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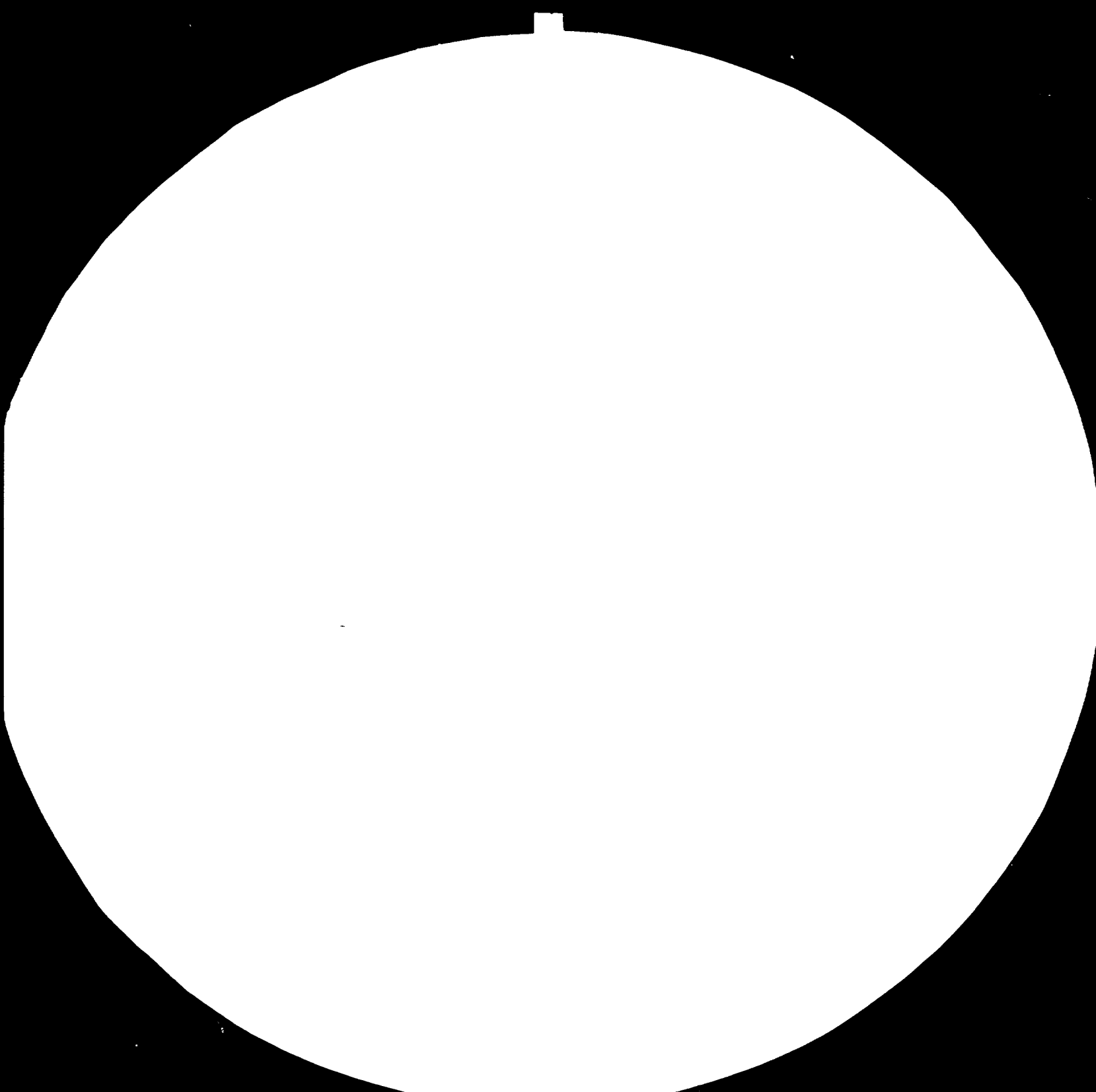

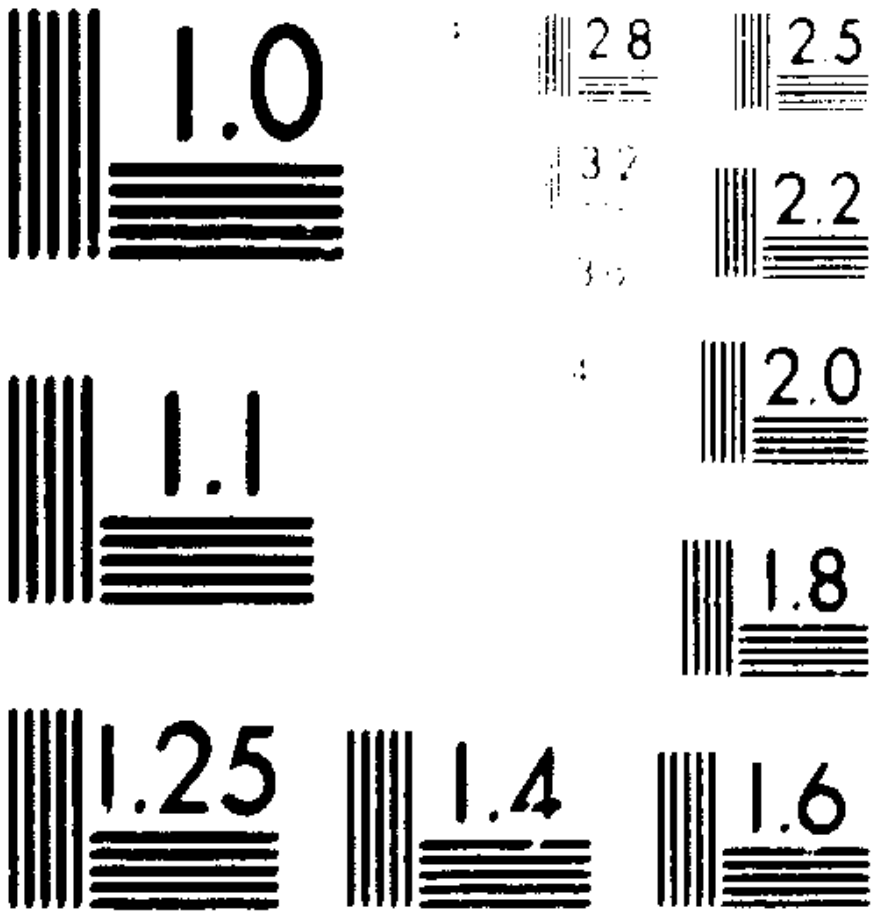

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28 April 1983

English

China.

