needed quantity (= n): There should be one such measuring tape per parallel project, but at least two for the whole Work-Study programme. --- NB: Any good make is acceptable.

3) n x Portable 50 kg (preferably 100 kg) weight scale (essential)

This is a spring-and-hook type scale as used, e.g., to weigh full sacks. Effective rust protection must be assured.

Needed quantity (= n): There should be one such weight scale per parallel project, but at least two for the whole Work-Study programme. --- NB: Rebüre scales can be recommended among other good makes.

4) n x Feed- and speed-indicator (essential)

Combined instrument, complete with accessories, needed for measuring number of revolutions per minute and surface speeds of machine tools

and machines in general.

Needed quantity (= n): There should be one such instrument-set per parallel project, but at least one for the whole Work-Study programme. --- NB: Any good make is acceptable provided effective rust protection is assured.

* * *

Above listed equipment (No.1 to No.4) is standard for Work Study. However, depending on the type of project, its utilization can be less frequent. This is why requested quantities lie below the number of counterparts to keep the initial expenses within acceptable limits.

d) Special equipment recommended for each parallel project or for the whole Work-Study programme

1) n x Complete set of Video equipment (highly desirable)

Each set will consist of the following items:

- video camera
- tripod and shoulder-rest
- video cassettes (about one dozen)
- video recorder (for battery and mains)
- video tuner (*)
- spare battery
- battery charger
- colour television set of large dimensions for hand and remote control

and other accessories prescribed or recommended by the manufacturer.

This equipment will be used for Work-Study purposes, including Motion Study. Projection possibilities (forwards and backwards) must, therefore, include: standard speed, increased speed, image-by-image and standstill projection.

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*) This item is not needed for Work Study, but would be needed for recording general broadcasts from National Television which would be suitable for inclusion in training courses.

Recommended quantity of complete sets (= n): Ideally, each parallel project should have a complete set at its disposal. Cost aspects, however, make it advisable to be satisfied with two sets for the whole Work-Study programme. One of them should be available from the start of the extended Work-Study programme. The other one could be supplied 6 to 12 months later, to allow for changes in specifications that may grow out of local experience. --- Equipment retained should be highly efficient and reliable, as is the case with products by Philips, Saba, Grundig, Hitachi, JVC, Sony and others. Final choice should be made according to maintenance possibilities.

* * *

It must be noted that utilization of Video equipment in Work Study is relatively new. However, it is steadily gaining momentum due to its great advantages, some of which are:

- fast and complete data gathering concerning existing work-place conditions, thus reducing operators' discomfort and increasing Work-Study efficiency
- possibility of immediate and objective "video comparison" of "old" and of "new" methods, either in the case of workers' complaints about related standard times or for orientation and training purposes in work shops, seminars or courses.

The last point also opens the possibility of creating a video cassette library on Yemeni Industry. Naturally, the equipment can also be used for projection of video films from other sources, local or foreign.

2) n x <u>Photographic equipment</u> (very desirable)

Each set will consist of the following items:

- instant-developing still camera of an advanced automatic design
- suitable electronic flash equipment, complete with battery, battery charger and spares
- tripod
- instant developing film reel (two dozen) - NB: Film can be stored for three years in a refrigerator and one year under normal conditions.

Recommended quantity (= n): There should be a complete set per parallel project, but at least two for the whole Work-Study programme.
--- NB: Instant development cameras by Polaroid are reliable and can be recommended, with Kodak as a second choice.

* * *

Additionally it would be useful to have one set of 24x36 mm photographic equipment available for the whole Work-Study programme. This equipment would be utilized to produce higher-quality pictures, possibly also slides, that could later be used for training purposes. Preference should be given to an automatic Reflex camera of advanced design with interchangeable lenses, complete electronic flash equipment, tripod and other accessories. A reasonable amount of film material should also be supplied (of the black and white type at first, since colour-development is not yet possible in P.D.R.Yemen).

3) Film equipment (desirable)

Utilization of film equipment in Work Study has become less common due to the spreading of predetermined time systems, such as MTM and then, of late, through the popularity gained by video equipment. Film equipment, however, is still useful for training purposes and should be available if formal training courses are to be included in the extended Work-Study programme.

A detailed list of recommended equipment would be established in due course. But it can already be said that minimum requirements would be:

- complete 16 mm sound-projection equipment (for performance-rating films and others)
- complete super-8 sound-projection equipment, since training films of this type are now frequently available.

The latter equipment could be completed with a super-8 sound-film camera, with adequate film supply, to be used as a complement to the video-filming equipment.

4) Further projection equipment (desirable)

Further projection equipment would be desirable in case the Work-Study programme were to include formal training or orientation courses. A detailed list of the necessary equipment would be established in due

course. As a reminder it can already be said that it would be advantageous to provide different equipment and material according to the following minimum list:

- projector for 5x5 cm slides (for projection of 24x36 mm pictures), complete with accessories and a large number of frames (preferably of the metal and glass protection type).
- projection screen and tripod
- overhead projector for transparencies of both the frame and the reel type, complete with a large amount of essential transparency material.

  NB: If it is desired to project already existing material, e.g., a graph or an illustration from a book, then photostatic transparency material should also be provided, to be used with a suitable photostatic copier.

- Projection screens, tripods and other accessories and equipment.

e) Financing of needed Work-Study equipment and material

The procurement of the equipment and material listed in Sub-Sections (a) to (d) requires a fairly considerable investment that might exceed Government's budget reserves for this field. The Expert suggests, therefore, that the possibility of financing this element of the Work-Study programme through U.N.D.P. funds also be analyzed by U.N.D.P. and UNIDO Representatives.

5-d7) Work-Study Manual

The Job Description for the present Work-Study programme says that the work carried out will leave behind an institution of self-assessment. It also says that differences between existing and improved production methods should be explained by film or otherwise (cf. Appendix II). This, naturally, should be done within the framework of the institution building aspect of the Work-Study programme as envisaged for P.D.R.Yemen.

These considerations had induced the Expert to request the cooperation of the National Television Corporation to prepare a short video film, comparing the old and the new working methods at the Aluminum Goods factory in Maalla. This film could, naturally, be broadcast for the

general TV audience to stir interest in productivity matters on a national basis. However, it would be intended mainly for limited projection within seminars and orientation courses that the Government might find desirable to organize for industrial management representatives. --- The National Television Corporation has shown interest in this request and it is likely that such a film will be prepared.

These same considerations have led the Expert to develop ideas about training needs and about professional material of all sorts needed for carrying out the the practical projects, and for training purposes, as set out in the foregoing Report Sections and Sub-Sections.

The preparation of a Work-Study Manual would fall into the same field. This refers to the systematic gathering of documented data from practical projects carried out in Yemeni industry and to their adequate presentation, in combination with general Work-Study principles, to serve as a reference basis for future Work-Study applications, and for training purposes as well. The preparation of a Work-Study Manual, that would start with a future Work-Study programme, is especially recommended by Mr. K.S. Desai, Team Leader of UNIDO's Industrial Advisory Unit.

Naturally, the creation of such a manual would require time. This time would have to be deducted from the total project time, thus reducing the time available to carry out actual work in the factories. However, UNIDO's assistance is first of all intended to be institution building. According to this line of thinking a Work-Study Manual would be most useful and the Expert recommends that this idea be implemented starting with the next extension of the Work-Study programme.

It would be premature to go into details concerning the desirable structure of such a Work-Study Manual. However, it might be found useful in due time to break up the total manual content into a general and a specific part. In turn, the latter could be broken down by type of machine or by operations. --- The Section on shearing machines, e.g., would start with a description of the experience gained at the Aluminium Goods Factory in Maalla (results achieved and by what means; critical points requiring attention; etc.). With time this Section would be completed with knowledge and experience gained with shearing machines in other factories in P.D.R.Yemen.

Furthermore, the Job Description requested that improvement in the work methods studied should not only refer to productivity, but also to safety and quality (cf. APPENDIX II). This request was already taken into consideration by the Expert when carrying out the practical projects, as well as with regard to the Audit Reports concerning the factories visited, which are subdivided accordingly (cf. APPENDICES VII-1 to VII-13). An identical or similar subdivision could be used in the Work-Study Manual for the various sections on individual machines and operations.

Thinking further along these lines it becomes evident that the Work-Study Manual could be expanded to contain operational instructions about the different machines; this not only with the aim of achieving maximum productivity, but also to protect the machine against overload or ill-usage that could lead to excessive wear, causing breakdown or high maintenance and repair costs. In this sense, the Work-Study Manual could mention which operations may or may not be performed on a particular machine (cf. "Post Scriptum" following this Chapter).

Naturally, the Work-Study Manual could also be combined with a (future) Maintenance Manual, or be just the starting point for it. It could also be the starting point for a general data-bank on industrial operations in P.D.R.Yemen.

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APPENDIX I

LIST OF FACTORIES IN P.D.R.Y REPORTING TO THE MINISTRY OF INDUSTRY (complete with number of people employed)

No.	FACTORY Approximate Name	PEOPLE EMPLOYED Men	Women	Total
	PUBLIC SECTOR			
1	Aerated Water & Ice Factory (4 units) (*)	232	31	263
2	Agricultural Implements Factory	122	28	150
3	Algundi Plastic Factory (*)	31	12	43
4	Brewery (New ! 1980-1981)	?	?	?
5	Carpentry Corporation (2 units)	?	?	?
6	Flour Mill	111	17	128
7	Leather Shoe Factory	46	55	101
8	Milk & Dairy Products	38	12	50
9	Martyrs Tailoring	21	139	160
10	Oil Mill	35	9	44
11	Oxygen Factory	37	4	41
12	Public Bakery	67	21	88
13	Revolutionary Workshop	81	12	93
14	Salt Factory	235	22	257
15	Soap Factory	69	4	73
16	Tannery	62	9	71
17	Textile Mill (*)	738	653	1391
18	Tomato Paste Factory	126	40	166
	TOTAL PUBLIC SECTOR	2051+	1068+	3119+
	MIXED SECTOR			
1	Aluminium Goods Factory (*)	84	58	142
2	Battery Factory	13	8	21
3	Cigarette & Match Factory (*)			
	- Cigarette Division	148	82	230
	- Match Division	65	47	112
4	Foam and Metal Furniture Factory (*)	40	9	49
5	Paint Factory (*)	48	8	56
6	Perfume Factory	14	24	38
7	Sea Sandal Factory	46	31	77
	TOTAL MIXED SECTOR	458	267	725
	(cont'd on page 2) Carried forward:	2509+	1335+	3844+

*) The seven factories marked with an asterisk are "in competition" (see text).

