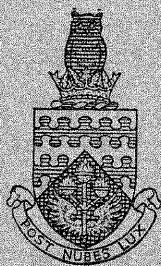


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THE COLLEGE OF AERONAUTICS  
CRANFIELD



WORK STUDY IN GERMANY  
A REPORT OF THE ACTIVITIES OF R.E.F.A.

by  
L.J. HARPER

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THE COLLEGE OF AERONAUTICS  
CRANFIELD

Work Study in Germany

A Report of the Activities of REFA

by

L. J. Harper

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SUMMARY

The writer was in Germany from April 4th. to April 16th. 1955 for discussions with the headquarters' staff of the REFA Organisation, and practitioners of the REFA techniques in various factories.

This report deals with the advice and impressions received during that visit.

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## 1. THE REFA ORGANISATION

REFA is the name of the German National Organisation for Work Study (Reichs Einrichtung für Arbeitstudien). Since the war the name has been changed officially to Verband für Arbeitstudien (Work Study Society), but the term REFA is still retained in all official publications and used as a familiar 'trade' name.

The Association is the only one of its kind in Germany and all training in the techniques used is carried out by specialist teachers, properly certified by the Headquarters staff after appropriate examination (see 2, Training Methods).

Agreements have been reached between the Employers Organisations, the Trades Unions and REFA about the application of Work Study practices and there appear to be no difficulties about using stop watches for instance.

The organisation is financed by -

- a) Subscriptions from its 13,000 members
- b) Surplus revenue from training courses
- c) Government grant

Headquarters of the organisation is at Darmstadt, and is under the directorship of Professor Bramesfeldt. The major functions of the Headquarters are -

- a) Control and co-ordination of training courses, conferences etc.
- b) Maintenance of registers and records of REFA practitioners throughout Germany.
- c) Publication of the Society journal (REFA Nachrichten) quarterly.
- d) Translation and dissemination of information contained in foreign journals (Arbeitswissenschaftlicher Auslandsdienst).
- e) Publication of pamphlets and books on specialist developments.
- f) Negotiations with Employers and Trades Unions on matters affecting the principles of REFA application.

Each major district has its local association and these Chapters appear to be very active. They are responsible for the training of newcomers to the work, and hold conferences at regular intervals.

The National Conference is to be held in Hamburg this year (1955) and it is expected that 1,000 to 1,200 men will attend.

## 2. TRAINING METHODS

### 2.1 The Plan

To become a qualified REFA man it is necessary to complete a protracted training and the structure of the training scheme can be seen from the attached chart (Fig. I).

The basic course consists of 66 - 80 hours of instruction and 54 - 70 hours of practical work, making a total of 120 - 150 hours. This can be carried out either continuously over three weeks or on a part time basis in evening institutes.

The second stage of instruction covers a period of about two years during which time the trainee is doing practical work in his company and receiving specialist instruction on a part-time basis. Twelve different industries can be covered in this way, and whilst it is permissible to undergo the training for any number of these industries, it is usual to concentrate on one only.

This instruction really deals only with Time Study and derivation of Time Values for payment purposes.

Five specialist courses are available for trainees wishing to develop their abilities to management level and these can be taken concurrently with the second stage training or afterwards as required and in any order to suit the student.

After completing all the foregoing instruction it is possible to attend an eight weeks course called a Seminar designed for senior practitioners or managers.

### 2.2. The Courses

**Basic Course.** The writer had the privilege of attending one of the two-hour sessions of the course being held in Hamburg. This was being run on lines similar to our Evening Institute courses, and was under the control of Mr. Franke who had the senior Work Study Officer from the Bergerdorf Eisenwerke ASTRA factory in support.



5.

The qualified teacher is supplied with a manual of instructions showing how much time and in which order, each part of the syllabus should be taken. (Comparable with the T. W. I. Manuals in England). This ensures that the method of instruction is at least consistent and that individual standards are comparable.

Little, if any, work is done on Method or Motion Study as we know it in England, although up to six hours of lectures (no practical) is spent on the subject of organising the work flow and workplace.

Most of the basic course concerns itself with the techniques of Time Study as practiced by REFA, and provides for 10 hours Rating Practice on synthetic jobs (films not used at this stage), 20 hours practice on Time Studying and a further 10 - 20 hours in exercises covering Time Study and the derivation of values. This is an addition to the lecture hours spent on the subject.

Job Evaluation receives considerable attention during this basic course, having an allocation of 6 - 8 hours lectures and 8 hours practical work.