ASSISTANCE IN HOT PROCESSING TECHNOLOGY

DP/CPR/81/031

CHINA

Visit Report

8. Juli 1983

Prepared

by

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UNIDO EXPERT IN HEAT TREATMENT

United Nations Industrial Development Organisation
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ABSTRACT

The present report is a result of a Technical Mission to Shanghai, China, by Professor T. Bell, University of Birmingham, England, expert in the field of hot metal processing technology, with the objective of contributing to Project DP/CPR/81/031/11-02/31.8.D. The main work of the Mission was:

(a) to assess the R & D capabilities of the Shanghai Institute of Machine Building Technology in the area of the heat treatment of metals;

(b) to make recommendations for enhancing the effectiveness of the Institute in servicing the heat treatment requirements of the engineering component manufacturing industries in the Shanghai Municipality.

The Mission in China was undertaken over the period 31st March - 20th April 1983 and involved public lectures, seminars to invited industrial and academic audiences, symposia with the management and technical staff of the Institute and a series of works visits to companies practicing in the field of heat treatment. These activities clearly identified a very variable level of appreciation of the science and practice of heat treatment in the Shanghai district. It is therefore strongly recommended that a cost effective and permanent solution to this problem would be the formation of a Heat Treatment Industrial Advisory Section within the Institute which would also compliment and, indeed serve to focus on the Industrial Applications and Research Activities of the Institute.

INTRODUCTION

The present Mission to Shanghai on behalf of UNIDO was undertaken to assess the heat treatment R & D capacity of the Shanghai Institute of Machine Building Technology and its effectiveness in influencing heat treatment practice in the Shanghai district. The Mission was undertaken in the light of the fact that in the manufacture of engineering components for use in the machine building industries there have been very significant advances in heat treatment practice within the technologically developed countries over the past 10 years. These advances can be divided into two main groups:

(a) fundamental innovations in heat treatment techniques, including laser and plasma processing, together with the related new coating techniques, chemical vapour deposition, and the various physical vapour deposition methods;

(b) innovations which have been initiated (i) as a result of environmental or energy conservation pressures, and (ii) large-scale production needs.

An example of b(i) is the development of gaseous nitrocarburising techniques as technically and economically viable alternatives to the former toxic salt bath treatments, while a good example of b(ii) is the widespread acceptance of 'boost-diffuse' carburising practice. Accordingly, it was on the basis of this framework of innovation that the Mission was conducted. In addition, priority was given to identifying those local factors in China which could inhibit the direct transfer of the best heat treatment practices into China.

MISSION PROGRAMME

Professor Bell, on arrival in Beijing on 31st March 1983, was welcomed to China by representatives of the Shanghai Institute of Machine Building Technology (SIMBT). On 1st April a briefing session with Mr. Albertus W. Sissingh of UNDP was held where it was agreed that, in order to maximise the time spent in Shanghai, debriefing in Beijing would not be required unless any special factors emerged during the Mission itself. After transfer to Shanghai, a series of discussions were held with Mr. Shen Baiquan, Vice-Director of SIMBT, and the following detailed technical programme was developed:

TECHNICAL ACTIVITIES OF PROFESSOR T. BELL

(4th April - 19th April 1983)

Date:	Time:	Activity:
4th April (M)		Identification of Mission Technical Programme
5th April (T)	a.m.	Lecture on "The Trends in the Development in Heat Treatment Technology in the World" and "The Activities of the International Federation for the Heat Treatment of Materials"
	p.m.	Seminar on the subject dealt with in the morning
6th April (W)	a.m.	Seminaron "Nitrocarburising"
	p.m.	Seminar on the subject dealt with in the morning
7th April (T)	a.m.	(a) Visit to Shanghai Industrial Sewing Machine Factory
		(b) Symposium on the relevant subject areas
	p.m.	Symposium on "Nitrocarburising"

Date:	Time:	Activity:
8th April (F)	a.m.	Seminar on "Carburising"
	p.m.	Seminar on "Carburising"
9th April (S)	a.m.	Symposium on "Carburising"
	p.m.	(a) Visit to Shanghai Heat Treatment Company
		(b) Symposium on relevant subject areas
10th April (S)		Free
11th April (M)	a.m.	Seminar on "Vacuum Heat Treatment and Plasma Heat Treatment"
	p.m.	Seminar on the subject dealt with in the morning
12th April (T)	a.m.	Seminar on "The Technology and Equipment for Nitrocarburising"
	p.m.	(a) Symposium on "Vacuum Heat Treatment and Plasma Heat Treatment"
		(b) Miconex '83, Exhibition of scientific instruments organised by China Instrument Society
13th April (W)	a.m.	Symposium on "Vacuum and Plasma Heat Treatment"
	p.m.	Continuation of above Symposium
14th April (T)	a.m.	Seminar on "The Present and the Future of Applications of Microprocessors in Heat Treatment" and "Laser Heat Treatment"
	p.m.	Seminar on the subjects dealt with in the morning
15th April (F)	a.m.	(a) Visit to Shanghai Tool Works
		(b) Symposium on relevant subject areas
		General visit of Institute facilities
16th April (S)	a.m.	Mission assessment discussions with staff of Institute
	p.m.	(a) Visit to Shanghai Electric Furnace Company
		(b) Symposium on relevant subject areas

Date:	Time:	Activity:
17th April (S)		Free
18th April (M)	a.m.	Mission assessment discussions with Mr. Shen Baiquan and senior colleagues
	p.m.	Tea Party
19th April (T)		Preparation for return to UK.