No.	FACTORY Approximate Name	PEOPLE EMPLOYED Men	Women	Total
	PRIVATE SECTOR Brought forward:	2509+	1335+	3844+
1	Al-Aidroos (Garments)	23	70	93
2	Aljazira for Paper Bags	6	-	6
3	Aluminium Doors & Windows (1981)	14	-	14
4	Bags & Belts (Handbags)	46	11	57
5	Van Zain (Garments)	11	24	35
6	Ice Cream Factory	7	-	7
7	Ice Factory (Ice blocs)	?	?	?
8	Middle East Plastic	53	2	55
9	Mirror Factory	4	3	7
10	Nail Factory	14	-	14
11	Printing and Paper Bags	6	-	6
12	Saba Clothing	20	33	53
13	Spices (Grinding & Packing)	6	-	6
14	Wollen Garments	15	7	22
	TOTAL PRIVATE SECTOR	225+	150+	375+
	GRAND TOTAL	2734+	1485+	4219+

N.B. The information in this Appendix is an excerpt from a document prepared in December 1979 by Mr. A. Aziz, Industrial Economist, Industrial Advisory Unit. (Employment figures are from 1978 - 1979; they could not be up-dated for lack of time.)

+) Actual totals are higher since employment figures are not shown in all cases.

APPENDIX II

JOB DESCRIPTION (Excerpt)

POST TITLE : Expert in Work Study

DURATION : Six months (*)

DUTY STATION : Aden, with possible travel in the country

PURPOSE OF PROJECT :

To study the motions of various work, examine the methods used critically and implement any improvements in methods that will increase productivity, safety or quality; time the new methods and establish norms which may be related to those pertaining in other countries; design and install a system of payment based upon productivity for each individual, with group, or factory as appropriate.

DUTIES :

The expert will be attached to the Ministry of Industry and under the guidance and directions of the Director, Department of Production of the Ministry and in close co-operation with the Team Leader of Industrial Advisory Unit, will be expected to carry out the following duties in respect of the selected industrial establishments :

1. Study the present methods and processes and list the motions and their timing with the assistance of a stop watch.

2. Compare observations made above (1) with practices in other countries, with a view to bringing about improvements in the productivity etc.

3. Make methods improvements on the basis of (1) and (2) above.

4. Explain the comparisons of (1), (2) and (3) through films or otherwise.

5. Decide on a standard list of motions with the timings.

6. Train the personnel on (5).

7. Prepare and implement a system to make this study on a regular basis.

The work of the project will leave behind an institution of self assessment.

(*) For logistic reasons the project had to be split into two consecutive parts, as discussed in the report.

APPENDIX III

LIST OF FACTORIES VISITED DURING THE FIRST PART OF THE PROJECT WITH THE AIM OF OBTAINING A GENERAL VIEW ABOUT APPLICATION POSSIBILITIES FOR WORK STUDY

No.	FACTORY AUDITED (*) Approximate name and location (and ownership)	DATE(S) OF VISIT(S) (1981)	REPORT ON FINDINGS Date completed (1981)	Ref. No.	Appendix No.
1	AGRICULTURAL IMPLEMENTS Khormaksat - 1.G. (Public Sector)	5 FEB.	22 FEB.	A-1	VII-1
2	ALGUNDI PLASTIC Khormaksar - 1.G. (Public Sector)	7 FEB.	24 FEB.	A-2	VII-2
3	ALUMINIUM FACTORY Maalla - 1.G. (Mixed Sector)	3+5 FEB.	10 MAR.	A-3	VII-3
4	CARPENTRY CORPORATION Maalla - 1.G. (Public Sector)	3+4	23 FEB.	A-4	VII-4
5	CIGARETTE AND MATCH FACTORY Maalla - 1.G. (Mixed Sector)	8 FEB.	26 FEB.	A-5	VII-5
6	FLOUR MILL Maalla - 1.G. (Public Sector)	4+7 FEB.	24 FEB.	A-6	VII-6
7	FOAM AND METAL FURNITURE Al-Durain - 1.G. (Mixed Sector)	10+11+12 FEB.	4 MAR.	A-7	VII-7
8	MILK AND DAIRY FACTORY Khormaksar - 1.G. ((Public Sector)	7 FEB.	25 FEB.	A-8	VII-8

No.	FACTORY AUDITED (*) Approximate name and location (and ownership)	DATE(S) OF VISIT(S) (1981)	REPORT ON FINDINGS Date completed (1981)	Ref. No.	Appendix No.
9	PAINT FACTORY Maalla - 1.G. (Mixed Sector)	3+4 FEB.	21 FEB.	A-9	VII-9
10	REVOLUTIONARY WORKSHOP Khormaksar - 1.G. (Public Sector)	5 FEB.	27 FEB.	A-10	VII-10
11	TANNERY Al-Durain - 1.G. (Public Sector)	12 FEB.	22 FEB.	A-11	VII-11
12	TEXTILE MILL Sheik Othman - 1.G. (Public Sector)	9+10 FEB.	5 MAR.	A-12	VII-12
13	TOMATO PASTE FACTORY Al-Fuosh - 2.G. (Public Sector)	11 FEB.	17 MAR.	A-13	VII-13

*) The visited factories are listed alphabetically for easy reference.

APPENDIX IV

LIST OF FACTORIES SELECTED BY THE MINISTRY OF INDUSTRY FOR WORK-STUDY APPLICATIONS, IN CONSULTATION WITH THE TEAM LEADER OF UNIDO'S INDUSTRIAL ADVISORY UNIT AND THE EXPERT

No.	FACTORY SELECTED (*) Approximate name and location (and ownership)	CORRESPONDING FINDINGS FROM INITIAL AUDITING REPORT to be found under "Reference Number"	in APPENDIX (Number)
1	ALUMINIUM FACTORY Maalla - 1.G. (Mixed Sector)	A-3	VII-3
2	TOMATO PASTE FACTORY Al-Fuosh - 2.G. (Public Sector)	A-13	VII-13
3	FOAM AND METAL FURNITURE Al-Durain - 1.G. (Mixed Sector)	A-7	VII-7
4	AGRICULTURAL IMPLEMENTS Khormaksar - 1.G. (Public Sector)	A-1	VII-1
5	FLOUR MILL Maalla - 1.G. (Public Sector)	A-6	VII-6
6	PAINT FACTORY Maalla - 1.G. (Mixed Sector)	A-9	VII-9
7	CIGARETTE AND MATCH FACTORY Maalla - 1.G. (Mixed Sector)	A-5	VII-5

*) The factories in this Table are listed according to the order of priority set forth by the Ministry of Industry for Work Study - Applications.

APPENDIX V

BREAKDOWN OF THE ACTIVITIES OF THE EXPERT, IN EUROPE AND IN P.D.R.Y., FOR THE WHOLE DURATION OF THE PROJECT

No.	ACTIVITY Description, and corresponding dates (1981)	DURATION (in days incl. weekly holidays) Individual	 Total by group
1	PRELIMINARY PHASE (Europe and P.D.R.Y.) Travel Lausanne-Vienna; briefing at UNIDO's Headquarters; travel to Aden; settling down in Aden (from 26 Jan. to 30 Jan.)	5	5
2	AUDITING OF FACTORIES (P.D.R.Y.) a) Established contacts with the Ministry of Industry, and set up schedule for factory-visits together with Officials of the Ministry and the Team-Leader of the Industrial Advisory Unit (from 31 Jan. to 2 Feb.)	3	
	b) Visited 13 factories in the Aden Region (First ans Second Governorate) to select suitable Work Study projects (from 3 to 12 Feb.)	10	
	c) Wrote reports on visited factories (cf. Appendices), as a guideline for final selection of Work Study projects, and for the benefit of the Ministry of Industry and of future UNIDO Experts (from 13 to 20 Feb. in day-work; plus about 10 full days in evening and week-end work, spread out over the period from 21 Feb. to 10 Mar.)	8+	
	d) Final choice of Work Study projects (choice of priorities) through the Ministry of Industry (from 21 to 22 Feb.)..	2	23+
3	PRACTICAL WORK (P.D.R.Y.) Work Study applications at the Aluminium Goods Factory in Maalla-Aden (from 23 Feb. to 2 Apr.)	39	39
	(Cont'd on Page 2) Carried forward :	67+	67+

N.B. The activities no. 2-a, 2-d a. 4-a (see next page) were carried out with the assistan[illegible] the Team-Leader of UNIDO's Industrial Advisory

No.	ACTIVITY Description, and corresponding dates (1981)	DURATION (in days incl. weekly holidays) Individual	 Total by group
	Brought forward :	67+	67+
4	CLOSING PHASE (P.D.R.Y. and Europe)		
	a) Presented results to the Ministry of Planning and to the Ministry of Industry; also organized return travel (from 3 to 6 Apr.)	4	
	b) Travel to Vienna; debriefing at UNIDO's Headquarters; travel to Lausanne (from the evening of 6 Apr. to 10 Apr.).....	4	8
	TOTAL (=Official Contract Duration) :	75+	75+
5	PREPARING FINAL REPORT (Europe)		
	Wrote final report upon returning to Switzerland, outside and additionally to official contract duration (from 13 April to the end of June, with interruptions)	60	60
	GRAND TOTAL :	135+	135+

+) For explanation see description of activity no. 3-c.

APPENDIX VI

RESULTS FROM WORK-STUDY APPLICATIONS CARRIED OUT AT THE ALUMINIUM GOODS FACTORY IN MAALLA (ADEN)

Project No.1 ("PP-ALU-01")

MANUFACTURE OF HANDLES OF DIFFERENT SIZES FOR MILK-CANS, FROM ALU-WIRE OF DIFFERENT DIAMETERS

A - PRESENT METHOD

1) Uncoil wire, straignten and cut to length (shearing machine)
2) Bend both ends (template in vice, on bench)
3) Shape into final form (template on anvil, on floor)

B - IMPROVED METHOD

1) Uncoil wire, straighten and cut to length (shearing machine, with new attachments)
2) Bend and shape into final form (new combined device)

C - RESULTS FROM IMPROVED METHOD

1) Time saving: approx. 50% (average of all sizes)
2) Production increase: " 100% (" " " ")

Project No.2 ("PP-ALU-02")

CUTTING ALU-SHEETS (approx. 1220 x 610 mm) INTO STRIPS OF DIFFERENT WIDTHS, TO BE UTILIZED IN PUNCH-PRESS OPERATIONS

A - PRESENT METHOD

1) Cut full-size sheet into halfs-sheets (shearing machine)
2) Cut half-sheet into strips (shearing machine)

B - IMPROVED METHOD

Cut strip directly from full-size sheet (improved shearing machine)

C - RESULTS FROM IMPROVED METHOD

1) Time saving: approx. 75% (average of all sizes)
2) Production increase: " 300% (" " " ")

Project No.3 ("PP-ALU-03")

CUTTING IMPORTED ALU-STRIPS (approx. 1500 x 15mm) INTO SHORT PIECES, TO BE USED FOR MANUFACTURING HANDLE-BRACKETS FOR TIFFIN-CARRIERS ("BURTONS")

A - PRESENT METHOD

Cut one strip at the time (shearing machine)

B - IMPROVED METHOD

Cut several strips at the time (improved shearing machine with special attachement)

C - RESULTS FROM IMPROVED METHOD

This project could not be completed for lack of time. Results can be anticipated as follows :

1) Time saving : approx. 80% (average of all sizes)
2) Production increase : " 400% (" " " ")

N.B. A fourth, very promising project ("Assembly of hinges for tea-kettles") had to be abandoned after initial analysis, due to inaccurate parts. This project can be taken up again when new dies will be available, that will assure parts of consistent dimensions.