At the session the writer attended a simple practical job was offered by the instructor and was carried out by a number of the students. The job involved

- a) sawing prescribed lengths from a piece of prepared wood, using a tenon saw and holding the wood on a slippery hard-board top,
- b) marking out and cutting out a piece of cardboard and
- c) attaching the cardboard to the wood by means of tinned tacks to form a small box having a rectangular base and two sides of decreasing height (representing a very small work tray).

During the operation which was repeated six times, the remainder of the students were scattered around the lecture room in three major groups.

The first group was taking Time Studies (without Rating), the second was attempting to determine something about planning and layout of the job with any method improvement that occurred to them (without formal Process Charting) and the third was taking a rather distant view with the object of Job Evaluation.

The Time Study group, using the continuous reading method and a split hand watch, was told at the end of the exercise the reason for recording the starting time but by this time it was not possible to get an Elapsed time check as many had stopped their watches. It was explained to the writer that the students were expected to learn by their mistakes!!

As there is but one form of incentive scheme in use in factories using REFA techniques there appears to be no attempt to teach or discuss other types of scheme. The method used is called Akkord (lit: Contract) and provides a straight proportional increment. There are, however, certain peculiarities about the starting point for incentive earnings, and the optimum earning level (if any) is related to the rating concept, (see 3. 2. Practices in the Factory).

### Second Stage Training

From discussions at factories the writer learned that the second stage of training (two years practice with part-time tuition) is very much the same as the sort of instruction a young man in England would receive in a Time Study Department and Evening Institute (allowing for the differences in concept and intent). A big advantage is to be found however in the fact that, as only one method is taught throughout the country, the practitioners in the factories and the tutors in the institute are using the same procedures in practically all instances.

### Specialist Courses

The two courses covering Statistical Methods of Control and Works Management are run jointly by REFA, the Employers' Federation and the Trades Unions. The remaining three are handled entirely by REFA with the assistance of specialists as required.

Again, a big advantage is to be found in having management subjects taught by a centrally controlled body so that the same techniques are used in all types of industry. There was no opportunity to discover the detailed contents of any of these courses but the impression received was that a high level of instruction was offered.

### Seminars

The eight weeks course for Senior Practitioners and Management, which is usually held once per year appeared to be worthy of special attention. The cost of tuition is 120 DM (approx. £10) per week plus 8 - 9 DM (13/- to 15/-) plus fifteen per cent per day for hotel accomodation.

Conferees are able to obtain thirty-three per cent reduction on Rail tickets.

Each week of the Seminar is intended to give complete coverage of the subject matter for the week, (or as complete as is deemed to be appropriate).

Thus it is possible for management representatives to attend for only those weeks in which subjects which interest them are covered. It is admitted that this creates difficulties in administration and teaching as some people are there for the full eight weeks whilst others attend for maybe only one or two weeks each year. It is assumed however, that the absorption rate for all will be at a low level at the beginning of the week

A qualified Engineer who goes through the preliminary training and attends all eight weeks of the Seminar (not necessarily in one year) and satisfies the examiners of his knowledge of the subject, becomes entitled to call himself REFA-Ingenieur.

The diploma offered to similarly trained graduates in other sciences does not yet carry the distinction of being an accepted professional qualification. There are for instance, no REFA Chemists or Accountants.

The tutors on the Seminar are all well qualified in their particular professions and are drawn from all parts of Germany and German industry to give their lectures.

In principle the contents of the Seminar-weeks are: -

- Week 1: The Function of Industrial Management, Political Economy, Social responsibility, Organisation of an undertaking, Negotiating Procedures and Machinery, American Management Practices, Planning and Programming.
- Week 2: Selection and Training, Human Relations, Industrial Psychology, Selection Methods, Training requirements and methods, Apprenticeship Training etc.
- Week 3: Industrial Welfare - Management, Men and Work; Hygiene and Health, Problems of Women and Young Persons in Industry, Working Conditions.
- Week 4: Effort and Reward - Communal and Social Effects of Wage Payments, Wage Structures in Germany and Abroad. Wage Differentials, Problems of Job Evaluation and Contract Rates.
- Week 5: Work Simplification and Rationalisation. Capital and Capital Economy. Materials and Equipment, Multi and Single Product Manufacture, Light, Colour and Ventilation. Office Methods.
- Week 6: Material Control and Work Methods. Strength of Materials, Common and Alternative Materials. Quality Control. Machining Methods. Men versus Machines. Work Flow.