3rd INTERNATIONAL CONGRESS OF HEAT TREATMENT OF MATERIALS

The Shanghai Institute of Machine Building Technology will be responsible, in November 1983, for detailed arrangements in Shanghai associated with the organisation of a major International Congress and Exhibition on Heat Treatment Technology and Equipment. This Congress and Exhibition will be held during the week beginning 6th November under the auspices of the International Federation for the Heat Treatment of Materials in co-operation with the Heat Treatment Institution of the Chinese Mechanical Engineering Society. This heat treatment event is the largest ever to be held in S.E. Asia. Clearly, it will provide a forum for the heat treatment community of China, and especially that of the Shanghai Municipality, to assess both the scientific and technological standards of industrially developed countries on a first hand basis. Accordingly, as President of the IFHT, I was able during the Mission to give guidance to both Mr. Xu Shaogao, General Secretary of the Chinese Mechanical Engineering Society, and Mr. Shen Baiquan, as to how they could best organise the Congress and Exhibition and, in turn, take advantage of the event to enhance heat treatment standards in China. In this respect, therefore, a series of organisational meetings were held in the evenings with CMES, SHK International Services Ltd. (the Exhibition organisers) and the appropriate staff of SIMBT..
In the present report these meetings are not described in detail, but

it is worth recording that (a) some 200-300 overseas delegates from 25 countries, and (b) more than 100 exhibitors of heat treatment and ancillary plant, are expected to attend the Conference and associated Exhibition. The principal topics to be covered at the 3rd International Congress include:

	Topic:	Invited Speaker:
1)	International Energy Resources and their Application in Heat Treatment	Dr. Norio Kanetake (J)
2)	Contribution of Physical Metallurgy to Heat Treatment Practice	Prof. G. Krauss (USA)
3)	Application of High Energy Heating in Heat Treatment Practice	Dr. J.H.P.C. Megaw (GB)
4)	Austenitic Thermochemical Treatment	Dr. J. Wünning (FGR)
5)	Ferritic Thermochemical Treatment	Prof. T. Bell (GB)
6)	Rare Earth Alloying Elements in Heat Treatable Steel	Prof. Zhang Shouha (PRC)
7)	Production, Control and Application of Controlled Atmospheres	Dr. I. Montevecchi (I)
8)	Quality Control Procedure in Heat Treatment	Dr. Shigeo Owaku (J)
9)	Surface Coatings	Prof. JU. M. Lachtin (SU)

from which it can be seen that many topics are very relevant to the Technical Programme of the present Mission.

TECHNICAL PROGRAMME

It can be seen from the time-table presented earlier that the technical activities of the Mission can be divided into:

1) Lectures:- Two major public lectures were presented to an invited

audience of between 400-500 people at the Shanghai Science Hall.

The first three hour lecture, "The Trends in the Development in Heat Treatment Technology in the World", was of a general nature, introducing the Shanghai Scientific Community to modern concepts of the theory and practice of heat treatment in industrially developed countries. At the request of Mr. Shen Baiquan, an introduction to the activities of the International Federation for the Heat Treatment of Materials was also presented, together with a summary of the technology transfer activities of the Wolfson Plasma Processing Unit and the Wolfson Heat Treatment Centre in the UK.

The second lecture, "Nitrocarburising", was of a much more technical nature describing the development of the Nitrocarburising Process which improves the wear, fatigue and corrosion resistance of steel and is a subject of very special relevance to the manufacturing industry of China. In this lecture it was possible to describe in considerable detail the current status of gaseous techniques from both a scientific and technological standpoint. A feature of particular importance was the requirement for China to fully develop methanol/ammonia based nitrocarburising treatments. This is due to the absence of readily available hydrocarbon gases in sufficiently large quantities to generate endothermic gas as a carrier gas for the heat treatment industry in Shanghai. The subject of methanol based nitrocarburising is currently being actively researched in the UK and a full report on this topic is to be presented at the 3rd International Congress in November 1983 in Shanghai.

2) Seminars:- A total of 10 seminars were given at the headquarters of the SIMBT, to audiences varying in size from 25-60 and involved the technical staff of the Institute (See Appendix 1.) together with specially invited heat treatment scientists and engineers from local universities and industry. Appendix 2. lists the organisations which were represented at this series of seminars. Each 2-3 hour seminar was normally followed by a 2-3 hour discussion period in which the audience very actively participated. These discussions, and the associated questions, were essential in identifying both the standards of heat treatment knowledge in Shanghai and the specific problems/ requirements of local industry. In turn, these data were very helpful in formulating the conclusions and recommendations of the present report.

Each seminar is not described in detail but the papers on which they were based are fully listed in Appendix 3. Copies of the majority of these references, together with appropriate slides, have been deposited with Mr. Shen Baiquan, which should greatly facilitate his staff in interpreting the tape recorded versions of the seminars and the associated discussions in the future.

3) Symposia:- The present series of 8 symposia to selected members of the staff of SIMBT were specifically designed to investigate both the technical level and commercial attitude of the Institute and to solve some of the Institute's specific problems. These discussions were particularly stimulating for both the UNIDO Expert and the heat treatment specialists of the Institute. Indeed, together with works visits, they were probably the best source of information on which to base the specific recommendations presented later.

4. Works Visits:- Although the time spent in Shanghai was very restricted, four companies of widely differing manufacturing backgrounds were visited. This series of selected works visits was essential not only in assessing the manufacturing style of the Shanghai Municipality but also the degree of empathy between such companies and SIMBT. Accordingly, each visit is reported at some length as follows:

(1) Shanghai Sewing Machine Factory

This Company has, for several years, had close links with the Shanghai Institute of Machine Building Technology, with the Institute providing heat treatment on-line and back-up facilities on a regular basis.

It emerged that, because of natural gas and propane supply shortages in the Shanghai Municipality, the Sewing Machine Factory was not able to undertake conventional endothermic gas/ammonia-based nitrocarburising for several engineering components, in particular small transfer gears for the sewing machines. Accordingly, the Institute had tried to develop a drip feed methanol-based ferritic nitrocarburising treatment, with very little success due to reproducibility problems. As a consequence, the Institute had introduced an austenitic methanol-based treatment into the Factory, but only with limited success due to shape distortion problems and associated noise problems during running of the sewing machines. This problem was currently being relieved by an expensive, time-consuming lapping process. The treatment was undertaken in an atmosphere sealed quench furnace recently installed at the Sewing Machine Factory. The electrically heated furnace was manufactured by the Shanghai Electric Furnace Company and during

demonstration runs showed it was capable of producing clean, soot-free work.