Auditing Report No. A-1

I - COMPANY IDENTIFICATION

Name (approx.): AGRICULTURAL IMPLEMENTS FACTORY

Economic Sector: Public Visited (Date/s): 5 Feb.81

Location (& Governorate No.): Khormaksar (1.G)

II - PRODUCTS

- Wire of different Ø drawn from imported 1/4 in. wire
- Wire fences, plastic-coated or galvanized, for housing and agriculture
- Home scissors and agricultural tools, like sickles and hoes (production has been stopped for some time)

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Drawing of wire, including storing and handling
2) Netting of fences (project to be taken in consideration only if delivery of new machines should be delayed beyond June 1981)

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are machine-controlled in the wire drawing section, they are partly man-controlled in the fence-netting section. Operators' performance level is about medium. - Metallurgical sections are closed down.

2) Health and accident hazard in the sections that are still operating seem to be low. However, in the wire-drawing section workers could stumble over the raw-wire coils on the floor and get caught in the wire; the machine should be shielded.

3) Quality of drawn wire and of fence-net seems to be satisfactory at first sight. However, raw-wire coils are rusty from inadequate storing. There is a fair chance that rust is not totally eliminated through the drawing process; this could be the starting point for later corrosion of wire and fences. (It must be noted that the plant site is located in a highly corrosive area).

4) Work methods in the wire-drawing and netting section are totally or partly machine-controlled. Still, there are some possibilities for work-study application, as for loading and unloading machines and for other aspects.

5) Plant-layout is not totally adequate for good material flow and for intermediate storage. Handling could not be observed directly but seems to be improvable; the work-study approach would be helpful.

6) General impression was positive. On the whole the plant is orderly and fairly clean; the machines in the closed-down sections are greased and covered with tarpaulin. Obviously, the recom-

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

mendations from a former report from UNIDO's Industrial Advisory Unit (*) were implemented. --- Furthermore, it must be noted that this company would be ready, if necessary in relation to UNIDO's present work-study program, to build fixtures and the like for other companies. This could be particularly interesting with respect to quality-control gauges that, no doubt, will be needed by different P.D.R.Y. factories in the future.

*) Mr. K. Mahalingham

N.B. Reportedly the metallurgical sections were closed down about two years ago because of inadequate marketing, high manufacturing cost through inadequate processes, and short tooling life (perhaps partly caused through inadequate heat treatment).

The marketing aspects are already being dealt with by the Industrial Advisory Unit (*), and one of their findings is that, in the past, agricultural tools had been supplied without wooden handles. This fact lies outside the scope of activities of the work-study expert, but is rather surprising in itself. It is, therefore, recommended that in the future tools for agriculture, as well as handtools that may be added to the production program, be supplied with handles. The latter may be manufactured by the company, or purchased from Carpentry Corporation or other sources.

*) Mr. A. Aziz

The metallurgical aspect in general is also already being dealt with by the Industrial Advisory Unit, so that the work-study expert will refer here to dies only. In his opinion (from the point of view of design, metallurgy and finishing) dies in general are high-technology equipment. The expert feels, therefore, that the company should rely exclusively on first-class imported dies for a number of years. This in view of the following considerations:

(a) Dies of inadequate design may increase the number of manufacturing operations, and therefore product-cost.

(b) Dies of poor metallurgy and/or poor finish lead to short life of the dies, and, generally, to excessive labour cost for deburring parts and for improving their finish.

To conclude, it must be stressed again that the company is located in a highly corrosive area. While it would be difficult to change the location of the whole factory, it might be possible and worthwhile in the future to transform the mechanical workshop into a separate company, and to move it to a location whose climatic conditions would be more in line with the needs of high-precision work (unless it were possible to install a

IV - MAIN COMMENTS AND POTENTIAL RDSULTS (Cont'd)

6) Cont'd:

highly effective air-conditioning system). It could then also handle maintenance and repair work for other companies that do not have their own M. & R. shop, or suffer from temporary overload in this field, by delegating its own workers.(*)

This remark applies whether or not the machine shop will continue making dies in the future. Naturally, a site change may make it necessary to also move a part of the heat-treatment equipment, or lead to the acquisition of additional equipment. But then, the acquisition of a spark-erosion machine would also be indispensable if the production of dies were to be continued.

*) Pending a final decision about its future, the workshop (machine shop, etc.) could already work on a temporary basis as a "service company" in the field of maintenance and repair to other factories, delegating its own machine-fitters (etc.) and reconditioning spares using the production machines in its own workshop. A possible customer (e.g.) could be the Aluminium Factory in Maalla.

(N.B. This auditing report was completed on 22 Feb. 81)

Auditing Report No. A-2

I - COMPANY IDENTIFICATION

Name (approx.): ALGUNDI PLASTIC FACTORY

Economic Sector: Public Visited (Date/s): 7 Feb.81

Location (& Governorate No.): Khormaksar (1.G)

II - PRODUCTS

- Crates for vegetables (multi-purpose) and beer
- Small household goods like cups and saucers

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Evacuation of excess material ("Flush") from injection mould in view of reducing machine idle-time
2) Determination of operator's workload in view of determining the amount of additional workload that could be handled during machine time

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Most operations are essentially machine-controlled, but the influence on the cycle-time by the operator is not negligeable. Operators' performance level is on the low-side in most cases. Furthermore, reportedly, the operators refuse to handle other work during machine time; if forced to, they are likely to quit the Company. This aspect should be studied carefully, also in view of the possibility of one operator attending two or three machines, which seems to be quite possible.

2) Health and accident-hazard seem to be generally low, an exception is the crunching machine for recuperating the raw material from rejects. This machine is very noisy and could cause deafness of the operator.

3) Quality has an aspect that is related to dimensions and appearance of the parts; this aspect seems to be on a satisfactory level but could not be analyzed closely. A second aspect is related to rejects which are numerous, at least in the case of the crates, that present holes due to improper filling of the mould. This is a technical problem that could have different causes like :

   - inadequate part or mould design,
   - inadequate process (melting temperature cycle duration or pressure),
   - inadequate raw material.

   The Company is already receiving assistance in this technical field from a G.D.R. Expert, so that UNIDO need not be concerned.

Auditing Report No. A-2 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

4) Work methods are mainly machine-controlled, but the removing of the flush (excess material) from the mould is done by hand and takes too much time, since the method is poor. Furthermore, the operators' performance level is low. --- Also, operators do not utilize machine time to deburr (e.g.) parts from the previous cycle or to attend other machines, as already mentioned. The Company should keep insisting that such "multiple activity work" be carried out by the operators, since it could lead to a sizeable reduction of labour cost. At the same time output would increase, even though slightly; anyway, equipment changes and their cost would be minor.

5) Plant-layout was not evaluated closely but it did strike at first sight as being plagued by important deficiencies. Material handling seemed to be acceptably good for small parts. No opinion can be expressed on the handling of large parts (= crates) since the corresponding section was not operating at the time of the visit.

6) General impression is positive. This Company seems to be well-managed from the point of view of production, even though not all problems are yet mastered, as discussed in the preceding points. In other words, though production aspects are fairly well mastered, production cost must still be brought down (this also refers to the reduction of the reject rate), in order to be able to resist the effects of competition from abroad. --- This seems to apply also to some extent to marketing, that must be improved. Management is aware of this and is imaginative about it, even though it does not have full freedom of action.

(N.B. This auditing report was completed on 24 Feb. 81)

APPENDIX VIII-3

Auditing Report No. A-3

I - COMPANY IDENTIFICATION

Name (approx.): ALUMINIUM FACTORY

Economic Sector: Mixed Visited (Date/s): 3 & 5 Feb. 81

Location (& Governorate No.): Maalla (1.G)

II - PRODUCTS

- mainly household good of all kinds, like trays, basins, tea-pots, cups, milk-kettles (also for farms), etc.

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Manufacturing of handles for milk-kettles (cutting to length, bending both ends, shape handle), from wire,
2) Manufacturing of handle for "tiffin-carrier" (multiple-pot for food transport) from imported strips
3) Cut sheet-metal into strips to be used to manufacture hinge-parts on punch-press (hand-press),
4) Assembly of hinges for tea-pots,
5) Punching of beak-hole into tea-pots,
6) Rivet hinge or handle onto tea-pot (would be studied with present workmethod if delivery of already ordered compressor for new rivetting-machine should be delayed).

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are man-controlled, operators' performance level is generally high, specially in the case of machine operators.

2) Health hazard through fumes or other causes could not be checked. Accident hazard, on the other hand, is high through unshielded belt-drives, lack of safety devices, e.g. on shearing machine, etc. (some punch-presses are provided with safety devices; these, however, can be short-circuited, and often are, to increase output). There is also some discomfort through flying chips around the spin machines (when trimming discs prior to beading); furthermore, their operators wear neither protective gloves nor goggles.

3) Quality is generally on a low level from the point of view of appearance and of the accuracy of parts to be assembled, that do not fit properly. This is partly due to machines and dies for punching parts, that are old and worn out; but also because the majority of the dies in themselves are of the most primitive design, that is totally inadequate for precision parts (fidelity in shape and dimensions, as would be needed for efficient assembly methods). Lack of adequate fixtures or holding devices for machining and assembly operations makes the situa-