- Week 7: Planning, Programming and Scheduling. Production Control for all sizes of factories. Graphic and other methods of Shop loading, Delivery and Supply schedules, Stores Control, Packaging and Despatch. Maintenance of Supplies, Buying and Sales Policy.
- Week 8: Costing and Industrial Economics.  
Principles of Accountancy, Costing for:- Materials, Labour, Transport, Distribution etc. Clerical methods and procedures.  
The Directors Viewpoint.

It will be seen from this that, although the REFA organisation is responsible for the training of Work Study Personnel, their activities embrace almost all aspects of Management in the Seminars. This latter training course appears to be a fairly recent development, and is apparently the only facility offered for the training of higher management. The writer is not aware of the existence of establishments such as the Administrative Staff College at Henley, in Germany. This is not to say however, that no such establishment exists or is in course of development.

#### The Teachers' Seminar

Unfortunately there was no opportunity to obtain detailed information about the breakdown of these courses, but there seemed to be no doubt of the high standard of knowledge and experience required before a REFA practitioner can qualify for inclusion in the course. To what extent such technical excellence presupposes teaching ability is unknown, but it is understood that some degree of attention is given to the development of teaching skills as well as the technology of the work (an aspect rarely covered in our Technical Institutes).

### 3. REFA IN PRACTICE

#### 3.1 Headquarters

Apart from the almost self-explanatory functions listed in Section 1 of this report, the staff of the Headquarters of REFA at Darmstadt are responsible for the interpretation of the results of research concerning human effort and the investigation of (and frequently, stimulation of invention of) new equipment, apparatus and methods, to assist in the furtherance of their managerial concepts. They have therefore, a close liaison with such organisations as the Max Planck Institut für Arbeitsphysiologie (see Section 4).

In this connection the work carried out by Dipl.-Ing. Helmut Spitzer on Rest Allowances and Calorie Consumption in Heavy Work \* has been published and is now treated (says Dr. Pechhold - who is responsible for training) as the basis for the calculation of rest allowances for all heavy work throughout Germany. (See comments on factory visits).

Only fairly recently have they become involved in investigation of the techniques of Random Observation Studies, and to the best of the writer's knowledge have done no work on Memo-motion techniques. An interesting paper has been written by Dr. -Ing De Jong on Random Observation Studies x in which he shows that whereas R. O. S. may not give a complete and accurate picture, certain of the dangers of traditional Time Study might be avoided by the use of the technique (App: 2)

Evaluation of these and other aspects of research and the dissemination of such information, particularly to REFA teachers, is an extremely important and valuable part of the headquarters' work.

Considerably more time and attention is given to aspects of Time Study than any other of the formal techniques of Work Study as taught at Cranfield. Whilst Method Study techniques are known at Darmstadt and the work of the Gilbreths is appreciated to some extent, there is as yet no pressure to include practice in these skills in the courses for REFA men. Oddly enough, despite the excellent photographic equipment on sale in Germany, there is no apparatus known to REFA in Darmstadt for film analysis other than a very ordinary film editor.

Under this heading of visual aids one might also include the absence of suitable material for training in or checking of Rating concepts. The S. A. M. films are used but there are no films comparable to the I. C. I., Hoover or Pilkington Rating films.

Other forms of propaganda or instructional films (with the exception of Fornaliez "Motion Study") are apparently unknown or discounted.

On the other hand great store is set by the full and detailed provision of instructions for the building up of a case of tools and equipment for handling the sample practical jobs practiced in the basic course (such as the work tray job described).

\* Der Energieumsatz bei körperlicher Arbeit, Sonderheft, Der Refa Nachrichten Darmstadt 1953.

x Multimomentaufnahmen, Darmstadt, 1954.

There is a predisposition towards accuracy of time recording by physical means and a useful instrument called a "Ferrari Parraprint Teilzeitdrucker" has been evolved. This small compact unit prints on to a roll of paper the element number and the duration in units of 100th. of a minute, zeroing after each printing, but obviously requiring manual control of the indicator showing the element number. This apparatus is used particularly as a control of the work of learners handling stop watches in the early days of their training.

Rating, Rest Allowances and use of Time Study data for payment purposes, however, all appear to be rather less positive and clearly defined. For instance, in some situations the writer found that working conditions and some aspects of fatigue engendering facets of a man's work were taken into account in the rating. Rest allowances in three factories were blanket allowances and procedures concerning Incentive Payment bases were highly localised.