Recent laboratory research studies at the University of Birmingham, England, have demonstrated that drip feed ferritic nitrocarburising using 50% methanol/50% ammonia atmospheres is both technically viable and reproducible. Appropriate advice was therefore given as to how to further investigate this treatment within the Shanghai Sewing Machine Factory. When successful, this will eliminate the distortion and associated noise problems. An alternative solution would be to incorporate a plasma nitriding treatment on the gears which would be responsive to plasma processing, since the steel currently in use is a 1%Cr-based steel. Naturally, this alternative solution would necessitate significant further capital expenditure.

(2) Shanghai Specialised Heat Treatment Company

This service heat treatment Company also has established links with the Institute since both organisations are operated under the auspices of the same Chinese Ministry. This is a large Company, even by Western standards, and operated the following processes on a sub-contract commercial basis for several hundred customers from both within and from outside of the Shanghai district.

The treatments available included:

(a) Salt bath carburising.

(b) Salt bath neutral hardening.

(c) A variety of pit furnace heat treatments.

(d) High, medium and low frequency induction hardening.

(e) Plasma (ion) nitriding processes (using equipment developed at the Institute of Machine Building Technology).

(f) Oil quench vacuum hardening tool steels (using equipment developed at the Institute of Machine Building Technology).

Discussions with the Manager of the plant indicated that the prices charged for the heat treatment services were, at least for the high technology treatments, approaching those charged in Western countries (in US dollar terms). The diversity of components which were treated by the Company, especially in the field of induction hardening, was enormous. This clearly indicated that considerable expertise was available but it was not possible in the time available to assess the quality control capability of the Company.

In the discussions with management which followed the visit, it emerged that it was the intention of the Company to introduce sealed quench carburising furnaces in the near future to replace the salt baths (because of environmental problems). I felt it appropriate to advise the exercise of caution in this matter because with untrained staff, problems could be experienced. I therefore recommended the phasing out of the salt baths rather than a sudden transition. This would be particularly important since, as with the Sewing Machine Factory, the well established endothermic gas thermochemical processing could not be used because of hydrocarbon gas shortages. Again, although some knowledge of drip feed carburising is available in the UK and elsewhere, the extent of the experience is limited and certainly significant R & D activity in this field within China is

thought to be essential before the established salt bath techniques were abandoned.

(2) Shanghai Tool Manufacturing Company

The visit to this Company was a revealing example of how a Chinese Engineer, trained in the UK in the 1950's has had the experience, foresight and enterprise to develop this sector of the Chinese Manufacturing Industry into one of international competiveness. The Company, which employs, 3,800 people, has a wide range of products, manufactured in a variety of tool steels, which include small and large twist drills, reamers, thread rolling dies, carbide tools and circular saws. The Company's products are produced in a variety of qualities and are clearly illustrated in a well presented brochure. Although the Company uses a variety of old and new machine tools to produce its products, there can be no doubt that the heat treatment knowledge and practices exercised in this Company are excellent. The efficient use of mechanised salt bath hardening and tempering lines and oxy-nitriding surface treatments for enhanced wear resistance of twist drills are examples worth repeating in other developing countries. Indeed, the extremely positive attitude to alloy conservation and exploitation of Chinese natural alloy resources in the development of new higher quality and less expensive tool steels, is one that needs to be studied by developed manufacturing countries.

In the discussion which followed the tour of the Factory, I was able to suggest that manufacturing difficulties in the production of large diameter circular saws, involving the mechanical fixing of the tool steel blade to a base material, might well be obviated by laser

welding techniques. Accordingly, arrangements are in hand for the Shanghai Institute of Machine Building Technology, using their own facilities, to initiate an R & D programme in this field. Since my return to the UK enquiries have revealed that very positive results have also been achieved in the laser cutting of the tooth profiles of heavy sectioned HSS circular saws.

(4) Shanghai Electric Furnace Building Company

The manufacturers of the sealed quench furnace in use at the Shanghai Sewing Machine Factory specifically requested that I should visit their Factory with a view to discussing innovations in furnace manufacturing technology. Accordingly, a short visit was arranged towards the end of the Mission in Shanghai.

There can be no doubt from the furnace production line I was shown, that this Company manufactures 1950's style bricked hearth open atmosphere furnaces on a big scale, with some 50 plus furnace casings being observed during the visit. This observation alone serves to demonstrate the lack of controlled atmosphere technology in general manufacturing industry in China. Again, a problem probably associated with the shortage of hydrocarbon gases necessary to generate the atmospheres extensively used in developing countries.

From their brochure it was clear that the Company was also capable of manufacturing a variety of mesh belt and vacuum furnaces, but only one example of the former was available for inspection. The mesh belt for which was of an imported variety, thus confirming earlier

advice from the technical staff of the Shanghai Institute of Machine Building Technology that the manufacture of high temperature alloy steels for furnace application (other than the simplest nickel-based alloy) was a serious problem in Chinese furnace manufacture.

In the ensuing discussion I was questioned extensively about innovations in Western furnace manufacturing procedures. Although I could not answer definitively in all cases, I was able to caution the Company about certain problems associated with the manufacture of metallic liner free controlled atmosphere pit furnaces. Clearly, there is a serious need for nitrogen-based controlled atmospheres to be introduced into China for general bright annealing and normalising applications using low thermal mass materials. Equally, a positive programme of simple vacuum furnace manufacture for the clean treatment of a wide range of products should be initiated using the technology already available within the Shanghai Institute of Machine Building Technology.

SHANGHAI INSTITUTE OF MACHINE BUILDING TECHNOLOGY

The Government Agency under which SIMBT operates is the First Bureau Mechanical and Electrical Industries Shanghai. The Institute, as reported in Project Document DP/CPR/81/031/B/01/37, has 795 workers and staff, among whom 244 are technical staff, including 72 engineers, 109 assistant engineers, 21 technical experts. There are six research departments in the Institute, namely, casting, forging, heat treatment, mould design, physico-chemical testing and metrology, supported by a metal working shop and an experimental

foundry shop. Based on these research capabilities, the Institute has become the research base of hot-processing technology in Shanghai.

