Nov.—Dec. 1963 Vol. XV Nos. 11—12

Vijnan Karmee

ASWI

Annual Subscription Rs. 10.00
Single Copy Rs. 1.00

Editorial Office :

CSIR, Rafi Marg
NEW DELHI-1

VIJNAN KARMEE

Journal of the Association of Scientific Workers of India

Founder President: **SHRI JAWAHARLAL NEHRU**

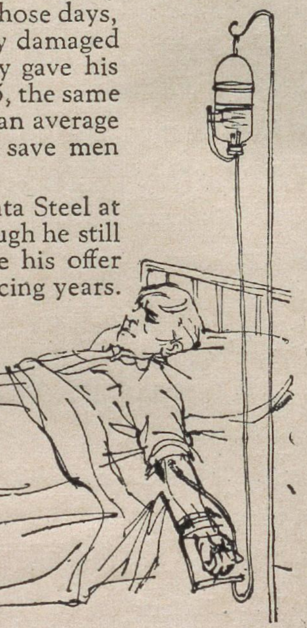
VOL. XV NOVEMBER-DECEMBER 1963 Nos. 11-12

CONTENTS

His blood has saved many lives

Way back in 1935, at Jamshedpur's Main Hospital, a man lay dying. Only a transfusion of blood could save him. In those days, most people thought that blood donation permanently damaged health. But a young man came forward and voluntarily gave his blood to sustain the ebbing life. Between 1935 and 1955, the same man freely gave his blood no less than 40 times--on an average twice a year—for victims of industrial accidents, to save men critically ill.

This extraordinary man is T. S. Balam, a typist with Tata Steel at Jamshedpur, a happy, healthy family man of 50. Although he still wants to donate blood, doctors decline his offer in view of his advancing years.



Inspired by the selfless example of men like Balam, many, many others in the steel town have donated blood. No less than 20,000 employees of Tata Steel have had their blood tested and grouped, while many more are coming forward regularly for testing and grouping . . . to help prevent avoidable deaths . . . to save families from sorrow and ruin.

This is yet another instance of the fellow-feeling, born of the indivisible bond of labour, that binds together the steelmen in Jamshedpur, a city where industry is not merely a source of livelihood but a way of life.

JAMSHEDPUR
THE STEEL CITY

GIVE FREELY TO THE NATIONAL DEFENCE FUND

The Tata Iron and Steel Company Limited

IWTTN 1254

Planning and Assessment of Scientific Research

A. RAHMAN

The question of the last decade: Should Science be planned, as Kaplan has pointed out, has now become: how, it can be planned. It would, therefore, be not worthwhile to go into the merits or demerits of planning, though it would be useful to examine the basic situation which has created the necessity.

Firstly, the resources available for science and technology are limited and the problems needing solution are extremely large necessitating a judicious deployment of resources. This means evaluation of each problem to be taken up for research in the context of national requirement and available resources and necessitates an allotment of priority.

Secondly, with the increase of scientific research the number of technical solutions for a problem are large. These are growing with time. According to Johnson, the number of technical choices in a particular military product situation is a function of time. During the middle thirties less than five choices existed, while during the middle fifties these have increased to about five hundred. Connected with the problem of technical choice, the problem of life of a technical solution is also very relevant for research. He calculated for weapons and came to the conclusion that the life span of weapon was about 1000 years, i.e. from the 5th century B.C. to about 1500 A.D. weapons hardly changed. In the 20th century it has been reduced to less than 10 years. Research on products and processes for non-military usage has not been carried out but what is true for military might as well be so for products and processes used for non-military purposes.

Thirdly, with the invasion of State Governments in the organization and direction of scientific and technical research as an instrument of social and political policy the question of research expenditure, actual technical effort and returns has come to acquire a great significance.

Fourthly, the organization of research at the State level has brought to the fore the question of estimation of available resources, present requirements, and the projection of resources and demands on the basis of existing conditions or with the probable changes, and the development of the policies to reduce the gap between the future requirements and available resources.

To meet these requirements a set of new procedures have to be worked out and developed. The first and foremost in these is the generation of ideas connected with a problem or a set of problems and the need of their preliminary scrutiny for feasibility. This is naturally followed by the selection of a few ideas for detailed study, which might aim at the estimation of significant aspects of the problem. There are no guide lines in this direction. So far the hunch of a director of research, his experience and opinion of colleagues guided him to make his decision. It should, however, be possible to make an effort in listing and quantifying some of the factors involved :

(*i*) requirements in men, material, financial resources,

(*ii*) socio-economic factors,

(*iii*) technological level of the country and industry, which is a factor in the utilization of results,

(*iv*) the current of scientific and technological opinion,

(*v*) anticipated cost of research and development,

(*vi*) time schedule for research including the possibility for other solutions by the time the results are available, and

(*vii*) probability of success and possible returns.

A detailed examination of issues involved could best be done by a team of workers, and then carrying out extensive discussions on the findings in the Institute. This procedure would have three advantages, there would not be any hasty adoption of a programme, a lot of concrete thinking would go into the working out of the programme, and the scientists in the Institute, including those not directly connected with the project would have a say, participate in the planning and may have something useful to contribute. Further, such a procedure would help in developing criteria, norms and standards for selections from amongst the alternatives.