### 3.2. PRACTICES IN THE FACTORIES

The writer was given facilities for visiting three factories and discussing problems and procedures. These were -

Menck and Hambrock - Altona  
Biersdorf Chemical Works - Hamburg  
Bergerdorf Eisenwerke - Bergerdorf

In each factory REFA techniques are accepted parts of the management and every effort was made to demonstrate their use of the procedures.

The following comments indicate the most noteworthy points observed -

#### a) Menck and Hambrock

This company manufactures heavy earth-moving equipment. The total payroll is approximately 1,800 of which 1,200 are in the works and 600 are staff employees. Of the works personnel about half are on the standard incentive scheme. A team of ten young men manage the works and the policy of "youth at the helm" seems to be acceptable to everyone. The Board of Directors is, of course, comprised of much older men. One of these ten is the Chief Work Study Officer, but with a rather unusual departmental structure. His title actually Arbeits-Vor-Bereitung or Works Planner. He controls the activities of about 182 people made up as follows -

Buying new machinery	2
Planning	15
Time Study (REFA men)	10

Tracers	15
Printing (Drawings etc.)	15
Design of Gauges, Jigs etc.	10
Manufacture of Gauges, Jigs	20
Stores for above and cutting tools	25
Manufacture of Cutting Tools and Machine Maintenance	70

Time Study has been practised for twenty years and a very high proportion of the production work is covered in this way. Each machine tool has an I. B. M. record card giving details of its performance under all conditions and cutting etc. times are derived from these cards by normal clerical methods. Data for Tables of Standard Values for many types of handwork (including filing, sawing, grinding, polishing etc.) has been compiled and a very comprehensive record has been built up. Nevertheless, new jobs are subjected to Time Study before work values are supplied and it seems that full use of the available data is not being made. It is accepted however, that as much of the data was derived before the war and necessary rebuilding has perhaps altered some aspects of working conditions, the Standard Data might be slightly suspect. No attempt appears to be made to check this.

It was not surprising therefore to find that none of the indirect operatives, or Maintenance employees are on any form of measured work. The very familiar attitude of "It won't work in this sort of manufacture" was almost nostalgic.

Actual Time Study procedures were not dissimilar to comparable factories in the U. K. A continuous, split hand watch was used and at least the mechanical aspect of time recording was better than a straight forward guess. Rating however, called Effort Grading, had to take account of many fatigue aspects as the method of completing a study was : -

Average Time x Average Rating  
 Plus 10% (blanket) for Policy and Lost Time and Rest  
 Plus 20% ( of 110%) = Allowed Time.

As the bonus earnings were reported to be rarely in excess of the allowed 20%(and obviously never below) I was left with the impression that either -

- a) The Time Study is extremely accurate
- b) " " " " tight in most cases
- or c) Restrictive practices apply.

The first alternative cannot easily be accepted and the last seems at variance with the impression received of the German workers. Tight values however are acceptable as the British worker or his Unions would hardly agree with the rating concepts proffered in this factory, even allowing for the mental arithmetic necessary to account for fatigue factors.

Nevertheless, the relationships between REFA men and workers seemed to be quite good, and the factory has no record of strife on this account. No examples of good Method or Motion Study were seen, although large assembly jigs were used in many situations.

Many of the jobs seen were quite heavy and would have received more than 10% C. R. in Britain (certainly if 10% C. R. was awarded to Capstan Lathe operators on light work). Dr. Spitzer's tables were unknown.

b) Beiersdorf Chemical Works

The factory manufactures Nivea products and is housed in very modern and pleasant premises, hampered to some extent by being split into two factories with perhaps one third of a mile between them. 1,800 people are employed of which about 1,200 are women, all of whom are on incentive. The Work Study Department has been established for only one year, and its Chief is not a trained REFA man. Four trained men are employed however, and they constitute the study team. Most of the values for the incentive schemes are admitted to be guesses with very little to guide them except experience and past records. Beiersdorfs are the first pharmaceutical factory to introduce REFA techniques, indeed, very little study work has been done outside of the Metal working industries. Consequently other pharmaceutical manufacturers are waiting for Beiersdorfs to produce standard data which they will be expected to make available to all.

In setting up the Work Study Department considerable care has been taken to ensure that complete records are kept of all Time Studies. Visible Index cards have been designed to show all the details of the Time Study analysis including element descriptions and full details of conditions, equipment etc. at the time of the study. This would be comparable with the Time Study Summary in Britain but, rather oddly, this permanent record also contains a list of the names of the operators in the team. This is said to be necessary because of the need for care in giving a work value for a known team "suited and accustomed to the work".

Apart from this aspect, the Visible Index Card (a copy of which is held) was a much better way of keeping this very important record than any other I have seen.