An analysis of the Institute's methods of working within the heat treatment field revealed three main activities:

1. A limited commercial heat treatment service to industry, e.g., salt bath hardening and carburising, and vacuum oil quench hardening of tools.

2. The development of heat treatment processes and prototype equipment for industry, e.g., methanol/ammonia nitrocarburising treatments and plasma nitriding equipment.

3. Research into the more sophisticated and specialised surface heat treatments and coating methods, e.g., laser transformation hardening and Physical Vapour Deposition Techniques.

A corresponding analysis of the income and expenditure of the Institute within these three fields was not possible but it was abundantly clear that

(1) The very old fashioned salt bath equipment or limited size of the modern equipment developed by the Institute could have very little real earning capacity.

(2) The Institute was spending a very large and probably unjustified proportion of its income into repeating expensive basic research into heat treatment techniques currently being undertaken by developed

manufacturing countries such as the UK, Japan and the USA.

In addition, the scale of the equipment designed by the Institute could in no way satisfy the volume demand of the rapidly growing manufacturing industries in China.

In summary, it was clear that while the Institute enjoyed a fruitful and respected relationship with manufacturing industry in the Shanghai Municipality they did not have the resources to respond to to the immediate and near future heat treatment requirements of large scale light/medium manufacturing industry. Later in this Report these requirements are identified, at least in part, and recommendations as to how the transfer of the appropriate technologies into industry could be made.

A detailed analysis of the activities of the Institute outside of the heat treatment field is clearly not within the remit of the present Mission, but since the UNIDO Expert has personal responsibilities in other areas of Hot Processing Technology and general engineering and the Institute requested advice in these fields, the following few observations could be of value:

1) The technological level of the Institute's foundry activities, especially its investment casting work, is very impressive. They certainly appeared to have a resonable scale of operation, capable not only of a significant earning capacity for the Institute, but which would also be valuable in training technical engineers for industry. Industry could then expand the scale of production to meet its own high quality high volume demand.

2) Although Metrology as an engineering discipline does not enjoy or require a fundamental research image, it is nevertheless an essential branch of modern engineering industry. The Institute clearly has a high reputation with local industry in this field and provides an invaluable service to local industry, through the highly sophisticated and efficient equipment in their Metrology Department, e.g., calibration of gauge blocks, etc.

3) The metallurgical services within the Institute, especially in the Metallography Section, have very good equipment, but whether there exists the expertise and ancillary equipment (e.g., automatic development facilities, etc.) to obtain the best from it was not at all clear. This Section clearly has the potential for a significant earning capacity for the Institute.

4) It was not clear during my tour of the Institute as to whether I visited a Central Workshops Facility, or those of the Heat Treatment Department, but in any case they were quite well equipped and appeared to provide a good service not only for the Institute, but also for manufacturing industry in the locality.

REQUESTS FOR SPECIFIC HEAT TREATMENT INFORMATION

In addition to the general status and requirements of the heat treatment sector in China, which emerged from the technical programme and on which the recommendations in this Report are made, there were many requests for specific items of information which included:

(1) Microprocessor control systems

(2) Sooting problems in vacuum furnaces

(3) Heat treatment specifications, especially for nitrocarburising quality control, and case depth specifications for carburising.

(4) Carbon profile analysis techniques.

(5) High temperature insulating materials (low thermal mass type)

(6) High temperature vacuum furnace material

(7) Carbon restoration techniques in the manufacture of tool steel

(8) Heat treatment and technical specification of nodular iron camshafts

(9) The equipment and specification for the treatment of transmission shafts in 8620 steel

(10) Plasma nitriding of 3-metre diameter gears for cement mill applications

(11) Nitrogen atmosphere generation techniques

(12) Distortion free heat treatment of sewing needles

(13) Polymer quenchants and accelerated oils

(14) Techniques for temperature measurement during induction hardening

(15) Kerosene based carburising atmospheres

(16) Oxygen probe suppliers and techniques

(17) Tribology test equipment

(18) Data on the power stability of commercial lasers

(19) Heat treatment specifications for bicycle components

(20) The provision of heat treatment courses and University education in this field.

In those instances where sufficiently detailed information was not available, it was agreed that the UNIDO EXPERT would collect such data and forward it to the Institute in due course.