Next step would be the actual scheduling of research including the mechanics of organisation for laboratory as well as developmental research, the division of work between different groups, organization of resources, fixing of time targets for each type of work. Some operational research has been carried out for each of these items, and rough indications are available as a guide. In the organization of a team of research productivity of a team size, time taken for arriving at a solution and the cost is to be taken into consideration. For instance, it has been noted by Johnson that size of a team for effective collaboration varies in basic and applied research. For basic research a size greater than six is conducive while for applied less than six would be more suited. The size of a team may not only affect the time taken but also the cost. For instance, the total accomplishment of a team of three may be economical in personnel, but might cost four to five times that of a group of six.

It may be desirable to mention in dealing with the cost of research and the size of group working, that the period of stay of a research worker is also directly connected with his effective contribution to research. It takes about a year to come to grip with a problem and too frequent chanages due to minor increase in emoluments may retard the progress of work. Further, there is a tendency in research establishments to discriminate against existing employees in favour of the new, this might lead to job hopping or dissatisfaction, both affecting productivity and successful execution of the programme of research.

After scheduling, reviewing is to be undertaken. The review should really cover the major fields, i.e. decisions, estimates and outcome. A judicious and scientific review of progress should really act as a directing and channelling force.

The planning of research in order to be effective and fruitful has to take various levels of research into consideration, viz. fundamental, adaptative and developmental. Fundamental research aims at developing new technology, while adaptative research aims at achieving current objective, developmental research is still more restricted. A considerable amount of research activity, particularly in the *applied* and *developmental* field in India—it may also be so in other developing countries—is *adaptative* in character. The knowledge and data available in advanced countries is being adapted, modified or changed to help in the utilization of indigenous raw materials, to suit Indian conditions and to meet the social objectives. The nature of activity can be characterized as research by the standards and definitions of applied research only the character is slightly different. Consequently, if the term applied research were to be changed to adaptative research it could easily cover the adaptation of ideas and processes, and the difference in shares of the same activity in advanced and lesser advanced countries could also be indicated.

The measurement of output brings to the fore a set of difficulties. *Fundamental research* by its very nature is difficult to measure, its newness makes it difficult to assess, and the farther it is from the current trends the more it takes in time to be fully understood and appreciated. The number of papers could be a criterion, but for the negative results and the false leads both of which are time consuming. The adaptative research is more amenable to evaluation through the goals set up, resources made available, results achieved and the application of the results. The output of developmental research, on the other hand, can be measured by another set of criteria which is more amenable to cost analysis of the expenditure and returns. In other words, for the three different types of activities three different standards of measurement are required. These standards vary in degree of accuracy and may not be strictly comparable to each other.

It may be worthwhile here to mention categorically that the major output of scientific research is technical information. The question of utilization of technical information is entirely a different matter where a large number of other factors are involved than mere technical feasibility. These require a different type effort to get the technical information utilized. The technical information obtained through research has to be measured from the objective set forth before the research was undertaken. The question of utilization is important and relevant but can never be a direct result of the research and an index to its success, at the most, if a large number of research processes are not utilized, it can be said that the objective set forth has either not been clearly defined or not pursued. Similarly the benefits accruing from the commercial utilization of a technical data and research are also not directly proportionate to the input. Very often they are quite disproportionate even if they are tangible. As long as the factors involved are not worked out more intensively and methods evolved to measure them, and their relative impact in a particular set of conditions, the measurement studies would act only as a rough guide and indicative of trends from which useful inferences could be drawn.

To sum up there are four distinct areas which require attention: Planning, Budgeting, Scheduling and Reviewing. Planning essentially involves project orientation of research, requires detailed budgeting of project to make it amenable to cost analysis research funds committed, spent and estimates of amount required, and finally makes it possible to measure input and output, i.e. the technical performance of work. It also makes possible to bring a group of workers to work compatibly towards a common goal, dovetailing of parallel programmes of research, integration and coordination of staff at various levels of responsibility to support timely decisions.

Science News

Photomechanical process of marking dials

Small batches of instrument dials can be produced economically by a new photo-mechanical technique developed in Britain.

It is suitable for marking dials for both standard and special instruments, and can also be used for reproducing designs on plastics and other non-metallic materials.

A fascimile of calibrations recorded on a transluscent master drawing, which is marked in opaque ink, is reproduced as a stove-enamelled design on the face of the dial. Any number of dials can be marked from the same drawing.

Black enamel is sprayed over a clean dial blank and stoved. Then a coating of white enamel is applied and air dried. Finally, a photosensitive substance is sprayed on. When this is dry—it takes about five minutes and can be accelerated by heat—the master drawing of the calibrations is superimposed. Dial blank and drawing are then exposed to ultra-violet light in a vacuum frame for about 2-1 /2 minutes, after which developer is wiped over the surface of the blank.

This removes the photosensitive coating from all the areas that were protected from the ultra-violet light by the markings on the drawing. Then thinner removes the air-dried white enamel from those areas, leaving the stoved black enamel underneath them. When the remainder of the photo-sensitive coating is washed off with water, the result is an exact replica of the master drawing in black on a white background. The dial can then be stoved to harden the white, or a clear stove enamel can be applied and heated.

The process can be carried out under the normal indirect lighting conditions of a factory. No darkroom and no special equipment other than a suitable vacuum printing frame are needed.

An alternative process, where stove-enamelling is not wanted, uses special dyes to fix the markings in any colour.

(Brit. Inf. Serv. BF 1254)

Miniature viewing probe for air crash investigations

Instruments of crashed aircraft can be examined undisturbed with a new miniature high-intensity viewing probe developed by a British firm.