Auditing Report No. A-3 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

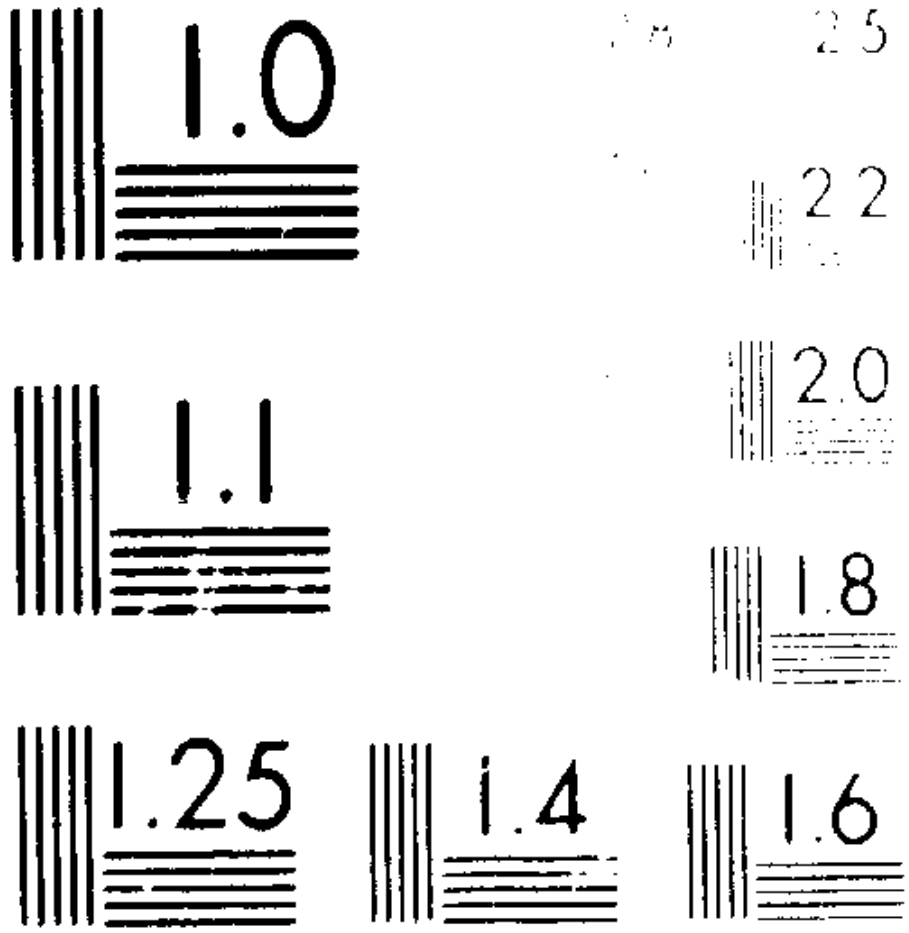
tion even worse. --- Furthermore the factory floor is crammed with semi-finished parts, that are exposed to damage through passing workers who may step on them, and through material-transport. Also, polished parts, like tea-pots, are simply thrown onto the floor after polishing, for intermediate storage, with a high risk of dents. --- In general, quality thinking seems to be absent; this may be a consequence of lack of competition through imports or plastic-products. (N.B. A subsequent analysis carried out on 24 Feb. 81 within the framework of a practical project, showed e.g. that dimensional quality of the parts for tea-pot hinges is so poor, that this problem must first be solved before improved assembly methods can be devised.)

4) Work methods in the press and spin sections are rather good (except for safety hazard); they are generally poor in the other sections. The few fixtures and other devices that are in use are generally of primitive design. Improvement possibilities through work study are therefore high, though partly impaired through the quality of the parts, etc.

5) Plant-layout is inadequate. However, the main machines in the press and spin sections have a common shaft for their belt-drive that makes changes difficult; but then, at present, plant-layout is not the main problem. A problem of greater magnitude is caused by material-handling and intermediate storing of work-in-process inventories, that are totally inadequate. There are practically no shelves and no standardized containers (old or reject basins are used in some cases, but they are not well suited for handling, for storing, and for quantity control). Therefore, parts pile up on the floor between "consecutive" work-places, resulting in high work-in-process inventories and in a high rate of damage. Inadequate production planning may also contribute to the poor material-flow.

6) General impression is difficult to formulate. Operations strike as a combination of generally fast workers and of mostly primitive workmethods, combined with products of unsatisfactory appearance, and with a poor material-flow. This company must have an agile management and supervisory team, or it would not be able to maintain its production rate for a long time. In the future, however, competition through imported aluminium products, or through locally made plastic goods, could make its situation less comfortable.

An important task is the reconditioning of machines of all kinds (this also refers to grinding of shearing-machine cutters) and of corresponding tooling, to produce parts of consistent


1.0
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

Auditing Report No. A-3 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

dimensions and quality that are absolutely essential for efficient assembly methods. Referring to dies, however, it must be stressed that reconditioning would not be sufficient and that they must be replaced by first-class dies of modern design. --- The reconditioning of the production equipment might exceed the capacity in men and machines of the Company's maintenance department. If this were the case, help would have to be sollicited from a "Service Company"(such as the "Revolutionary Workshop", or the workshop of "Agricultural Implements"), that would delegate its own machine fitters and other specialists; additionally to rebuilding spares or to making new ones in its own machine-shop. Naturally, a service company from abroad could also be taken into consideration.

Another essential and urgent task refers to preparing dimensional drawings of all individual parts and assemblies manufactured by the Company, and of all tooling and auxiliary equipment as well, with indication of needed finish, acceptable range of dimensional deviations, etc. These drawings are vital for maintaining a consistent quality-level, provided they are systematically utilized in combination with measuring instruments and/or gauges that must also be procured. These drawings and control-equipment will be the basis on which a quality control-system will be built in the future. So far the Company has not used drawings of any kind; this is reflected by the quality of its manufacturing methods and of its products.

In summary, this Company has a lack of qualified technical personnel of intermediate level, that will be needed for existing and for new "staff" functions to be created in the future; e.g. for designing and drawing of parts, of manufacturing equipment (fixtures and devices of all kinds) and of quality-control gauges; e.g. for manufacturing-engineering, and for work and time-study; e.g. for production planning and control; and for others.

Moreover, as already stressed, the Company has an urgent need for modern dies, that must be procured from adequate sources. Hiring of a good tool-designer with experience in dies might be taken into consideration at a later point. Additionally, the whole machine-park is antiquated. It would be advisable to replace at least some machines (like the small hand-presses), while reconditioning the remaining ones. A similar statement applies to the melting section ("Small-Part Foundry"), that has a totally inadequate equipment; dimensional quality and finish of cast parts are of a corresponding level. The remaining sections, such as reception of material, washing of finished goods, shipment and others, could not be studied more closely, so that no reliable comments can be offered.

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

Subsequent remark from 5th March 1981

Close analysis of several machine and assembly operations, within the framework of the practical projects carried out in this factory, has shown that in the case of some workplaces or operations it could be premature to do detailed methods' improvement work. This is because of the poor quality of the parts to be assembled, that cannot be properly positioned in adequate assembly-devices due to lack of dimensional fidelity and poor finish (burrs, dents, bent corners).

It may, therefore, become advisable or necessary at a particular point to temporarily interrupt the detailed methods' improvement-phase and to replace it, within the framework of the work study-programme, by a study of the pure handling aspects around and between the workplaces. This in view of creating a system of containers for "new", for "intermediate state" and, possibly, for "finished" parts, that would streamline the material-flow while simplifying production control.

Detailed methods' improvement-work could then be resumed on a broader basis when machines will be reconditioned and, specially, when new dies become available.

APPENDIX VII-A

Auditing Report No. A-4

I - COMPANY IDENTIFICATION

Name (approx.): CARPENTRY CORPORATION

Economic Sector: Public Visited (Date/s): 3 & 4 Feb. 81

Location (& Governorate No.): Maalla (1.G) - Factory has a second plant in Khormaksar (1.G) that was not visited.

II - PRODUCTS

- wooden furniture, also upholstered (this is the main product-line)
- small cabinet-maker's work (like jewel boxes) with jigsaw decorations
- guitars

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Mark table legs for machining (N.B. with modern production methods this operation would be totally eliminated)
2) Any machining operation offering a sizable batch-size (e.g. "drill-mill" rectangular hole for cross-support in table leg)
3) Assembly of chairs (or possibly another assembly operation with sizable batch-size)

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are man-controlled. Operators' performance level lies in most cases in the medium-low range.

2) Health hazard through fumes could not be assessed. Health hazard and discomfort through saw-dust and flying chips is definitely present. Accident hazard is rather great through unshielded machines and blades, as is frequently the case with wood-working machines. Fire-hazard is definitely present, since smoking is allowed in the whole plant and there is no sprinkling installation; furthermore there seem to be no fire extinguishers around.

3) Quality is allegedly impaired by inadequate raw material, purchased by "Home Trade" disregarding Company specifications. A definite quality loss is related to parts that are not interchangeable because of lack of fidelity in their dimensions. This is a result of positioning parts in the machines using pencil-drawn lines as reference. This is a totally inadequate system. It should be replaced by stops and guides, that would be mounted on the machines, to eliminate the need for previous marking of the parts with pencil and ruler (consistent parts would also eliminate adjusting work during assembly). Insufficient quality also applies to top-plates of desks, that are not

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

totally even. This is a result of applying the finishing plastic-leaf by hand, and of pressing the leaf against the plate with the palm of the hand (mechanical pressing of some kind should be available, to obtain an even distribution of pressure while the adhesive is drying).

4) Work methods are generally poor and in many cases inadequate. There are definite improvement possibilities through work study.

5) Plant-layout and material-handling are totally inadequate. Definite improvement possibilities through work study exist; but apparently a new layout has already been studied in relation to the purchasing of new machines, that are due for delivery in coming June.

6) General impression is difficult to formulate specially since considerable changes are being introduced in the layout and in the production equipment that is going to be completed by new machines within a few months. In its present state, however, the Company is very disorderly from several points of view and stirs a "pre-industrial" impression. This is also related to the fact that the Company is obviously in need of technical talent; that it uses no drawings in the classical sense; that there is no coding nor a reference catalogue for the existing templates (they refer mostly to the outer form of the furniture); that parts or complete pieces of furniture are tinted or painted (by the brush!) in the courtyard where they are exposed to sandy wind; and other aspects. --- It can be safely assumed, therefore, that in the case of this Company the whole industrial process has to be totally reorganized.

(N.B. This auditing report was completed on 23 Feb. 81)

APPENDIX VII-5

Auditing Report No. A-5

I - COMPANY IDENTIFICATION

Name (approx.): CIGARETTE AND MATCH FACTORY

Economic Sector: Mixed Visited (Date/s) 8 Feb.81

Location (& Governorate No.): Maalla (1.G.)

II - PRODUCTS

- cigarettes
- matches

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Put cigarettes into tray at end of cigarette-making machine (2 operators)
2) Recuperate cigarettes from reject packs (1-4 operators)
3) Wrap 10 packs of cigarettes into parcel on parcelling line (7-8 operators)
4) Handfilling of matches into family-size boxes

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are partly machine-controlled, partly man-controlled. Operators' performance-level is high in connection with machine work, low in connection with purely manual work.

2) Health and accident hazard seem to be in general on a low level. However, no opinion can be expressed about the effectiveness of the automatic fire-extinguishing installation in the match division.

3) Quality in the cigarette division seems to be good as far as appearance of cigarettes and packs is concerned. No opinion can be expressed about the smoking quality in itself. --- Quality in the match division is satisfactory as far as appearance of matches and boxes is concerned. No opinion can be expressed about the ignition quality of the matches.

4) Work methods are generally good in the case of machine-work, they are unsatisfactory in the case of purely manual work. There are, therefore, a few interesting application possibilities for work study. (This would also apply to the receiving section of the cigarette division where operations and handling require a considerable amount of handwork; however, new, more effective equipment has already been ordered and should be installed and ready for work within a few months.)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

5) Plant-layout was not closely analyzed but seems on the whole to be quite satisfactory. Possible minor errors would be bridged anyway, in most cases, by the process-type material flow, and would, therefore, have a relatively low influence on the cost of the product.