In all the Time Studies so far carried out a blanket Rest Allowance of 12% has been added. It is not possible to compare this with anything else seen because other fatigue engendering factors are taken care of in the Job Evaluation Rate which is applied to most of the jobs at this factory. Effort rating did not attempt to include fatigue factors.

Whilst walking around the factory a comparison was made of the pace of working with similar work in British factories, but on a short visit a snap judgement can be very unfair. The guide was asked to Rate one of the operators on a team job, belt paced, packing tubes of toothpaste. Unfortunately it was near to a break time and this created the inevitable problem of supplies down the belt. However, the guide instructed the team supervisor that a demonstration of 100% performance was requested and to oblige she sat at the bench, collected her supplies around her and proceeded to turn on a demonstration of a 100 Rating (normal). The supervisor established the pace and the Time Study man said - "It must be so". Pace setting by supervisors was apparently an accepted part of the team set up.

To compare the Rating with any British concept is, again, not possible, due to the differences in our approaches to the final derivation of work values.

The procedure in this factory was like this. A number of cycles would be timed in the normal way. (The study sheet provided for ten cycles and this was considered to be adequate). A blanket Rating would be assessed for the whole study and applied to the average observed time for each element. To this Normalised Time would be added a Rest Allowance - (in this particular factory an allowance of twelve per cent was given to all jobs irrespective of job conditions) and again a further twenty per cent was added to ensure that a bonus of this proportion would be earned. However, as previously stated, Job Evaluation takes account of weight and other fatigue factors, a blanket of twelve per cent is given as standard and Rating is used to level out other inequalities between jobs. When all this is done, it is only by the addition of twenty per cent to the Normalised time that a bonus can be earned, and indeed is earned at about the twenty per cent level.



Whether these methods are right or wrong, the only means of comparison with similar workers in Britain would be on actual output figures for identical jobs. Certainly there is no basis for comparison in concepts of Rating or indeed of issued values. In fact, the assessment of the supervisor during her demonstration would have been perhaps 115 - 120 (on a 100 - 130 scale) but this only corrects for some part of the 20% addition applied at the end of the study calculations.

Notwithstanding all the foregoing, the factory girls working on belt controlled or paced jobs were working on a fifty-five minute hour basis with five minutes given in each hour during which time they compulsorily changed jobs in the team. This time, amounting to 12% was additional to the other calculations and was considered to be a necessary part of the job where objects were moved past the operators at a fairly fast speed. Graphs were produced to show that by this means a higher average performance was maintained throughout the working period. This procedure was not used for the girls operating presses etc. and was not being considered for any type of work other than belt work.

With regard to methods of working much of the machinery used was modern and well designed but there appeared to be scope for investigation of, storing, handling, lay out and scrap levels. For instance, containers of various sizes were being punched out of standard size alloy sheets. The scrap from the bigger sizes appeared to be disproportionate to the advantage of standardisation of sheet size. No attempt was being made to investigate these aspects.

The general impression received was that whilst progress was being made in the Work Measurement field, considerable savings might have been effected by a concentrated Methods investigation.

c) Bergerdorf Eisenwerke

This factory produces refrigeration units for ships and large installations, buttermaking equipment including pasteurisation plant for bulk manufactures, some textile machinery and a variety of special plant calling for foundry and sheet metal work. Of 1,500 employees about 1,200 are in the factory and of these 67% are on incentives based on Time Study. The Production Manager, Herr Reitmeier handles two inter-related departments and is himself responsible to the Managing Director.

His department cover a) Preparing and Planning, and  
b) Progressing and Wages.

The division is fairly clear and appears to give the minimum of trouble. The preparation and planning section includes Jig and Tool design and production, determination of work values and first stage processing, some method study, and some aspects of maintenance.

The Planning and Wages section handles shop loading, scheduling, time keeping and all incentive scheme administration as well as the normal Wages Department function. There are five REFA men employed (apart from Reitmeier himself) four of whom are engaged on Time Study and the fifth on Method Study. This latter function is mostly limited to processing new jobs.

Standard values have been derived for all machine work but it was admitted that it was rare to check back to see that a machine was still capable of maintaining the output indicated on the Standard Values derived in many cases some years before. The Process sheet provided with each job laid down the tooling requirements and this in turn indicated the machining times. Foremen were made responsible for seeing that tools and equipment were available and up to specification.

The factory operates a highly mechanised foundry for which even more mechanisation is scheduled. The tempo of work in the foundry particularly was very good and during the visit with one of the Time Study men, everyone seemed to be working very well. (A later comment about Rating may have significance).