Evidence that might be destroyed if the instrument were dismantled for inspection, can be obtained by inserting the probe, through which photographs can be taken to produce a permanent record.

The probe is in two parts—an optical probe and a quartz rod lighting probe—and they will pass together through a hole less than 0.4 in. in diameter. Alternatively, the two parts may be used separately.

Since the optical probe is cooled by forced air or inert gas and is watertight it can be used to inspect the interiors of components that are hot or full of fuel or other liquid. The quartz rod, of course, needs no cooling.

(Brit. Inf. Ser. BF. 1254)

Moulding of metals by liquid shock waves

An electro hydraulic machine for forming metals into pre-determined shapes by means of liquid shock waves is being produced by a Scottish firm. The machine, said to reduce the cost of awkwardly shaped components, which would otherwise require expensive tooling, was developed by the British National Engineering Laboratory.

In operation, a bank of capacitors is charged via a high voltage transformer-rectifier combination to a pre-determined voltage. The hollow blank to be formed is placed inside the mould, and filled with water. A pair of electrodes is inserted into the water.

The electrodes are connected to the capacitors via an ignitron, which normally prevents their discharge. When triggered the ignitron becomes almost a short-circuit and allows high currents to pass through the forming system. The sudden release of energy to the forming chamber in the form of a shock-wave, expands the materials into the mould.

Any energy upto the 10 kili-joules limit is obtained by adjusting the charge voltage. To obtain a high discharge rate, all connections between the components of the discharge rate circuit are by heavy copper bus-bars or flexible straps. To initiate the discharge a thyrator is fired which ignites the ignitron, in series with the forming electrodes. Peak currents of up to 80,000 amps. occur, ensuring fast discharge of the capacitor bank.

(Brit. Inf. Ser. BF 1254)

New bread-making process

A new bread-making process that cuts fermentation time from about four hours to a maximum of three quarters of an hour, saves space, and produces a bread that is softer and whiter and stales less rapidly than conventional bread, has been developed by the British Baking Industries Research Association.

Bulk dough fermentation time is eliminated by the expenditure of intense mechanical energy during the mixing, which is carried out by powerful batch mixers.

The process permits the production of any common variety of bread without bulk fermentation, causes no loss of quality or unusual crumb structure in the product. It can be used on any scale, with any normal bread-making flour.

Apart from the intense mixing, the process requires the use of a fast-acting chemical oxidation by the inclusion of either a low level of a fast-acting or a higher level of a slow-acting agent. Extra water must be added, but no preferment or liquid ferment. The yeast level of normal recipes has to be raised by 50-100 per cent, depending on the scale of operations.

The extra water is compensated for by the retention of solids normally lost during fermentation. The fact that there are none of the losses associated with bulk fermentation, and that there are extra ingredients, increases the yield by about 7 lbs. of dough per 100 lb. of flour. The value of this, it is said more than offsets the extra costs of yeast, chemical oxidant and electrical power.

(Brit. Inf. Ser. BF. 1254)

Factory Made Flats

A new British building system based on factory-made units, by which a 12-storey block of 44 flats was erected in 28 weeks by 41 men of 13 different trades, is to undergo further development aimed at adapting it for oversea use.

The flats were built at a cost ten per cent below that of traditional methods, which would have taken 52 weeks and involved 88 men of 19 different trades.

Twenty-one factory-made units positioned on site by a crane, are used in each flat. Walls and floor are of pre-cast concrete.

The finishes, window frames, window glass and thermal insulation of the external walls are completed at the factory.

Panels for internal walls and ceiling have surfaces so smooth that no plastering is required. Ducting for water, waste disposal, and ventilation is all pre-formed.

The programme for the erection of the flats was worked out by computer, which analysed the various tasks, calculated the time required for each, and determined when each must start and finish if delays and disruptions were to be avoided.

(Brit. Inf. Ser. BF 1297)

Cheaper, Lighter Heat Exchangers

A new design of liquid-to-liquid heat exchangers is said to cut production costs by up to 25 per cent and weight by as much as 66 per cent compared with conventional designs. The British firm responsible for the design claims that it is the first of its kind in the world.

The tube-end plate of the heat exchanger is cast in epoxyresin around the tube bundle and threaded inserts. This method of construction solves the problem of ensuring a large number of pressure tight joints and allows relaxed tube tolerances. Any suitable tube can be used, although aluminium is preferred. Previously end plate and tubes were produced in copper and soldered together.

Straight tube or 'U' tube heat exchangers can be produced by this method and they are capable of withstanding temperatures up to 150°C. and high pressures.

(Brit. Inf. Ser. BF. 1297)

Do it yourself Car windows

A power-window unit which can be fitted to any car in place of ordinary window winders is being marketed by Britax Ltd., Byfleet, Surrey, England.

It will enable the driver to open or close his and the passenger's window electrically at the touch of a button. The passenger has a button on his side to raise or lower his window and in the event of an electrical failure both windows can be operated manually.

The mechanism is contained in two small housings, which are fitted over the winding spindles of each door after the winding handle has been removed. These units are wired to the battery.

The firm say the unit can be easily installed by the practical motorist. It uses about the same power as a horn.

(Brit. Inf. Ser. BF. 1267)

A Collaboration between National Laboratories and Universities

A. K. MUSTAFY

The need for effective collaboration between National Laboratories or Institutes and the Universities has been felt for quite some time.