6) General impression is positive. The Company is on the whole clean and orderly. There are no congestion-points for the material flow, and all major production aspects seem obviously to be understood by Management, and well under control.

(N.B. This auditing report was completed on 26 Feb. 81)

APPENDIX VII-6

Auditing Report No. A-6

I - COMPANY IDENTIFICATION

Name (approx.): FLOUR MILL

Economic Sector: Public Visited (Date/s) 4 & 7 Feb. 81

Location (& Governorate No.): Maalla (1.G.)

II - PRODUCTS

- flour (in 60 kg. sacks)
- bran (in 25 kg. sacks)

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Filling and sewing of bran sacks, and loading on truck (8 operators?)
2) Filling and closing (sewing?) of flour sacks and arrange for shipment (2 x 2 operators?)

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are essentially machine-controlled but with a considerable amount of handwork at beginning and end of each section, mostly for loading and unloading machine groups (i.e. feeding and evacuating). Operators' performance level is on the whole of medium level, but high in some cases (like filling of bran sacks).

2) Health hazard through the pollution from flour or dust could not be assessed. Accident hazard through unshi lded machines seems to be rather low in general.

3) Quality as related to the product (flour and bran) in itself could not be assessed. However, the flour sacks remained open for some time after filling and were, therefore, exposed to pollution through insects.

4) Work methods are of average level; they are very good in the case of the filling operations. Still, improvement possibilities through work study definitely exist. This may also apply to the receiving section, but this could not be assessed since work was stopped at the time of the visit.

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

5) Plant-layout is determined on the whole by the process, and was therefore not closely analyzed. Definite improvement possibilities exist, however, in the Filling Stations (where sacks are filled with flour or bran). They can be realized through work study and should lead to a reduction in the workers' number and to make work easier for the remaining ones, simplifying material handling that is considerable with the present solution.

6) General impression is positive. The factory is on the whole clean and orderly. Production operations seem to be well under control. This, however, does not necessarily apply to all aspects of the production cost that could not be analyzed when the plant was visited.

(N.B. This auditing report was completed on 24 Feb. 81)

APPENDIX VII-7

Auditing Report No. A-7

I - COMPANY IDENTIFICATION

Name (approx.): FOAM AND METAL FURNITURE FACTORY

Economic Sector: Mixed Visited (Date/s): 10, 11, 12 Feb. 81

Location (& Governorate No.): Al-Durain (1.G.)

II - PRODUCTS

- foam-rubber blocks, cast and cut to size, for mattresses, pillows and other purposes
- metal furniture (beds only, at the present time)

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Cutting foam blocks into layers on automatic "band-saw" (including loading and unloading of machine, and storing finished material)
2) Assembly and welding of bed-frame consisting of four angle-irons
3) Drill two holes for cross-bar in bedstead

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are partly machine-controlled and partly man-controlled. Operators' performance level is generally high in the foam section, rather low in the metal-furniture section.

2) Health hazard is high in the foam-section through chemical fumes; some operators wear a breathing mask but this might lead to discomfort in the hot season. An efficient fume-exhaust system should be installed. This also applies to the metal-furniture section, where discomfort through welding fumes is rather high. Furthermore, welders and other workers should be shielded against strong light from (electric) welding. --- Accident hazard is medium to low in both sections. However, it would be advisable with the present working method to shield the blade of the cutting machine for foam layers, since there is a definite risk of injury.

3) Quality differs with the product. In the foam-section it has three aspects: the quality of the foam in itself, dimensional fidelity of the cut foam-layers, and general appearance of same. The first two could not be checked but it is assumed that they are correct. On the other hand, the appearance of the finished product is impaired by greasy hand-marks and by sand-incrustation through weather exposure, or inadequate handling and storage, or other causes. This kind of defect should be totally eliminated. --- In the metal-furniture section quality is no

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

doubt adequate from the point of view of mechanical resistance; but it is inadequate from the point of view of dimensional accuracy and finish. Among other consequences (such as rejection through customers, in the future), this also leads to increased manufacturing cost. This is caused by lack of jigs and fixtures, as well as guides and stops. Furthermore, drill-bits are not properly ground, and this causes strong burrs. (The holes for the re-inforcement bar of the bedstead, e.g. are poorly aligned, in addition to presenting strong burrs, so that the assembly of the bar onto the bedstead is not possible without extra work. --- Finally, the painting is done by brush, all parts being exposed to sunshine and sandy wind: finish is therefore poor (the more so, since the plant is in a corrosive area, and raw material is therefore frequently rusty).

4) Work methods are partly good in the foam-section. There is, however, an interesting application possibility for work-study, that refers to the machine for cutting the foam-blocks into layers. Here, labour cost can be reduced and output increased through reduction of machine idle-time. In the metal - furniture section there are also important possibilities for improvement through work study, that will lead to a strongly increased output, reduced labour cost and considerably improved quality.

5) Plant-layout is inadequate in general, and should be improved. Material-handling and material-flow are poor and should be improved also. This is specially true in the foam-section, where there is considerable lack of space on the floor or on shelves for intermediate and final storage. It must be stressed, however, that improvement must come as a result of detailed work-study of the work-places; and this will then automatically grow into an improved layout and material flow.---This fact must be stressed in view of the new plant that the factory plans to build sometime next year. It is recommended that the construction work be delayed until the new layout, that has already been prepared, can be reviewed from the work-study angle; i.e. when all essential workplaces have been improved with the help of work study. Disregarding this rule would most likely mean that some of the present errors will simply be transplanted into the new building.

6) General impression is difficult to formulate since this factory has some contradictory aspects. Thus, e.g. the foam-section and the working habits of its operators are close to an industrial situation; while the metal-furniture section is still totally artisan-oriented. No doubt this Company has an agile Management, also on the production level, to keep it going without too much trouble at its present output-rate.

(N.B. This auditing report was completed on 4 Mar. 81)

APPENDIX VII-8

Auditing Report No. A-8

I - COMPANY IDENTIFICATION

Name (approx.): MILK AND DAIRY FACTORY

Economic Sector: Public Visited (Date/s): 7 Feb 81

Location (& Governorate No.): Khormaksar (1.G.)

II - PRODUCTS

- pasteurized (= medium-life) and sterilized (=long-life) milk in tetra-packs
- yoghurt in sealed goblets
- white cheese in helpings, packed in sealed plastic bags

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Unload milk packs from Tetra-Pack machine, put into special crates and store away, ready for shipment (man-assisted automatic line)

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are mainly machine-controlled (process type) but with a sizable amount of continuous or random supervision through operators. Additionally, there is a fair amount of hand work in the receiving section for milk, and in the milk-packing section to unload the Tetra-Pack line and to store the milk packs. Operators' performance level is rather on the lower side.

2) Health and accident hazard could not be assessed without a close analysis, but seem to be very low.

3) Quality could not be assessed. However, it can be assumed to be good from the point of view of cleanliness and good shape of the processing equipment. On the other hand it must be pointed out that the automatic yoghurt-filling machine does not provide a lid that would cover the goblets before filling, and immediately after, leaving the goblets exposed to insect-action during several packing-cycles before automatic sealing. A suitable lid should be provided.

4) Work methods on the whole are dictated by the production equipment, and are in general of a checking and controling type. There are, however, some application possibilities for work

Auditing Report No. A-8 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

4) Cont'd:

study, even though the success-potential would not seem to be very great. Such possibilities exist, for example, in the receiving section and in the milk-packing section (unloading and storing for shipment). On the other hand, the number of workers engaged in checking and controlling of the continuous processes is quite high. It might be interesting to carry out some day a long-range check through work-sampling or other techniques, to determine whether their number could be reduced without endangering quality of products, or equipment safety.

5) Plant-layout was not closely analysed but did not strike as being plagued by gross errors. Minor errors would be bridged anyway through the "process-type" material-flow. For the same reason there is only a limited amount of material handling, concentrated in receiving and milk-packing. It does not interfere with the fluidity of the production process, but its cost could probably be somewhat lowered.

6) General impression is positive. The plant is orderly and well kept, and in general very clean. The production aspects of this Company seem to be under control. No major problems of maintenance were reported. On the other hand, cost break-down could not be analysed and could therefore not be assessed.

(N.B. This auditing report was completed on 25 Feb. 81)

APPENDIX VII-9

Auditing Report No. A-9

I - COMPANY IDENTIFICATION

Name (approx.): PAINT FACTORY

Economic Sector: Mixed Visited (Date/s): 3 & 4 Feb. 81

Location (& Governorate No.): Maalla (1.G.)

II - PRODUCTS

- paints in one-US-gallon tins, in two varieties (commercial, and anti-corrosion for ships)
  N.B. The tins are wholly manufactured in the plant(*), but for the imported wire-handles

*) from imported sheet-metal that is already cut to size for main parts

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Complete tin-manufacturing section (12 people including foreman)
   N.B. Layout and handling problems may force the project to stretch into the section where the paint is made and filled into tins.

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are man-controlled. Operators' performance level is high in the tin-making section, low in the paint-packing section.

2) Health hazard is rather high due to fumes both in the paint-packing section and with the soldering operation in the tin-making section. Accident hazard is rather low in general within the buildings, except for punch press in the tin section. Accident hazard is rather high in the court-yard were solvent-barrels are stapled; bumps through trucks could lead to leakages and subsequently to fire and explosion (smoking is permitted in the yard).

3) Quality of the paint is accepted as good; the expert has no opinion to offer on this subject. On the other hand, the quality of the tins could be improved. There are numerous rejects during manufacturing, especially with the operation for fastening the tin-bottom to the cylindrical part (the rim is not properly beaded, and this could be caused by dents due to poor handling). There are also leakages with filled tins.

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

4) Work methods are rather good in the tin section; they are generally poor in the filling section. Definite possibilities for improvement through work study exist in the whole plant.

5) Plant-layout is not adequate. This applies both to storage and to manufacturing operations, and makes material-flow difficult. Material handling is not satisfactory, specially in the case of stored raw material and in the tin section. In the latter the parts pile up between consecutive operations on the floor or on work tables, cramming the whole section. Furthermore, the parts lingering about on the floor (no containers are being used!) are exposed to damage by passing workers, who can step on them. This section has to be totally re-balanced.

6) This Company makes in general a good impression. But its manufacturing costs are burdened by a high reject-rate and by open-air storing of raw material (sun exposure of the pigment sacks causes e.g. chemical changes in the pigment; wind and rain lead to heavy losses of pigment).

N.B. The Management wished to do away with the open-air storage in the factory court-yard for the reasons mentioned above and to avoid barrel leakage through bumps by delivery trucks. A request for a sheltered storeroom, together with other technical measures, was turned down by the Ministry of Industry.

This could be interpreted in several ways. One possibility being that Management had not justified sufficiently well its project with respect to one or more of the following aspects :

- technical details
- total estimated cost
- expected savings per year
- pay-off time

This brings up the question of feasibility studies that should accompany investment requests. Feasibility studies may not yet be common in P.D.R.Yemen or they have not received the commanding attention they deserve.