Next to the foundry was a fettling shop where the cast iron was handled. This sort of work rarely provides an ideal in working conditions but by comparison with the foundry, the fettling shop had been sorely neglected and could have been much more efficient had some attention been given to materials handling. Work Values had been derived for this shop after six days of Time Study using two men. Despite the great variety of products handled the values had been contrived into scales of time per kilo of finished product and with a remarkably small number of factors to compensate for intricacy of work.

Using this type of simplified approach the Work Study department now has standard values for ninety-five per cent of all the factory productive work. It was noteworthy that all machine times were given at Normal Time (i. e. 100 R ) and was in fact treated as our Process Allowance. There was never any doubt in anyones mind, apparently, that bonus times could only be related to human effort.

Time Study procedures were of course in accordance with REFA teaching but again there were local differences of treatment of results and concepts of Effort Rating. In one instance a young worker was working extremely hard, tamping down the sand in a moulding box on a Vibrating Machine, carrying the box (weighing perhaps 120 lbs.) to a stack about twenty-two feet away and returning to collect an empty moulding box to fill. He was stripped to the waist and sweating. What his overall performance for the day was is not known. It is doubtful if he could have maintained that effort for more than a few hours. The guide assessed his effort at 110 - 120 and wouldn't be more specific than that because he was not carrying out a Time Study. Other comparisons showed a similar tightness in Rating but a marked consistency was not apparent.

Subsequently it was learned from this same Time Study man (a slightly disgruntled individual who had been self employed as a watchmaker (!!) until the war) that the Time Study men were looked upon as slave drivers and were not happily accepted in the workshops. None of the REFA men employed were experts in this type of work and appeared to be afraid of being fooled by the workers. Consequently there was some over compensation for their doubts.

Most of the work would have been ideally suited to the application of Dr. Spitzer's tables of Rest Allowances. These were not known however, and the system of blanket allowances operates.  $7\frac{1}{2}\%$  allowance for hand work and 11% for machine work are the standards. In this factory, 10% is added for bonus (compared with 20% at the other factories) and bonus earnings are generally between 10 and 20% above the bonus base rate. The Basic Rate for the factory (before Job Evaluation, where applied) was 1.62 DM (11.76 DM to the £) approximately 2/8d. per hour. A rate of 1.78 DM was paid as Akkordbasis (Bonus base) for 100% performance. A performance of 120% earned 120% of 1.78 DM but a performance of less than 100% meant that basic rate of 1.62 DM applied.

Whether a Cost of Living bonus applied as well is not known, but it is perhaps significant that this factory is short of men, particularly in the skilled trades.

Lieu bonuses operate for all assembly jobs. No attempt has been made to apply Maintenance, Tool Room, Stores or other ancillary workers.

#### 4. RESEARCH

The Max Planck Institut für Arbeitsphysiologie in Dortmund is part of a National Research Organisation and is concerned with physiological problems of work. A constant stream of most valuable information is poured out from this Institute and is made available to the sundry people to whom it is useful. For instance, one department is concerned with designing machinery so that it meets the physiological limitations of a normal operator. Problems are presented from industry and the results of the experiments are fed back and put to work.

When a machine designer has determined the mechanical requirements of his machine, the Max Planck engineers investigate the design and introduce modifications to reduce fatigue in the operation of the machine. These two aspects of design are taken as complimentary and essential and some extremely good results ensue. Some of the most intensive research is in the field of fatigue and recovery time and the laboratories are very well equipped for making controlled experiments.

This report cannot concern itself with technological problems of physiological research. Further detailed information can best be obtained by reference to the bibliography published in January, 1955, and entitled "Arbeiten aus dem Max-Planck Institut für Arbeitsphysiologie, Dortmund". This lists some hundred papers published, mostly since the war, on such subjects as Pulse Frequency under Working Conditions, Energy Consumption, Climatic Effects on Workers, Muscle Use and Training, Industrial Psychology, Design of Machinery and Equipment, Vitamins and Hormones, Physiological Chemistry, and so forth.