The Universities have a double role: namely, research, and teaching & training, though perhaps teaching & training function in Universities has quite rightly received more attention. However, with the pace of development in science and technology, research and teaching functions are bound to overlap — the one directly motivates the other.

So far, collaboration between National Laboratories/Institutes and the Universities has not grown to the extent desirable on account of several factors, the primary ones being:

(*a*) A feeling that if the Laboratories have to be recognised as centres for post-doctoral research by every University, there was a chance that on account of elaborate specialised facilities obtaining in the Laboratories, the best research students might go to the Laboratories thereby reducing research potential in the Universities.

(*b*) A feeling that the Laboratories will act as rivals to the Universities in the matter of higher research and in the process there is a chance that the Universities might not get enough resources by way of grants and facilities and cease to attract sufficient talent. A list of Universities who have recognised the CSIR institutions for post-doctoral research is given in Table on pages 12-13.

(*c*) The statutes of the various Universities do not automatically permit recognition of National Laboratories/Institutes which are situated all over India for post-doctoral research work, because the University statutes lay down territorial limits within which such recognition is possible.

The National Laboratories and Institutes were set up generally with the specific purpose of research in more or less special fields of science and technology. The CSIR was not entirely unaware of the situation that might arise as a result of the concentration of resources in the Laboratories. To partly counteract this tendency, the C.S.I.R. has largely supported research in the Universities by way of financial aid, offer of fellowships and sponsoring various research schemes in the Universities. A fairly large number of CSIR research schemes are handled in the Universities under Investigators-in-charge who are either Professors or Readers in the Universities. In spite of this, it is felt that the scope of collaboration between the National Laboratories and the Universities has to be enlarged substantially for the undermentioned reasons:

(*i*) The Universities do not have experimental facilities at the same level as they exist in the National Laboratories and Institutes.

(*ii*) There is a higher degree of specialisation in certain specific fields in science and technology in the National Laboratories, which are also well equipped from the point of view of experimental facilities, as compared to the Universities.

(*iii*) By and large, the National Laboratories have a more intensive coverage in selected problems of Applied Science and Technology which the Universities do not have.

The development of science and technology is now a national problem and definitive barriers between the Universities and National Laboratories in the matter of research functions are neither necessary nor called for in the present scheme of things. What is to be aimed at, is the most efficient use of available talent and resources, and the efforts of the Universities and the National Laboratories /Institutes must be complementary with a view to ensuring optimum utilization of existing resources and facilities.

Besides these considerations, it would be in the interest of National Laboratories to develop close collaboration with the Universities. Specialised research institutes, by the very nature of their functions, have to limit themselves to specific problems. While therefore, the effort is intensive, the programmes tend to become more and more specialised and narrow. This itself creates an atmosphere for inbreeding in thought, ideas and approach which in the long run might have detrimental effect on the capacity of the institutions to function in a dynamic way. Similarly, an analysis of research programmes in the Universities reveals that often the subjects of research are confined to a few selected fields which, primarily, are those which belong to the field of interest of the University professors and teachers. Thus, successive batches of students undertake researches of a repetitive and follow-up kind without significantly broadening the scope of work. Close collaboration between National Laboratories and Universities is an answer to this two-fold problem. Besides, Universities are the rallying points of a continuous stream of young talents whose interest and energy cannot be purposefully utilised unless larger opportunities for research are created. The special facilities existing in the National Laboratories will have to be thrown open to some extent to all deserving persons to meet this situation.

There is another significant result which might arise out of this collaboration. It is becoming difficult to get right type of men at various levels in the National Laboratories /Institutes. If the National Laboratories /Institutes were to participate in teaching and training programmes at post-graduate levels in selected fields in the Universities, the chances are that some of the bright youngmen in the Universities will get specialised orientation in research which will enable them to fill the gap that is developing in some of our Laboratories at certain levels. Similarly, the talents existing in the National Laboratories can to some extent be utilised for teaching at advanced levels in the Universities to partially supplement their existing teaching resources. The following measures are expected to achieve this end :

(*i*) National Laboratories situated in any particular part of India may be recognised by all Universities as centres for post-doctoral research irrespective of teerritorial barriers. To this extent, the statutes in the various Universities will have to be amended.

(*ii*) Scientists in National Laboratories / Institutes might be given an opportunity to deliver specialised course of lectures in Universities. For this purpose, they might be recognised as Hony. or Visiting Professors or Readers in the Universities, depending on their status in their respective fields.

Similarly, University professors and other members of the teaching staff might be invited to work in the National Laboratories/Institutes during vacations and utilise the experimental facilities which might be lacking in the Universities.

(*iii*) At least once a year, a seminar in some selected subjects might be arranged in the National Laboratories/Institutes in collaboration with the Univversities. These should be thrown open to the students at the post-graduate and doctoral levels in the Universities and the staff members of the Laboratories.

(*iv*) Regular study courses may be arranged in the Laboratories on specialised subjects in which the junior staff members of the Laboratories as also students of the Universities at post-graduate level may participate.

(*v*) Certain subjects for joint research by Universities and National Laboratories may be selected as a regular programme provided the Univrsities and the Laboratories happen to be situated in close proximity.

(*vi*) A list of specialised experimental facilities existing in the Laboratories may be circulated to the Universities so that whenever necessary, they can depute their staff members or research students to carry out their experiments.

(*vii*) The Universities are particularly suited for research on basic and fundamental aspects. It would be worthwhile for the Laboratories to keep in touch with the progress of research work in the Universities specially in these fields so that unnecessary duplication of effort might be avoided.