SUMMARY AND RECOMMENDATIONS

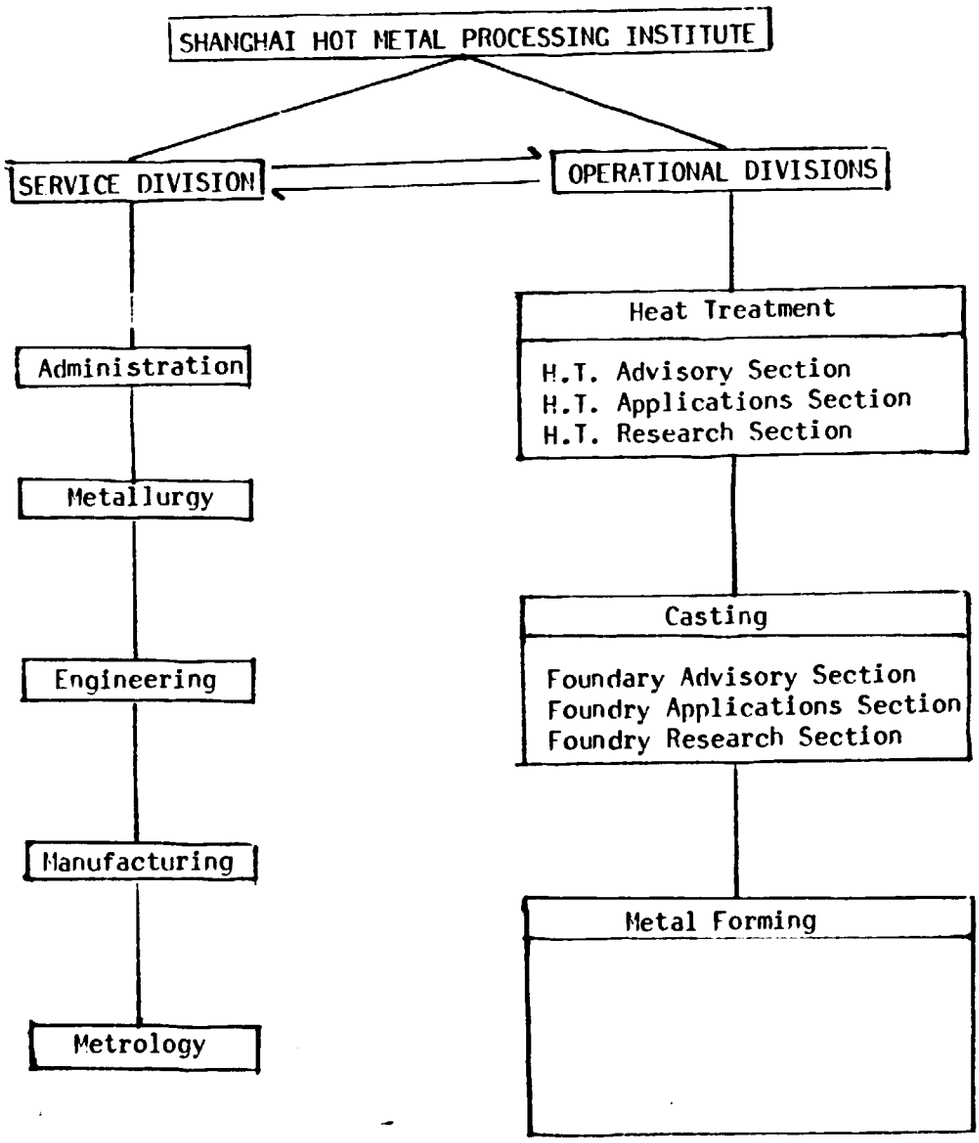
1. During the 1950's - 1970's it was the general practice throughout the developed countries for Research Institutes to be funded entirely from the central resources of either Government or industrial organisations. History has shown that centrally funded Research Institutes can be very vulnerable during times of recession and yet their elimination has been known to detract from the long term growth of the associated industries. Accordingly, there is an increasing tendency for National and Company Research Departments to undertake Application and Service/Advisory roles. These changes have been made in an effort not only to enhance the economic stability of such organisations, but also to foster an environment for a more rapid and effective technology transfer of fundamental research into practice.

   In this respect the Shanghai Institute of Machine Building Technology is well placed with its traditional Research, Application and Advisory roles, and it is recommended that this approach should be encouraged and built upon.

2. Any organisation which has a responsibility for the transfer of technology into manufacturing industry, should have a title that truly reflects this role. In this respect the title of the Shanghai Institute of Machine Building Technology is a misnomer. Arguments could be made for dividing the Institute into several new institutes, including for example, Shanghai Heat Treatment Institute and Shanghai Casting Institute, and perhaps this would

be the best solution if one was starting afresh.

However, the most practical and effective solution could well be to re-organise and re-name the Institute along the lines described in the flow chart below, and it is recommended that such changes be explored by the Institute.



3. Even if the preceding recommendation is inappropriate, it is still strongly recommended that the heat treatment activities of the Institute be re-organised into three sections as described below.

(i) Heat Treatment Industrial Advisory Section

In 1972 the author of the present report published a report, "Survey of the Heat Treatment of Engineering Components" (Ref. 50 in Appendix 3.) in which a recommendation was made that to improve the level of understanding of the science and practice of heat treatment in the UK a Heat Treatment Advisory Bureau should be established in the UK. In 1974, through the generosity of the Wolfson Foundation, The Wolfson Heat Treatment Centre was opened in the UK (See Appendix 4.). This Centre has been remarkably successful in raising the standards of industrial heat treatment practice in the United Kingdom and its current activities include the publication of the well-established journal, "Heat Treatment of Metals", the running of training courses for heat treatment engineers, the dissemination of heat treatment data and standards, and advice on heat treatment equipment selection.

A similar advisory service, adjusted to meet the needs of the heat treatment community in the Shanghai Municipality would be a most effective and long term solution to enhancing the overall standards of heat treatment and practice in China.

It has already been recommended to the Institute that they should, as a matter of priority, seek funding to initiate a Heat Treatment Advisory Section.

(ii) Heat Treatment Applications Section

It is envisaged that the major roles of this Section would be

(a) The development, in conjunction with the Research Division, of controlled atmosphere and carburising techniques using existing knowledge, but modified to meet the anticipated large scale requirements of the engineering component manufacturers in China.

(b) The training of heat treatment technicians and operators.

(c) The provision of a modern heat treatment service to industry.

However, a major limitation on the growth of the engineering component manufacturing industry in China is that large scale surface hardening operations are largely restricted to salt bath carburising techniques. In order that an expansion in industrial activity in this sector can take place, it is essential that seal quench furnace technology and its applications are rapidly introduced into China. It is inevitable that, at least in the early stages, this technology is imported from the developed countries. In these countries sealed quench furnaces are extensively used for bulk

heat treatment operations and the furnace technology itself has continuously developed in response to changing energy demands.

A constraint to the introduction of this sealed quench furnace technology exists in the Shanghai district and that is the shortage of natural gas or propane to generate endothermic carrier gas for large scale carburising operations. It will be necessary, therefore, to employ a range of "drip feed" systems, e.g., methanol/nitrogen, to generate the required carburising atmospheres. Although this technology does exist in the developed countries it has only recently been introduced, and does not yet enjoy widespread application.

To deal with this problem it is recommended that a sealed quench furnace line is introduced into the Institute, which is sufficiently flexible to use a range of carburising atmospheres. This could be used (a) for training heat treatment engineers throughout the Institute and (b) to provide an effective, but limited production, and component evaluation service to Industry.

It is also recommended that the Applications Section should be equipped with a high pressure gas quench vacuum furnace, of the type which has largely replaced oil quench vacuum furnaces for the treatment of tool steels. Such a demonstration facility would also have a very significant earning capacity for the Institute.

(iii) Heat Treatment Research Section

The primary functions of this Section should be Applied heat treatment research to enhance the activities of the Heat Treatment Applications Section and Basic research to provide a high level of technical awareness on an international basis within the Institute.