(N.B. This auditing report was completed on 2 Feb. 81)

APPENDIX VII-10

Auditing Report No. A-10

I - COMPANY IDENTIFICATION

Name (approx.): REVOLUTIONARY WORKSHOP

Economic Sector: Public Visited (Date/s): 5 Feb. 81

Location (& Governorate No.): Khormaksar (1.G.)

II - PRODUCTS

- spare parts and mechanical elements for industry, on order
- gates and drive-shafts (also threaded) for dams
- sheet metal work (e.g. air conduits for ventilation and air-conditioning)
- tricycles and open-air playing equipment for children (swings, roundabouts, etc.)
- machine prototypes and foundry work (on a small-scale artisan-type work)

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Manufacturing of children's tricycle (all operations for manufacturing, assembling and painting)
2) Assess adequacy of welding fixtures for making dam-gates, in view of dimensional fidelity of finished parts and of work-efficiency

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are in most cases man-controlled. At the time of the visit a majority of sections were not operational; in the remaining ones, operators' performance level was in the medium-low range.

2) Health and accident hazard could not be assessed in a general way, since the factory was only partially operating. However, fumes and strong light from welding operations caused at least discomfort to the surrounding workers, if not to the welders themselves.

3) Quality could not be defined in a general way due to the diversity of the manufacturing programme, and because not all sections were operational when visited. However, parts (including threaded shafts for dam-gates) waiting for further utilization in the different factory-sections, within or outside the buildings, were totally or partially rusty and, furthermore,

Auditing Report No. A-10 (Cont'd)

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

exposed to dust through sandy winds. The factory site is indeed in a highly corrosive area and should be moved if possible to another location, more in line with precision-work. Moreover the buildings offer insufficient protection against sandy winds. --- Strong attention should be paid to this aspect, since faults of any kind in the spares delivered by the Company can have a repercussion on the quality of the products manufactured by the client company. This is specially important in view of the jigs and fixtures that the Company may be called upon in the future to deliver to its clients in the framework of UNIDO's work study programme; it naturally also applies to dimensional fidelity and good finish.

(N.B. Independently from other considerations, the rust problem must be solved without delay. Thus, parts must be greased immediately after machining. This will give factory Management some time to study the problem more thoroughly in view of introducing more sophisticated long-range anti-corrosion protection, such as emulsion-coatings supplied by the oil-industry, or other procedures and techniques.)

Another weak-spot from the point of view of quality lies in the general appearance of children's-tricycles (this also applies to the imported wheels that are of poor finish, or suffered from inadequate handling before or after delivery). Furthermore, the paint coat is of poor appearance, which may be a consequence of one or more of the following causes: inadequate paint-quality or painting-system; poor finishing after welding of frames and other tricycle-parts; exposure to sand wind (or simply : wind and strong sun-shine) during painting or drying; others.

Some doubts can also be expressed about the advisability of creating product diversification by copying existing products from other companies without a licensing agreement since (A) it could be illegal, and (B) there would be no transfer of know-ledge and experience from the original Company. --- Thus (e.g.) "Revolutionary Workshop" built the prototype of a water-pump in this way (actual production has not started for want of interest by possible clients). Related to this example it must be stressed that water-pump technology is not as simple as suggested by the look of the object. Thus, water-pumps are exposed to destructive action through corrosion, erosion and cavitation, that can be mastered through special metallurgy only, additionally to adequate design. It can be assumed that such knowledge is not available at "Revolutionary Workshop".

4) Work methods could not be observed in all cases under working conditions, so that no general comments can be made about them. But the few fixtures and other devices seen in the different

Auditing Report No. A-10 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

4) Cont'd:

sections of the factory did not make a convincing impression. Work-study application is a must but should be preceded by a clear definition of the production programme.

5) Plant-layout is inadequate at present, but a new layout has reportedly been prepared in view of the delivery of new machines, expected for the near future. Material handling and intermediate storage is inadequate and costly, and offers a vast opportunity for work-study applications. Final storage should be analyzed more closely before comments could be offered; it was just somewhat surprising to see that finished prdoucts, or a part of them, were stored in the open, totally exposed to weather action.

6) General impression of manufacturing operations is rather unfavourable. The factory, in spite of its large total size, does not give the impression of an orderly industrial enterprise. Management is aware of this and is obviously keen to introduc rovement. However, it faces many problems, one of which being a wide spectrum of products, each of which would individually need its close and continuous attention.

Another problem lies with its work-force, that has obviously grown used to a low level of activity; it may not be too easy to revert the trend and bring the workers back to continuous and systematic work habits when the factory will have to increase its output due to greater demand for its products. --- A good start towards a new industrial ambiance could be made in the tricycle section that should be brought up to top-shape from every point of view (work methods, handling, intermediate and final storage, quality, operators' performance level, etc.) This same pattern could then gradually be extended to other sections, for which the tricycle section would serve as an example.

Management is of the opinion that there is a good market for tricycles. If this is true, and considering that it is a sound practice to expand into a line of products belonging to a family of technology that one already masters or knows fairly well, it might be interesting from the point of view of marketing to follow a strategy like this: first step, for immediate application, is to improve quality of the tricycles and then their output; second step, to be taken in two to three years, is to expand into making bicycles for children; third step, to be taken in four to five years, would be to start making bicycles for adults. (Further growth in the "wheel-product family" could be possible with items like light motor-cycles, light carts for special purposes, and others).

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

Such a product family could match well with the open-air playing equipment for children that is already being manufactured and that is reportedly well-accepted by customers. This could be the starting point for a successful division of the "Revolutionary Workshop", with which the general public would find it easy to identify. --- With time this same growth-philosophy could be gradually applied to the other Divisions of the Company, some of which have already been selected for changes with/without assistance by UNIDO.

With reference to the "spare-parts market" it must finally be stressed that making spare parts is just one facet of the "Maintenance & Repair Business" and that, therefore, "Revolutionary Workshop"should consider the possibility of doing actual maintenance and repair work on the premises of their clients, as a "Service Company", by delegating its machine-fitters and others, naturally against billing for their services. --- Such technical assistance could be of value not only to smaller companies that have no maintenance and repair department of their own, but also to larger companies that are temporarily in need of outside assistance, because, for example, for some reasons that would be difficult to define "a posteriori" they have neglected in the past routine-maintenance work. It can be assumed that such companies are quite numerous in P.D.R. Yemen, and that therefore such "service work" could gradually meet with great demand.

(N.B. This auditing report was completed on 27 Feb. 81)

APPENDIX VII-11

Auditing Report No. A-11

I - COMPANY IDENTIFICATION

Name (approx.): TANNERY

Economic Sector: Public Visited (Date/s): 12 Feb.81

Location (& Governorate No.): Al-Durain (1.G.)

II - PRODUCTS

- mutton skins (from Aden's slaughter house) conserved with salt, for export
- skins and hides, tanned and dyed or spraypainted, for the home-market

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Salting of fresh mutton-skin for conservation and export(including spreading out on the ground, two days after salting, for drying through sun exposure); pile and wrap conserved skins in sackcloth and sew to bales, ready for shipment
2) Piling of a dozen tanned skins, cut leg-parts and fold, ready for export

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are mostly process-or machine-controlled but with a considerable amount of manual work for loading and unloading machines, and for other tasks. Operators' performance level ranges in general from low to "good average".

2) Health hazard through salt and chemicals action is certainly present but could not be assessed. Accident hazard is also present through rotating machines and machine-drives, though its degree does not seem to be very high. Nevertheless some shielding is no doubt necessary.

3) Quality of tanning would need chemical and wearing tests that could not be carried out. Quality of appearance, as a consequence of conscientiousness of the work-force, seems to be good at first sight. On the other hand, the quality of the raw material in itself is to some extent mediocre as a consequence of diseases or insect action on live animals, and through an excessive number of cuts proceeding from unskilled or careless work in the slaughter house. This point was subsequently confirmed and stressed by a member of UNIDO's

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:
Industrial Advisory Team, who has (*) greater experience in the leather industry and who had an opportunity of visiting the tannery on 22nd February 1981.
*) Mr. A. Aziz

4) Work methods are partly acceptably good, partly rather poor, but on the whole "not too bad for a tannery". Furthermore, the acquisition of modern machines or equipment, that will bring considerable relief, is already planned or in the process of procurement. This is true for example of the fastening of the wet, tanned skins and hides on wooden boards, so they will remain flat after drying. At present they are simply nailed on the boards; this is time consuming and causes further damage to the hides.

5) Plant-layout is not at its best, but on the whole, changes would not be advisable without changing the production equipment and machinery. Material handling is rather considerable but in general intermittent, so that it could not be observed close enough in many cases, particularly not with machine-operations. Nevertheless, it would seem that there are definite possibilities for improvement through the work-study approach.

6) The general impression is rather positive, in spite of the old buildings and equipment, the inadequate layout and the usual difficulties inherent to a tannery. The factory makes on the whole a good impression. It is acceptably clean and tidy. Moreover it is not crammed with work-in-progress inventories. The production side of this factory seems to be efficient in general, and well under control.

(N.B. This auditing report was completed on 22 Feb. 81)

APPENDIX VIII-12

Auditing Report No. A-12

I - COMPANY IDENTIFICATION

Name (approx.): TEXTILE MILL

Economic Sector: Public Visited (Date/s): 9 & 10 Feb.81

Location (& Governorate No.): Sheik Othman

II - PRODUCTS

- Integrated cotton mill, with all production processes pertaining thereto, like spinning, weaving, finishing and dying (or printing), with the following lines of finished products: bed sheets, table cloths, scarves or head-shawls, flags and others

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Spinning Section : prepare bobbins for flyers (remove remaining yarn)
2) Weaving Section : remove beam with finished fabric from loom and insert new beam into loom

Or other projects

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are in most cases machine-controlled but the duration of machine idle-time and (though to a lesser extent), the number of machine stops due to breaking of the yarn, depend on the skill and speed of the operators. The sample observed was not large enough for final conclusion; still operators' performance level seems to be satisfactory in general with machine-controlled operations, while it is generally low with purely manual operations.

2) Health and accident hazard in the production sections could not be assessed closely, but does not seem to be very high, though some machines could be better shielded. In general it does not seem to differ greatly from what exists in other textile mills. This also applies to the noise level; still it is recommended that operators wear ear-protection. Furthermore, it must be stressed that the air-conditioning does not work properly, or is totally out of order. It is, therefore, likely that the air in the fibre-processing sections (from receiving to weaving) contains a large amount of short cotton-fibres. In the long run this could lead to diseases of the respiratory system.

3) Quality in a cotton mill depends largely on technical conditions (length of fibres, state of machines, and others); these aspects could not be analyzed. Quality depends furthermore on the degree of humidity, that has an influence on the resistance of the yarn and the frequency of breaks; a high number of breaks

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

reduces output and quality. Due to the shortness of the visit this aspect could not be analyzed; however, it can be assumed that it causes problems, since the air-conditioning system does not work properly or is shut down altogether. This is a consequence of having built the mill in a highly corrosive area that has lead to gradual distruction of the air-conditioning system (though poor maintenance may also have contributed to this situation). Management is striving to get the air-conditioning system rebuilt; no doubt this will have a greater bearing on quality.