(*viii*) The CSIR has now increased the number of fellowships both for the Laboratories and the Universities and other institutions. It may be considered if certain number of fellows may be specially selected and placed at the Universities to carry out research on fundamental aspects of certain problems whose primary motivation arises out of the research programmes of the Laboratories and Institutes.

(*ix*) Wherever facilities exist, National Laboratories/Institutes might fabricate equipment for the Universities on a No-Profit-No-Loss basis on request from them.

(*x*) Quite a number of Universities are lacking in special equipment, required for micro-analysis, self recording ultra-violet and infra-red spectrograph NMR, ESR, Vapour phased Chromatrograph, mass spectrograph etc. Quite often, research work in the Universities are held up on account of lack of such facilities. Several National Laboratories and Institutes have these equipments and it would, therefore, be natural to expect that whenever requests are received from the Universities for assistance in respect of work requiring the use of of such specialized pieces of equipment they should be promptly attended to. If a list of specialised equipment as suggested in para (*vi*) above is circulated to the various Universities, they would be in a position to know what special facilities exist in any particular Laboratory or Institute. If the specialised jobs emanating from the Universities are sufficient enough, then the existing personnel in the Laboratories can be strengthened to provide proper service to the Universities in respect of such specialised jobs. A close watch on this has to be kept.

(*xi*) The Universities do not possess sufficient facilities for maintenance of their equipment. It is essential that Research work in the Universities is not held up merely because some special apparatus or equipment has broken down. Although this type of work belongs properly to the Central Scientific Instruments Organisation when it starts functioning, as an interim measure, it is thought that wherever National Laboratories/Institutes can provide such repair facilities, they should do so on a No-Profit-No-Loss basis, to the Universities.

(*xii*) Similarly, facilities should also be extended to the Universities from the animal house maintained at some of the CSIR Laboratories and also for the supply of plants etc. from their own collection. It is felt that a certain amount of collaboration is immediately possible in respect of the undermentioned Laboratories/Institutes with the respective Universities noted against each :

1. N.C.L., Poona — Poona University.
2. N.P.L., New Delhi,—Delhi University.
3. C.F.T.R.I., Mysore — Mysore University.
4. R.R.L., Hyderabad — Osmania University.
5. N.A.L., Bangalore — Indian Institute of Science, Bengalore.

Recently Heads of National Laboratories and Institutes were addressed to hold study courses on the above lines. The response has been very satisfactory and a special cell is being opened at the C.S.I.R. headquarters to properly plan and coordinate the work of collaboration as envisaged above.

TABLE

List of National Laboratories/Institutes which have been recognised by Universities for post-graduate Study & Research.

Sl. No.	Name of the Laboratory	Universities affording recognition
1	2	3
1.	National Physical Laboratory, New Delhi.	1. Andhra University. 2. M.S. University of Baroda. 3. Bombay University. 4. Banaras Hindu University. 5. Panjab University. 6. Delhi University. 7. Madras University. 8. Agra University. 9. Travancore University.
2.	Central Road Research Institute, New Delhi.	1. Agra University. 2. Andhra University. 3. Madras University.
3.	Central Salt & Marine Chemicals Research Institute, Bhavnagar.	1. Bombay University. 2. Karnatak University, Dharwar.
4.	Central Drug Research Institute, Lucknow.	1. Agra University. 2. Aligarh University. 3. Andhra University. 4. Bombay University. 5. Calcutta University. 6. Madras University.

1	2	3
		7. Poona University. 8. Panjab University. 9. Vikram University, Ujjain.
5.	Central Building Research Institute, Roorkee	1. Bombay University. 2. Poona University.
6.	Central Electro-Chemical Research Institute, Karaikudi.	1. Agra University. 2. Andhra University. 3. Bombay University. 4. Karnatak University.
7.	Central Leather Research Institute, Madras.	1. Madras University. 2. Karnatak University. 3. Rajasthan University.
8.	National Metallurgical Laboratory, Jamshedpur.	1. Agra University. 2. Andhra University. 3. Bombay University. 4. Madras University. 5. Banaras Hindu University.
9.	Central Fuel Research Institute, Jealgora.	1. Agra University. 2. Andhra University. 3. Aligarh University. 4. Baroda University. 5. Bombay University. 6. Kerala University.
10.	Central Glass & Ceramic Research Instt., Calcutta	1. Agra University. 2. Andhra University. 3. Banaras University. 4. Calcutta University. *(Although formal recognition has not been received but two research workers of the Institute have enrolled themselves with Calcutta University for Ph. D. degree).*
11.	Central Food Technological Research Institute, Mysore.	1. Panjab University. 2. Nagpur University. 3. Bombay University. 4. Madras University. 5. Poona University.
12.	Regional Research Laboratory, Hyderabad.	1. Osmania University, Hyderabad. 2. Andhra University, Waltair. 3. Poona University. 5. Kerala University. 5. Muslim University, Aligarh. 6. Banaras Hindu University, Varanasi. 7. Calcutta University, Calcutta. 8. Nagpur University, Nagpur.
13.	National Botanic Gardens Lucknow.	1. Agra University. 2. Karnatak University.
14.	National Chemical Laboratory, Poona.	1. Madras University. 2. Poona University. 3. Bombay University. 4. Agra University.
15.	Indian Institute for Bio-Chemistry & Experimental Medicine, Calcutta	1. Calcutta University.