It is not intended to make specific recommendations about the applied research programmes other than to strongly emphasise that they should be goal orientated projects initiated to anticipate short/medium term industrial requirements for improving the quality and reliability of engineering components. However, in the field of basic research it is recommended that effort is focussed on a few relative areas in order that standards are achieved which are of an internationally accepted level. In addition, where possible, these programmes should be chosen so they do not duplicate activities in other Institutes and Universities in China. Accordingly, two possible areas where the Institute could focuss attention would be (a) laser heat treatment, (b) plasma processing techniques.

4. The Institute would greatly enhance its reputation in the field of quality control if it could provide manufacturing industry with a modern metallurgical analysis service-based on Optical Emission Spectroscopy. This would also be invaluable, not only to the Applications and Research Sections of the Heat Treatment Division, but also to the Foundry Division.

5. The Institute possesses considerable engineering and manufacturing expertise. It may well be worthwhile considering focussing such knowledge into the manufacture of a complete range of simple vacuum furnaces to meet the anticipated large-scale requirement for bright annealing by industry.

6. In the present Report specific recommendations about all aspects of training cannot be made in time for them to be effective within the time-scale of Project DP/CPR/81/031. (Those that are possible are the subject of a supplementary report which is being prepared by Professor T. Bell at the request of UNIDO.) However, if future projects should be developed to implement the above recommendations, a variety of training programmes would need to be carefully devised. In addition, although it is recognised that University training is outside of the remit of UNIDO, it would be helpful if the attention of the appropriate sister bodies could be brought to the requirement for such specialised education in the field of heat treatment.

APPENDIX 1.

List of Participants

from

THE SHANGHAI INSTITUTE OF MACHINE BUILDING TECHNOLOGY

attending

SEMINARS AND SYMPOSIA

by

PROFESSOR T. BELL

4th April - 19th April 1983

NAME	TITLE
Shi Fusheng	Director
Shen Baiquan	Vice-Director Engineer
Mei Zhiqiang	Chief of Heat Treatment Department; Engineer
He Baoxiang	Chief of Heat Treatment Section; Engineer
Zhou Xi	Chief of Equipment Department; Senior Engineer
Xu Yaoxin	Chief of Technology Developing Section; Engineer
Yang Qidun	Engineer
Xiao Shunshu	Engineer
Yan Tianji	Engineer
Jing Xueyong	Engineer
Wu Yongkang	Engineer
Tu Hengyue	Engineer
Yan Caifu	Engineer
Shen Zhenxin	Engineer
Shun Hongbin	Engineer
Yang Weijiang	Engineer
Shi Yiren	Engineer

APPENDIX 2.

INDUSTRIES REPRESENTED AT HEAT TREATMENT SEMINARS

by

PROFESSOR T. PELL

4th April - 19th April 1983

Shanghai Institute of Machine Building Technology

Shanghai Electric Furnace Plant

Beijing Institute of Machine Tools

Shanghai Miniature Bearing Factory

The Ministry of Mechanical Industry, Beijing Institute of Machine and Electricity

Shanghai University of Technology

Shanghai Institute of Iron and Steel

Shanghai Bicycle Factory

Shanghai Heat Treatment Factory

Shanghai Operating Instruments Factory

Hua Tong Switch Factory

Wu Han Institute of Protective Material

Shanghai Jiao Tong University

Branch School of Jiao Tong University

Xian Institute of Electric Furnaces

Tian Jin Institute of Heat Treatment

Shanghai Sewing Machine Factory

No. 9 Desiging Institute

Mechanical and Electric Products Designing Institute

Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

East China Textile College

Shanghai Institute of Machine Building Technology

Shanghai Tool Works

APPENDIX 3.

PUBLIC LECTURES - SEMINARS - SYMPOSIA

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by

PROFESSOR T. BELL

4th April - 19th April 1983

Shanghai Institute of Machine Building Technology

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APPENDIX 4.

Official Opening of the Wolfson Heat Treatment Centre

Welcome

Dr. J. A. Pope, Vice-Chancellor of the University, welcoming the participants, said that the excellent attendance by representatives of the industry in a difficult period showed great sincerity to the cause of the Wolfson Heat Treatment Centre.

Dr. Pope

Dr. Pope outlined the position of Aston University in relation to industry and commerce. The University possessed an abundance of expertise and facilities and he stressed that there was a strong economic case for industry to deploy the services offered rather than purchase its own lavish equipment which would, generally, be under-utilised. The efficient selling of University services is now a ruthless commercial activity and the same approach would apply to the Wolfson Heat Treatment Centre in order to make it a success.

Background

Dr. T. Bell, of Liverpool University, spoke on behalf of the Heat Treatment Joint Committee by whom he was appointed, in 1971, to undertake a survey of the heat treatment of engineering components. He outlined the observations which lead him to recommend the formation of a heat treatment advisory bureau in the U.K.

Dr. Bell

Summarising the objectives and conclusions of his report, Dr. Bell argued that the fragmented nature of the industry had prevented the science and practice of heat treatment obtaining the full recognition and attention it deserved in view of the vital contribution it makes to the manufacturing industries. As an indication of its importance, he estimated that in excess of £125M is spent each year on the heat treatment of automobile components alone.

Dr. Bell bemoaned the fact that costing of heat treatment of components has received very little attention in British industry, particularly in integrated engineering companies where often heat treatment costs are not itemised on production data sheets but are simply included in overheads. This approach contributed to the lack of understanding of heat treatment problems at senior management level and, in turn, restricted capital expenditure for equipment and research.

Dr. Bell suggested that the variable level of understanding of the science and practice of heat treatment, which restricted a general improvement in standards in the U.K., could be ascribed to a number of reasons including:

(i) little formal training of heat treatment personnel at technical and operator level
(ii) the lack of generally available codes of heat treatment practice
(iii) the lack of a technical journal in Great Britain which officially devoted the major part of its coverage to a balance between the theory and practice of heat treatment
(iv) the existence of no official body to which the heat treatment practitioner could refer for advice on problems
(v) a marked reluctance on the part of universities and colleges of technology to involve themselves in research and development relating known physical metallurgy facts to heat treatment practice.