4) Work methods as related to machine work seem to be fairly good in general, though improvement possibilities through work study definitely exist. This also applies to maintenance and repair work in the production departments as well as to set-up work. This also refers to the utilisation of adequate handtools, that may or may not be available in the plant; e.g. it was noted on occasion of the plant visit that some workers struck on a loom part with an adjustable wrench to straighten it, which leads one to imagine that hammers are not provided or that workers are not properly trained (in a Report from January 1979 about the textile mill by a former UNIDO Expert(*) it had already been pointed out that maintenance and repair workers were not provided with adequate hand-tools). For work study application in the main machine sections (spinning and weaving) it would be advisable to first make a "work sampling" study, to determine correct priorities for an improvement programme. --- Work methods as related to manual work are poor in many cases, and offer greater opportunities for improvement through work study. However, the incidence of such work on total labour cost is considerably smaller, as compared to labour cost related to machine work.
*) Mr. N. Siniscalchi

5) Plant-layout and material handling could not be analyzed but seem to be of acceptable level. This also has a bearing on general appearance of the production sections that are, on the whole, orderly and reasonably clean, and not jammed through excessive work-in-process inventories.

6) General impression is positive. This, however, would not necessarily apply to the cost aspect, that could not be analyzed. Furthermore, it was surprising to learn that each one of the three production departments has its own maintenance service; and that there is furthermore a workshop that makes spares for these maintenance services, and that belongs to a fourth department ("Technical"). This solution contributes to high overhead costs and does not necessarily assure the most efficient maintenance and repair work. --- This Company also reports some marketing problems. In this context it was surprising to learn that in the Organization Chart

Auditing Report No. A-12 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

the responsibility for "Marketing" and for "Purchasing" is attributed to one and the same department. This is not in line with prevailing organizational principles and could be resporsible for existing marketing problems. --- In summary, and to stick to production aspects, a company of this type and size has so many technical and planning facets that the origin of insufficient output, high costs, and others, can be manifold and interrelated. A large-scale corrective programme should, therefore, be preceded by a thorough and comprehensive data-gathering programme that would cover the following aspects at least:

- present plant-layout, material-flow and handling;
- work sampling of all activities (or "lack" of activity!) of men and machines (broken down by causes for stand-still), for the production and technical departments - and possibly others;
- audit of all maintenance and repair activities, including workshop;
- auditing of training needs related to production, maintenance and repair, workshop and other departments or sections that could have a bearing on former;
- audit of organization structure, including organization chart;
- audit (were it only simplified) of current practices in marketing and purchasing;
- audit of storing of raw-material; of intermediate storing; of final storing and shipment, including handling;
- audit of the present time-study system (if any!) and of the wage-incentive system, including the base-wage system;
- audit of waste-recovery;
- auditing of the organization and procedures for quality-control;
- auditing of production-planning and control procedures, the latter also in view of accurate quantification of amount produced by each worker or group of workers during the reference period (day, week or other);
- auditing of the situation related to the supply of electric power (300 production hours lost in 1980 due to power cuts, i.e. a loss of about 80% of a month's production, disregarding additional losses through impaired quality);
- audit of the organization structure of the whole factory, and of the corresponding organization chart, to determine weak-spots (additionally to the already mentioned merger

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

of the marketing and purchasing functions, there is e.g. another surprising point: thus the Company has three independent production managers, one for spinning, one for weaving, and one for finishing);

- others.

A reliable diagnosis of the present situation and, therefore, the definition of the steps of suitable action, must rely on quantified information. Both aspects must therefore build up on a detailed and thorough data-gathering phase that may require many man-months to be completed. --- During this initial phase detailed improvement-work may go on, like introduction of minor technological changes to the textile machines, or like work study-applications. On the other hand, major changes that would require large investments should be held back until completion of the investigation phase and definition of the improvement programme.

APPENDIX VII-13

Auditing Report No. A-13

I - COMPANY IDENTIFICATION

Name: (approx.): TOMATO PASTE FACTORY

Economic Sector: Public Visited (Date/s): 11 Feb.81

Location (& Governorate No.): Al-Fuosh (2.G.)

II - PRODUCTS

- tomato paste in tins of 150 and 450 grammes (N.B. semi-finished tins are imported, and completed in the plant)
- an unsuccessful attempt to diversify into tinned vegetables was made two or three years ago; the corresponding production equipment is still in the plant but not utilized, and is supposed to be dismantled

III - LIMITED PROJECTS SUITED FOR INITIAL WORK STUDY APPLICATIONS THAT CAN BE USED IF FACTORY IS RETAINED FOR STUDY (Shortness of present UNIDO Mission would exclude study of whole plant)

1) Feeding of packing-machine with tins (4 operators)
2) Shaping imported flattened tins back into cylindrical form (10 operators - during the plant visit they were engaged in other activities, so that the corresponding workplaces were unoccupied)
3) Storing (and storage!) of packed tins from the previous week's production in the General Stores, in one large heap during one week to detect leakages. --- The project would cover all phases, including handling, storing and checking; and probably also the final packing of the tins into cardboard boxes, and the final storage as well, pending shipment (the number of operators is unknown to the Expert).

IV - MAIN COMMENTS ON OBSERVED OPERATIONS AND POTENTIAL RESULTS (ALSO IN VIEW OF SAFETY AND QUALITY)

1) Operations are partly machine-controlled, partly man-controlled. Operators' performance level varies with the section, but is generally not very high.

2) Health and accident hazard could not be assessed closely but seems to lie in the minimum range.

3) Quality in this factory has different aspects. --- A first aspect refers to the composition of the tomato paste, that presents no additives of any kind besides salt; this, in contrast to imported tomato paste (it could be advantageous to mention this on the tin, or to stress it in advertisements). On the other hand, the true composition of the product is not known, since the factory has no chemical laboratory, nor a chemist

Auditing Report No. A-13 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

(a laboratory-room is provided but totally devoid of analytical equipment). Therefore, for example, it would not be possible to determine the acidity-degree of the paste at a particular moment, and then compensate it, if desirable, through addition of another tomato-paste variety drawn from a tank, to assure a blend of "constant taste". Such blending would naturally require additional equipment, and, in turn, additional space to place it conveniently in the factory (lay-out changes!). It is therefore obvious that the problem of chemical analysis has to be solved urgently.

There is another fact that stresses the urgency for analyzing capacity : this is related to the explosion of individual tin cans after delivery to "Home Trade", that leads to soiling of all tin-cans that are placed in the same shipment-box. "Home Trade" refuses to accept soiled tins and returns them to the factory, sometimes weeks or months after delivery.

The quantity of returned tins is rather high (in 1979 they were 3000 tins (boxes?)) and this leads to dissension with the Management of the Tomato-Paste Factory, that attributes the explosions to poor storing conditions in "Home Trade's" warehouse (no cooling system, and direct exposure to sun). --- Management of "Home Trade", on the other hand, is of the opinion that the explosions are due to excessive fermentation, which implies a high degree of acidity due to an inadequate manufacturing process, or to an inadequate variety of tomatoes. --- It is obvious that systematic chemical analysis during the manufacturing process would be the only means for establishing responsibilities and, then, for taking adequate corrective action.

A second aspect refers to the amount of tomato paste packed in each tin can. During the factory visit it was noticed that one of the two filling beaks of the automatic filling machine did not work correctly, or was poorly adjusted. Thus, the tins were not full, the amount lacking being around 10% (the tins of the parallel line were properly filled). The operators on the packing machine should be trained to watch this point closely and to stop the machine immediately as soon as such a defect occurs. Indeed, tins that are not completely full could lead to strained customer relations; but, also, the air-content could be one of the causes for later fermentation and tin-explosion.

A third aspect refers to inspection of fresh tomatoes in the receiving section (after washing). At the time of the visit two operators out of four were absent, but the inspection line moved at its usual speed, making it impossible for the two remaining operators to remove all defective tomatoes and other reject-parts, as could be shown by work-study. --- Since inspection was carried out partly only, one may wonder whether this

Auditing Report No. A-13 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

could have an influence on the quality of the finished product, such as its taste and appearance. If so, the inspection line (and the immediately following processing section) would have to be totally stopped whenever the inspection crew is incomplete. Or, perhaps, inspection could be eliminated altogether? One may also wonder whether there should not be a first inspection outside of the factory building, upon delivery of fresh tomatoes by the State Farms (the price paid to the farms could then be gliding, according to tomato quality).

A fourth aspect refers to tin leakage. Thus, packed tins are stored one full week in the General Store building to allow for detection of leakages, that are very numerous (reportedly leakage rate used to be 3-5% but has increased to 7-10% since 1980). There are two disadvantages in the present detection system, i.e. :

(a) the filled tins are stored disorderly on the floor in one heap, and a leak leads to the soiling of several tins that have to be cleaned before final packing into the cardboard shipment boxes;

(b) when filling the shipment boxes the tins are taken from the"disorderly" heap; when a leaking tin is detected it would not be possible to assign it to a particular production line or to a particular production day (of the previous week!)

Feedback of information and corrective action would, therefore, not be possible; therefore, a new handling and storing system should be developed with work study, that would reduce cost and increase leak-detection efficiency.

A fifth aspect refers to a problem of hygiene related to the handling of the empty tins, that are fed manually into the packing machine. Thus, the workers who carry out this work introduce their bare fingers into the tins to grasp them; this is not desirable. Moreover, empty tins are partly made ahead of time and stored upside down in shipment boxes for some weeks. This system allows for a more even distribution of the labour force in high season (January to April), but also causes increased handling costs. Moreover, there is no total assurance that tin-inside is protected against dust or insect action.

A sixth aspect (that is itself related to the fourth aspect) refers to the recuperation of tomato paste from leaking tins, as detected after a one-week-storage period in the General Store. At present, after leaking tins have been opened, their content is simply poured into a larger container or tin, and then brought back periodically to the filling machine; here it is mixed with the fresh tomato paste without any previous

Auditing Report No. A-13 (Cont'd)

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

3) Cont'd:

control. --- This recuperation method is at least open to questioning, since the whole procedure is not totally hygienic. Furthermore, the old paste may already have been soiled or is already in a state of fermentation, and, therefore, unsuited for mixing with new tomato paste.

4) Work methods are improvable in many cases from the point of view of output and quality. There are, indeed, in all sections definite application possibilities for work study. This also applies to the re-shaping of the imported tins, that are flattened prior to shipment to reduce volume. Thus, the tin-making section has to be totally reviewed to increase efficiency, reduce handling and intermediate storage, as well as the number of leakages.