ASSOCIATION NEWS

(*A Letter to D.G.S.I.R. by Gen. Secy. ASWI*)

Dr. M. S. Iyengar,
General Secretary (Orgn.)
Ref. No. ASWI/CEC/63.

4, Raksha Bhawan,
Ashoka Road,
New Delhi,
21st October, 1963.

The Director General,
Council of Scientific & Industrial Research
Rafi Marg, New Delhi-1.
Subject: *Unified Scale of pay for Scientists.*

Dear Sir,

The Central Executive Committee of the Association of Scientific Workers of India at its meeting on 10th October, 1963 considered the memorandum on the Unified Scale of Pay for CSIR Scientists proposed by its Lucknow Branch (Appendix A) and approved it with the following amendments:

1. The grade for the Fellows should be Rs. 325-15-370 and the period of probation for the Fellows should not in any case exceed three years. At the end of each year or earlier their case should be considered for recruitment to the Unified Scale of Pay by a competent Selection Committee. If at the end of three years a Fellow is not found suitable for the Unified Scale of Pay, his services should be terminated.

2. No distinction should be made between the technical and scientific staff for recruitment to the Unified Scale of Pay.

3. The cases of JSAs' and SSAs' who have already completed three years' service at the time of implementation of this Unified Scale of Pay, should be reviewed by Selection Committee for absorption into the Unified Scale of Pay. Provision should also exist for further periodic reviews. Further, they should be allowed to continue in their existing scale of pay if they fail to qualify for the Unified Scale of Pay.

4. The detailed procedure for the appointment of the Selection Committee, their composition etc. the composition of the Selection Committee for merits increments and promotion would have to be worked out in detail and it was decided that the Lucknow Branch would send its recommendations on these immediately. The Central Executive Committee was of the view that scientists belonging to the Unified Scale of Pay should be designated as "Scientists" only and all other designations should be done away with. However, the Central Executive Committee asked the General Secretary to elucidate information on this question from Branches and Units by the end of this month.

The Association considers an early implementation of this resolution necessary for creating the proper condition for scientific research. We hope that the CSIR will give this resolution its earnest consideration and implement it.

Further proposals regarding the details of the Selection Committee etc. are being worked out and would be communicated to you in due course.

Yours faithfully,
Sd/-
(M. S. Iyengar)

APPENDIX A

ASSOCIATION OF SCIENTIFIC WORKERS OF INDIA

LUCKNOW BRANCH

Subject: *Unified Scale of Pay for Scientists*

It is a matter of great satisfaction to scientific workers all over the country that one of their long-suggested proposals—the removal of the existing multiplicity of grades for scientists and their amalgamation into a single grade has at last been accepted in Principle by the Council of Scientific & Industrial Research, one of the biggest employers of scientific workers in the country. It is hoped that this example will be emulated by other scientific organisations and Universities in the country.

BASIC CONSIDERATION

The object of introducing an unified scale is: (*a*) to attract the best talent, to the scientific profession by offering suitable material inducements, and (*b*) create a sense of equality which would be conducive to free exchange of ideas and, what, is more important, free and objective criticism of each other's scientific work, so essential for the development of science, particularly in our country, where traditional respect for position and fear of authority are carried to the limit of subservience.

2. It has to be clearly realised that scientists as a class are also following a career and as such entitled to adequate financial rewards just as much as any person in any other profession. The practice of science may in itself be a source of satisfaction to some individuals and may provide them adequate compensation for lack of material benefits, but it would be impractical to expect the majority of the hard working scientists to subscribe to this ideal. This important point has to be taken into consideration and, therefore, the proposed unified grade should be modelled on the lines of the other central services, so that there is no large scale diversion of scientific talent to administrative services or other professions merely for better remuneration.

3. Not only should a scientist be offered an attractive starting salary on entrance to the grade but he should also be assured of certain minimum prospects within a reasonable period. The time scale of the grade should be such as to ensure continuous fincial advancement for him right upto his retirement, without any stagnation due to non-availability of posts. Original and outstanding work can be recognised by award of additional increments, but, in order to avoid arbitrary decisions, these awards should be made according to well-defined principles.

PROPOSALS

1. *Time scale*

The proposed unified grade should have the time scale: Rs. 480-40-800-EB-50-1300 Merit bar-60-1600-Merit Bar-75-1900.

2. *Entry to the unified grade*:

Persons who already hold scientific posts in the C.S.I.R. would naturally constitute the nucleus of the unified cadre and all of them would be absorbed therein.

Fresh recruitment would generally be after a period of training as Research Fellows, at a University or National Laboratory or equivalent institution, of 5-6 years after a post-graduate degree. Fellows would be expected to obtain their research degree during this period, if possible. The grade for fellows should be: Rs. 300-25-350-EB-400-425-450. Thus, before a person enters the proposed unified cadre his performance and suitability for a scientific career would have been evaluated thrice under actual working conditions; once at stage of award of fellowship, next during the tenure of fellowship and finally at the time of actual recruitment. This procedure should be a sufficient guarantee for the selection of the right type of personnel.

The starting salary of Rs. 480/- will normally correspond to the age of 26 of the entrant. But in case of entrants at a later stage they should be entitled to advance increments corresponding to the number of years of scientific experience. Outstanding persons may be given further advance increments, but such increments should not normally exceed three in number.