He pointed out that all of these features, which were essentially matters of communication, had contributed to a limitation of the overall acceptance and utilisation of optimum heat treatment practice. It was this situation which prompted him to recommend that a heat treatment advisory bureau be established. He summarised the organisation and activities which he had envisaged for the bureau and the way in which his suggestion had become reality in the shape of the Wolfson Heat Treatment Centre.

In conclusion, Dr. Bell assured Professor Alexander, the Centre's Acting Director, of the fullest co-operation of the Heat Treatment Joint Committee (now the Heat Treatment Activity Group of the Metals Society) in ensuring the success of the Centre.

Progress

Professor Alexander replied that he hoped that the Wolfson Heat Treatment Centre could build on the excellent foundation laid by Dr. Bell in his survey. He also acknowledged the Centre's gratitude to the Wolfson Foundation for the financial support which had enabled the venture to become established.

Professor Alexander

RESTRICTED

28 April 1983

English

SUPPLEMENT TO

ASSISTANCE IN HOT PROCESSING TECHNOLOGY

DP/CPR/81/031

CHINA

Visit Report

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UNIDO EXPERT IN HEAT TREATMENT

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Introduction

In the main report of the visit to the Shanghai Institute of Machine Building Technology, by Professor T. Bell, over the period 31st March - 20th April 1983 (as part of Project DP/CPR/81/031/11-02/31.8.D.), specific recommendations were made concerning changes in the structure and organisation of the Institute which would enhance the effectiveness of the heat treatment activities of the Institute. These recommendations included:

(a) the establishment of a Heat Treatment Advisory Section,

and (b) the enhancement of the Heat Treatment Applications Section.

These recommendations were made with the specific objective of providing a means by which the engineering component manufacturing industry in the Shanghai Municipality and surrounding District could improve their heat treatment standards, thereby directly improving the performance and reliability of those machine components in the manufacture of such industrial goods as sewing machines, bicycles, textile machinery and the moulds and dies so essential to the growth of the plastics processing industries.

In addition, it was recommended that the fundamental heat treatment research activities of the Institute should be restricted to a limited number of areas where a valuable contribution to the international scientific literature would be possible.

The present supplementary report has been prepared at the request of Mr. M.S. Czub, Back-stopping Officer for Project DP/CPR/81/031/11-02/31.8.D.). It provides, in note form, specific advice as to how UNIDO, through the present project and future projects, can support the concepts which are outlined above, and which are further described in the main report.

Recommendations

(1) The present project (DP/CPR/81/031/11-02/31.8.D.) funded by UNIDO covers both heat treatment and foundry aspects of Hot Metal Processing Technology, and it has been useful in identifying the overall nature and status of the Shanghai Institute of Machine Building Technology in both fields. Accordingly, it has been possible, in the main report by Professor T. Bell, to make recommendations covering the structure of the Institute, which will enhance its long term interaction with the Shanghai Manufacturing Sector.

However, it is strongly recommended that in future UNIDO only accepts detailed projects from the Institute which are specifically related to either Heat Treatment or Foundry Practice. This is essential if the special constraints on the growth of a modern heat treatment industry in China, e.g., in the sealed quench field, are to be overcome (see main report and the further recommendations below). Major constraints on effectiveness may also be identified in the Foundry Sector and it is suggested that the Foundry Experts, who are to visit the Institute as part of Project DP/CPR/81/031/11-02/31.8.D., are asked to pay special attention to this matter.

(2) In the main report to UNIDO lack of experience with sealed quench heat treatment systems for hardening, carburising and nitro-carburising was identified as a major constraint to the development of large scale modern heat treatment operations in China. It is recommended, therefore, that changes are made within the budget of the present Project DP/CPR/81/031/11-02/31.8.D. to provide training (under the direction of Professor T. Bell) in a major UK heat treatment company. This should include the training of at least two heat treatment engineers in the practical aspects of sealed quench furnace operation, appropriate atmosphere control systems, and quality control procedures. This programme would last about 6 months.

(3) Established sealed quench furnace practice within the developed manufacturing countries relies largely on endothermic gas, as the carrier gas for carburising and carbonitriding, etc. This practice is not possible in Shanghai due to lack of availability of natural gas and propane on a large scale.

Accordingly, it is recommended that a Chinese Senior Engineer should make a study tour of those heat treatment installations in Europe (which can be identified by Professor Bell), which use methanol and related "drip feed" practices for thermochemical processing. This study tour would take about 2 months and would require a multi-lingual engineer; alternatively, the engineer would need to be accompanied by a very competent technical interpreter.

(4) In November 1983 Shanghai will be the setting for the 3rd International Congress on the Heat Treatment of Materials, and an associated major heat treatment exhibition, Heatex '83. This provides a unique opportunity for the Shanghai Institute of Machine Building Technology, which is actively involved in the organisation of these events (in association with the International Federation For The Heat Treatment of Materials and the Heat Treatment Institute of the Chinese Mechanical Engineering Society), to interact directly with the many international delegates and trade organisations, and to thus demonstrate the viability of the Institute in the eyes of the heat treatment community in the Shanghai District.

Accordingly, it is recommended that:

(a) The appropriate UNIDO representatives from both inside China (Mr. Albertus W. Sissingh) and from Vienna, should attend the Congress to assess its impact on the manufacturing community in China.

(b) Consideration should be given to requesting Professor Bell, President of the IFHT, to extend his visit to Shanghai in November 1983 to act as a UNIDO consultant. The work would involve formulating, in conjunction with UNIDO personnel and the Chinese Authorities, a new UNIDO project to establish a Heat Treatment Advisory Section and an enhanced Heat Treatment Applications Section within the Institute.

If this recommendation is approved, Professor Bell would be prepared to spend the necessary time between now and November 1983 in

(i) Devising, organising and costing appropriate training programmes for the new proposals described above.

(ii) Identifying and costing, in conjunction with Dr. Hubert A. Janiszewski, of UNIDO, the acquisition of the necessary heat treatment information and know-how essential for the Heat Treatment Advisory Section. These data would be obtained from such bodies as The Wolfson Surface Engineering Unit, University of Birmingham, The Wolfson Heat Treatment Centre, University of Aston, The Metals Society, UK, and The American Society for Metals.