5) Plant-layout in the whole factory does not seem to be adequate. This also applies to storage (intermediate and final). Some sections are crammed, whereas others strike through excessive space. Material handling (and storage) is also inadequate from the point of view of cost, space needed, as well as production and quality control. All these aspects increase the cost of the final product and should be reviewed through detailed work study.

6) General impression is positive. The factory is fairly clean and orderly, and the operators seem to concentrate on their tasks. There are, however, some major problems that have already been discussed.

An additional problem stems from the discontinuity of the manufacturing process that lasts only from January to April; while the work force is almost constant throughout the year, their number being in accordance to peak production requirements. During the low season the workers are engaged in general maintenance, in house-keeping and the like; they are, of course, not fully utilized and this has a negative influence on their morale, as well as on the cost of the finished product. --- Management would naturally like to reduce the number of people employed; this would necessitate a more even distribution of the work tasks over the whole year. In view of this, Management is taking into consideration two alternate solutions.

The first solution is of a technical nature, and is based on a UNIDO Report from 1976(?). It considers installing a storage tank to absorb excess-production from the paste-making section, to process it through the packing section over a longer period of time. This solution is based on the assumptions that there is a bottleneck in the packing section and an excess production-capacity in the paste-making section (these points could not be checked).

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

This solution seems to be technically feasible; moreover, it could somewhat increase the total production capacity of the plant. However, according to Management, detailed studies were not yet carried out. Thus, it is not known, e.g., if chemical additives would be necessary to store tomato-paste in tanks during an extended period of time. --- When this study is resumed it might be worthwhile comparing it with a solution that would consider using "cool or frozen storage" (feasibility study). This also in view of the Company's intention to start the packing of full, unmashed tomatoes at a later point.

The second solution is related to production planning, but would also need a storage tank to be fully feasible. With this solution there would be three totally distinct production phases, each one of four months' duration. The first production phase would be utilized to make the empty tin-cans; the second phase would be utilized to make the tomato paste; the third one would be utilized to pack the tomato paste.

This solution is already partly utilized, in as much as a sizable amount of tin-cans is prepared ahead of the packing time. Its disadvantages were already discussed when referring to "quality"; they would now be magnified, so that it is strongly recommended to stay away from this solution. It may be worthwhile to list again some of its disadvantages:

- need for very large inventories (intermediate and final), thus increasing the cost of inventories and also increasing the danger of accidental damage;
- no possibility whatsoever of tracing back defects, thus excluding early feedback into the production process that would allow for corrective action at the right time;
- some defects, when discovered too late, could even endanger total production (e.g. fermentation or soiling of the paste in the tanks; leaking of all tins through worn out packing equipment, etc.).

A final problem for the Management of the tomato-paste factory refers to the utilization of the seeds and peels, that amount to approximately 25% of total raw-material weight, i.e. about 1'700 tons of waste per year. (The factory processes indeed about 7'000 tons of fresh tomatoes per year).

Management is of the opinion that seeds and peels can be utilized for chicken food, while at present it is thrown away onto neighbouring fields, simply causing additional handling costs. This aspect should, therefore, be thoroughly analyzed, since recuperation of such an amount of waste could greatly reduce the factory's overall production cost. --- If feasible, seeds

IV - MAIN COMMENTS AND POTENTIAL RESULTS (Cont'd)

6) Cont'd:

and peels should be sold to chicken farms; or a new chicken farm should be created next to the factory; or right on its ground.

But other possibilities of waste recovery should also be analyzed. It might be possible, indeed, to use seeds and peels as fertilizers; or as raw-material for the production of industrial alcohol or others. --- It might also be possible to use seeds and peels as combustion material, at least temporarily, e.g. to satisfy the needs of the Tomato Paste Factory for heat (for processing of tomatoes), steam (for cleaning or sterilizing, etc.) or power (through steam engine or turbine, possibly coupled with an electric generator).

But this combustion material might also be useful for a new factory, such as a regional bakery; or for a smaller brick factory, for heating the kilns; or others. It is even conceivable that this new factory could work in alternation with the Tomato Paste Factory, absorbing its labour force or part of it during the low season.

To sum up, it is no doubt true to say that many of the problems of the Tomato Paste Factory, and this may hold true for other factories in P.D.R.Yemen as well, are due to a lack of continuous technical care and concentrated attention. The factory's technical staff should, therefore, be increased, an organic chemist being among them. Naturally, a fully-equipped laboratory would be need on the plant, or the chemist would only waste his time.

(N.B. This auditing report was completed on 17 Mar. 81)

APPENDIX VIII

TIME STUDY - A SIMPLIFIED INTRODUCTION

A - DETERMINATION OF TIME STANDARDS

The determination of time standards for industrial operations is partly a matter of philosophy. Accordingly, several time-study systems are available to the practitioner, that differ partly in the basic concept, partly in technical details.

The time-study system that is based on the concept of "normal performance" is the one that has met with the widest international acceptance. It has been utilized in the current Work-Study programme and is briefly described here.

Under this system the so-called normal-performance level (= 100%) can be exceeded by a motivated worker. Excess production, on a continuous basis, is usually in the range of 10-20% above "normal" or standard production. Sometimes it is more, depending on the skill of the worker, on the lot-size and on other factors.

-- Motivation stems frequently, but not exclusively, from wage-incentive payment. Other motivating causes may be job satisfaction, pleasant working conditions, and, most important of all, adequate supervision.

For the benefit of those who are not totally familiar with time-study principles, the following short description will explain the procedure to be followed to obtain a time standard that is in line with the concept of normal performance.

1) The time-study man measures the actual elapsed time (=ET) per part with the help of a stopwatch.

2) Simultaneously the time-study man "rates" the performance level of the worker being studied. In other words, the time-study man compares the actual performance of this worker (as can be judged by the speed and accuracy of his motions) with a "normal performance image" that has been impressed in his mind through a thorough training in time-study.

   The time-study man will then express his rating as a percentage figure. Thus a fast worker will be rated e.g. "at 120%", meaning that he works 1.20 times as fast as the imaginary normal worker. Whereas a slow worker would be rated e.g. "at 95%", meaning that he works only 0.95 times as fast as the normal worker.

3) The time-study man will then convert his performance rating (%) into a "performance-rating factor (PRF). Thus a performance rating of e.g. 120% will become a PRF of 1.20; and a rating of 95% will become a PRF of 0.90.

4) The time-study man will now determine the "normal time" (=NT), also frequently referred to as "levelled time", "average time", or "basic time". He will obtain it by multiplying the actual elapsed time with the performance-rating factor, i.e.:

$$NT = ET \times PRF$$

TIME STUDY - A SIMPLIFIED INTRODUCTION (Cont'd)

A - DETERMINATION OF TIME STANDARDS (Cont'd)

4) Cont'd:

Through this simple procedure the time-study man has now determined a time-value that is internationally accepted as a fair measurement gauge of the operator's performance. --- Naturally, this time-value applies exclusively to the studied operation. And only as long as there are no changes in the work-method or in other aspects pertaining to the particular operation or to the part concerned.

5) Nevertheless, the normal time is valid under ideal conditions only. In actual factory operations there will be many contingency interruptions that are independent from the will of the worker and that will delay the accomplishment of his task. The delays can originate from different causes, such as :

- waiting for instructions from foreman
- sharpen cutting tool
- wiping hands before grasping tool
- trip to toilet
- temporary drop in the performance level due to facigue
- extra work due to defective parts

and many more.

Such delays must naturally be compensated for, or the time given to the worker to complete his task would be tight. This compensation takes the form of "relaxation allowances" - or simply "allowances" (=ALL) - that are expressed in percentage of the normal time (=NT). Allowances are then added to the normal time to obtain the valid time standard, that is also called "standard time" (=ST) or "allowed time". Thus :

$$ST = NT + ALL$$

This is now the final time value that will be utilized throughout in all factory operations, both for production planning and control, and for the payment of wage incentives.

B - SOME ASPECTS OF THE ALLOWANCES

Allowances can vary with the type of work, with the type of manufacturing organisation, with the surrounding conditions, with the climate and others.

For light and medium-type work, allowances are frequently in the range of 10-15%. In the Aluminium Goods Factory, e.g. the UNIDO Expert has temporarily introduced a value of 20%, to take into consideration the present difficulties in the production process. The time standards that are mentioned in the text of the Report were, therefore, determined as follows :

$$ST = NT + 20\% \quad (\text{or : } ST = NT \times 1.20)$$

B - SOME ASPECTS OF THE ALLOWANCES(Cont'd)

The amount of the allowances must be determined in all cases through actual analysis of prevailing conditions. Such analysis will be carried out with the help of "Work Sampling", or through long-duration time study. Obviously, therefore, the 20% allowance retained in the case of the Aluminium Goods Factory is a provisional value that will have to be reviewed in the course of the Work-Study programme.

As already stated, the amount of the allowances can vary with the type of work. Consequently within one and the same factory, allowances can vary among the different production departments and even among the different work places or operations. Moreover, conditions in a factory are not static, and this may lead to the need for occasional or periodical revision of the amounts set for allowances. Four examples, among many possible ones, will illustrate this point :

1) The installation of an air-conditioning system will reduce operators' fatigue. It should, therefore, result in lower allowances.

2) An improved storage and in-plant transportation system will assure a faster delivery of new parts to the work-place, and thus reduce the operator's waiting time. It should, therefore, result in lower allowances.

3) Grinding of the drill-bits by the toolroom crew, instead of by the drilling machine operator, as previously the case, will give the worker the possibility of devoting more time to productive work. It should, therefore, result in lower allowances.

4) Purchase of a different quality of aluminium sheet for draw-press operations may be favourable with respect to raw-material cost, but might lead to increased rejects due to brittle material. This should, therefore, result in higher allowances.

C - MAINTAINING TIME STANDARDS

The correct determination of time standards is just one aspect of time study : proper administration and maintenance of the time standards is equally important, specially when wage-incentive payment is at stake.

"Maintenance" refers here to the continuous adaptation of the time standards to take care of changes in the products, in the methods, in the conditions and in the organisation, which very frequently occur in an industrial set-up. When time standards are not properly maintained, they will gradually deteriorate and lose their credibility as a neutral "measuring gauge". This lack of care will also be the beginning of the destruction of the wage-incentive system and at the same time it will strongly weaken the efficiency of the production-control system that also builds on time standards.

C - MAINTAINING TIME STANDARDS (Cont'd)

To conclude these considerations, the importance of correct determination of time standards must be stressed once more, very especially with respect to the influence exerted on actual times by the work methods utilized. Thus, time study must build up on two essential conditions :

1) The work-methods of the operation under consideration must first be analyzed and standardized, and naturally improved where necessary;

2) The operator must first be trained in the new method.

These conditions must be respected before a time standard can be set. Where this is not done, time standards will soon be out of line with reality and will lead to difficulties of all sorts, especially where incentive payment is involved.

The introduction of time study in a factory implies, therefore, that Management is aware of its possible consequences, and that it must be prepared to introduce the organisational changes and other steps that are essential for proper determination, administration and maintenance of the time standard.