3. *Efficiency bar*

After such a rigorous selection procedure, detailed above, an entrant to the cadre should be allowed to go upto the Rs. 1300/- stage without impediments. Every scientist should be assured of reaching this minimum salary in his profession, subject of course, to normal considerations of efficiency. An efficiency bar at Rs. 800/- about the middle of the first stage, has been provided. This would operate according to existing established procedures, the criterion for crossing it being a record of steady satisfactory service and 95% or more of incumbents would be expected to cross the bar.

4. *Merit bars*

At the Rs. 1300/- stage there should be an evaluation by a specially constituted committee composed of specialists in the field of work of the person undergoing evaluation. Those who cross this bar would be expected to function as leaders of research groups, scientific and technical projects and hence the evaluation would be of a much higher standard than for a normal efficiency bar. Since the time scale is a unified one there would be no other limitation to crossing the bar, except that of merit. A further evaluation after Rs. 1600 would take a qualified scientist to Rs. 1900/- in a total period of 28 years from entrance to the cadre i.e. at the age of 54 years in a normal case.

If within a year of a person's reaching the Rs. 1300/- stage the employer does not get his work evaluated for judging his suitability for crossing the bar, he shall have right of appeal.

5. *Merit increments*

Normally meritorious and original work performed by a scientist rarely goes unappreciated by his colleagues in his own country and elsewhere. Facts, figures and theories developed by a scientist, if they are of merit, will be freely quoted by others: similarly, discovery of new processes and products, if of any value, will be readily accepted and utilised. In the past award of merit increments and promotions has not always followed any generally accepted principles, and these decisions have caused heart-burning among others who considered themselves to be as deserving, if not more. It would be desirable to revise the existing basis for evaluation of merit for such purpose and lay down general principles which would be strictly adhered to. It is also suggested that some limit should be fixed to the number of increments to be awarded to a person, and the number of times such awards can be given to an individual during the tenure of his service.

6. *Fixation of salary of existing staff*

The present scientific staff, on absorption into the unified grade, would normally be placed at points in the time scale next higher than their existing salaries.

In the case of those who have stagnated for more than five years in their present grade, without being considered for promotion due consideration should be given to the loss of increments suffered by them while fixing them in the unified scale on the basis of their age, qualifications, experience and published work. The Association of Scientific Workers, Lucknow Branch strongly feels that the above procedure is essential to the success of the scheme and will remove many anamolies that are expected to arise in the wake of introduction of unified system.

7. *Right of option*

A member of the existing staff of the CSIR shall have the right of option to remain in his present grade, should anyone feel the unified scale will operate adversely, financially or otherwise against him.

Dr. S. Husain Zaheer Addresses CFTRI Scientific Workers

Addressing the scientific workers of CFTRI, Mysore on May 19, 1963, Dr. S. Husain Zaheer, Director-General, Scientific & Industrial Research, said that one of the reasons why science has not prospered to the extent it ought to be is that Scientific Workers' Association has not played an effective role in the promotion of science. He said that he is more interested in the Scientific Workers' Association now than ever before. Non-existence of scientific climate or scientific community with scientific standards in India is one of the major obstacles to the development of science in the country. Lack of climate prevents scientists from being effective in building up modern scientific society in the country. Efforts to promote science are not succeeding in the manner we would like to see. If we cannot use science for the benefit of man, what use has it?

Among other obstacles in the way of development of science are too much regard and respect for outmoded tradition, too much regard for age, fear to express ones views or raise voice against corruption and inefficiency and lack of atmosphere for free discussion.

I consider it my duty to provide better conditions for scientists, promote science in the country and analyse the reasons for inadequate progress of science.

There should be a forum for taking erring scientists to task. It is the absence of this forum which is impeding the progress of science. He stressed that strong Associations of Scientific Workers are of very great importance in creating public opinion to correct the faults of scientists and in setting up standards and codes of conduct. "Many things happen among scientists which, as Director-General, I cannot correct although I know they are wrong. But if there is a strong body of scientific workers, it could create the morality and the public opinion that is necessary to correct the faults of scientists." Only a Scientific Workers' Association can condemn superstitions and wrong and misleading information about scientific discoveries, sometimes published in newspapers. The Scientific Workers' Association should discuss and find out why science and scientists are not making effective contribution to the social and economic development of the country.

In—Situ Combustion in Underground Petroleum Reservoirs

PROF. W. H. SOMERTON

(Under the auspices of the Association of Scientific Workers of India—CFRI Branch—Prof. W. H. Somerton, UNESCO Specialist in Petroleum Engineering, Indian School of Mines, Dhanbad, gave a talk on "In-situ Combustion in Underground Petroleum Reservoirs—Applications and Implications" on April 29, 1963 at CFRI with Dr. R. K. Srivastava, Vice-President, presiding.)

The World consumption of petroleum and petroleum products is increasing rapidly. Petroleum being a wasting asset and the present method of recovery being not more than 50 per cent, something has got to be done to increase the recovery since the cost of exploration is also increasing. Therefore today's best practices combine both primary and secondary recovery processes. Advancing technology has continued to seek means of improving secondary recovery and one of the methods under trial is thermal or in-situ combustion. By this method oil recovery can be increased to over 80 per cent.

Secondary recovery was first practised in the older and shallower reservoirs of the Appalachian region (USA) and has since spread to all oil producing regions of the world. When combined with primary recovery it is applied to deep reservoirs; when practised on depleted reservoirs, it is generally limited to economic factors to reservoirs shallower than 3000 ft.