The work previously referred to on the rest allowances based on calory consumption is perhaps of greatest direct interest in Work Study. There are, however, some very interesting results to be seen from the very fine work measurement undertaken in a variety of industries. These experiments show for instance that even on what would be considered to be well balanced teams of operators whose jobs have been defined by the traditional Time Study methods, the degree of unbalance between the most fully occupied operator and the other members of the team might be often as great as fifty per cent i. e. No. N operator occupied for 98% of the time and No. n operator for only 50% with the unoccupied time completely hidden from the Time Study Observer. This has been found to be true in many other examples - engineering workshops particularly; where great inequities are present though hidden. The results of these inequalities are manifold but there is a particularly bad effect when highly skilled operators are given jobs with "tight" times in the full knowledge that men of lesser ability are having less trouble making bonus. No solution is offered but the graphic presentation of the facts provides a warning which Time Study men would

do well to heed.

Some further and equally interesting work has been carried out in connection with, training muscles to do specific tasks, fifty-five minute hours for all types of work, the effect of heat loss and sweat rate on muscles, etc. For full information on these and other research projects reference should be made to either the bibliography previously quoted or to Professor Lehman at Dortmund.

## 5. CONCLUSIONS

REFA has a wonderful opportunity for standardisation of practices and procedures, but so far full advantage of this has not been taken. Much could be done to simplify and rationalise the approach, particularly in the Rating and computation fields. No use seems to be made of productivity indices. Operator and Department Unit Hour type of indices were unknown and the thought of using this type of data for Standard Labour Costing and other aspects of Management Control seemed to be new to everyone with whom it was discussed.

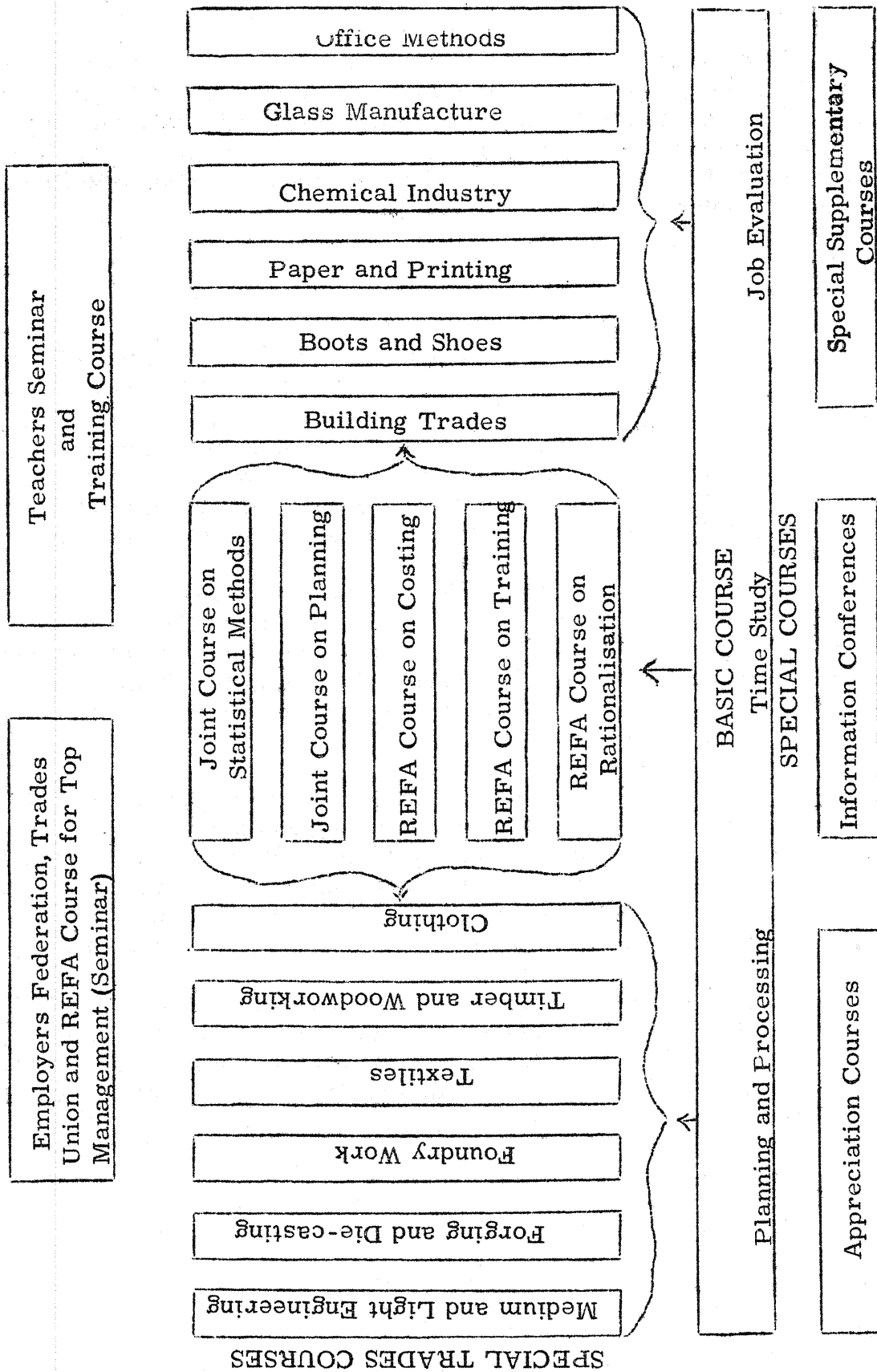
Headquarters of REFA are only just becoming interested in Pre-determined Times and are disposed towards embracing M. T. M. as part of their normal training. As a result of this visit some further interest has been aroused in the B. M. T. S. system produced by Production Engineering Limited and it is possible that some investigations into the various merits and demerits of both systems might ensue.

The factory employees appeared to be hard working and published figures indicate the tremendous increase in output which has taken place since the war. Perhaps the reward for the effort may not always agree with our British concepts, but nevertheless the shops are filled with many attractive products at prices which usually compare very favourably with ours despite an alleged burden of taxation and restrictions to pay for war damages.

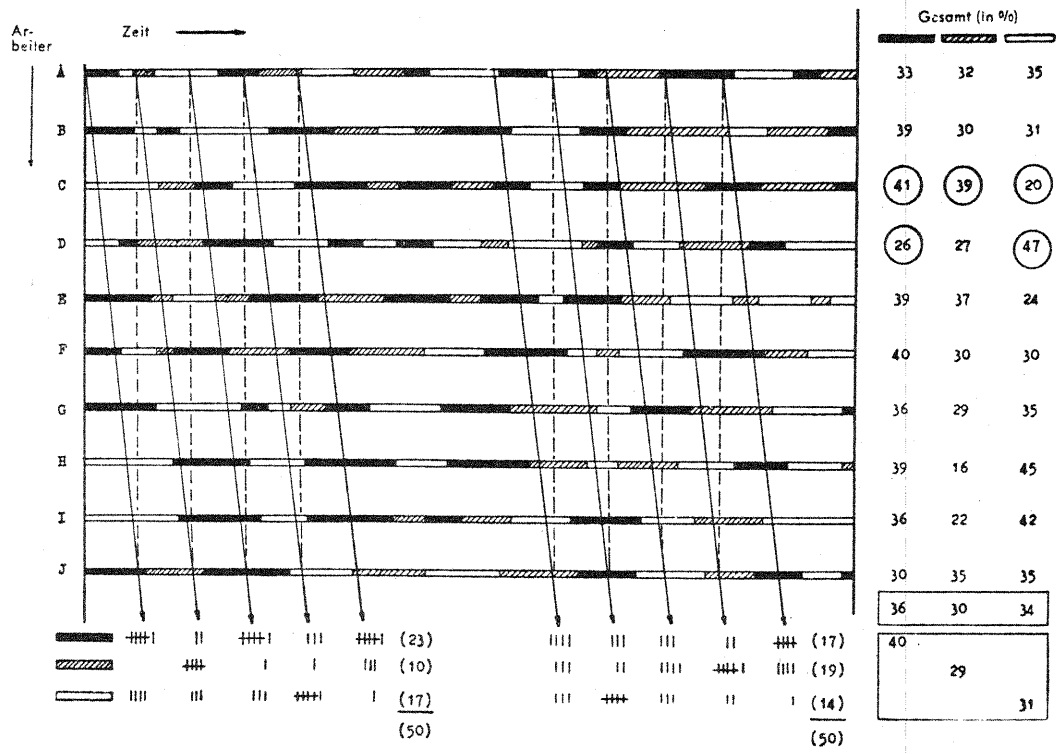
The research establishments have much to teach us if only in respect of the equipment and housing which they enjoy. They have the same problems as we have in conveying information to industry and converting the results of experiments into practical data, but their efforts in these directions seem to bear rather more fruit than do ours.

SPECIAL TRADES COURSES

REFA TRAINING COURSES







Lines A to J show the activities of operators doing the same jobs. The analysis shows the results of Time Study. A Random Observation Study, using a fixed interval between observations, is plotted in two parts. The average percentages for each of the three conditions recorded show a reasonable consistency with those derived from Time Study (Enclosed boxes bottom right). Time Study of Worker C or D would have given an unacceptable result by comparison.

(Multimomentaufnahmen - Dr. Ing. de Jong)