Energy is supplemented by introduction of either gas or water under pressure into the reservoir. The following are the techniques: (*i*) Gas expansion drive—In this method gas moves the oil and the recovery is of the order of 15-20 per cent; (*ii*) Gas drive method—Recovery of oil in this case is of the order of 25-40 per cent; (*iii*) Water drive method—In this case the recovery of oil is much higher (25-60 per cent). The injected fluid (gas or water) drives the oil remaining in the reservoir to the vicinity of production wells, from whence it can be lifted to the surface.

Two types of wells, viz. injection wells and production wells, are required for secondary recovery operations. Locating wells in standard patterns permits intensive development of a given land area and ensures the maximum penetration of injected fluid to all parts of the reservoir. In early times a single injection well was surrounded by a large number of production wells. This pattern, known as a circle drive, is still used for gas injection operation. Another pattern, viz. the time drive, is a line of injection wells offset by a line of production well.

The most common well pattern is the five-spot. Square networks of injection and production wells interlocked so that each injection well is at the centre of a square consisting of 4 production wells, and each production well is at the centre of a square consisting of 4 injection wells. The spacing between injection wells and production wells will depend on local physical conditions of the petroleum reservoir and upon economic factors. Spacing economics is controlled by the amount of gas or water that can be injected into or produced from a single well.

In the in-situ combustion methods, a fire or combusition process is started in the reservoir at an injection well. By continued introduction of gas containing oxygen and other material to support combustion, burning of oil takes place at temp. of the order-of 600°F which provide a flow of heat ahead of the combustion zone to lower the oil viscosity and increase the recovery. The burning of heat generates combustion products and vaporized oil gases. These together with the bank of condensed water vapours, form a composite gas and water drive moving towards the producing wells with the combustion front. In addition, the gaes carry heat and raise the temperature of the rocks and fluids ahead of the combustion front, although the rapid alteration of the temperature wave tends to delay the improvement in well productivity until the fire comes close to the producing wells. The vaporization process immediately ahead of the burning front leaves deposits of heavy oil residue or coke, and these serve as fuel for the final combustion reaction. As a result, the rock through which the fire passes is left essentially clean with all its oil displaced or burnt out. There is a tendency for improvement in the gravity of the oil recovered by in-situ combustion.

Scales of Pay of Scientific and Technical Posts

Dr. G. S. Sidhu

Prior to the implementation of the recommendations of the Second Pay Commission, there was no distinction in the scales of pay of scientific and technical posts in the CSIR.

As a result of the recommendations of the Second Pay Commission, the following scales of pay for Research and Technical Staff in the National Laboratories /Institutes of CSIR were approved by the Governing Body of the CSIR :

Senior Scientific Officer Gr. I : Rs. 700-50-1250.

Senior Technical Officer Gr. I : Rs. 700-40-1100-50 /2-1250.

Senior Scientific Officer Gr. II : Rs. 400-40-800-50-950.

Senior Technical Officer Gr. II : Rs. 400-400-450-30-600-35-670-EB-35-950.

Junior Scientific Officer : Rs. 350-25-500-30-590-EB-30-800 EB-30-830-35-900.

Junior Technicalr Officer : Rs. 350 25-500-30-590-EB-30-680.

The disparity in the scales of pay for Research posts and Technical and Information posts was considered at the Ninth Conference of Directors held in Mysore in June, 1961 and a Committee consisting of the following was appointed to go into this matter and formulate its recommendations for the consideration of the DGSIR :

1. Lt. Gen. H. Williams.
2. Professor S. R. Mehra.
3. Dr. B. Mukherjee.

The Report of the Williams Committee was discussed in detail at the Tenth Conference of Directors held at Hyderabad in July, 1962 and the following recommendation was made :

"It was felt that it was sometimes difficult to make a distinction between research, scientific and technical staff working in engineering, pilot plant, workshop and information and liaison sections. Some distinction would have, however to be made in regard to staff who were engaged in purely routine work. In regard to all others, the scientific scales of pay should be made applicable provided they were engaged in scientific work and had the necessary scientific qualifications. The mere fact of their assignment to certain Divisions of Sections should not be considered as a bar to their getting the scientific scale of pay. The DGSIR would look into all these cases. The Directors were requested to look into the qualifications and duties of officers engaged in different Divisions and prepare an objective list for consideration of the DGSIR. The other recommendations of the Committee were accepted."

This question also came up for consideration at the Conference of Information Scientists held at Mysore in May 1963 and the Conference recommended :

"The distinction between technical grades and scientific grades should be abolished. Information scientists with subject qualifications are scientists in their own right and their contribution to the total research effort is no less important than that of laboratory scientists."

Scientific Laugh

The management called an efficiency expert who came with his note book and stop watch. The workers resented and decided to give silly answers:

The expert asked the first worker: "What do you do here ?"

He answered: "Drink coffee and read newspaper." The expert noted it down, went over to the next man and asked "What is your work here"?

He said "I drink coffee and read newspaper".

The expert made a note of it, and repeated the question to the third man who answered "I drink coffee and read newspaper".

"I get it" beamed the efficiency expert, "Duplication of work!"

* * *

Upon being complimented as a great inventive genius, Thomas Edison replied "Most of my ideas belonged first to other people who did not bother to develop them".

* * *

While setting the camera for a group photo, the photographer found a lady holding her skirt tightly. "What's the matter ?" he enquired. She promptly replied "I know you are going to tilt me upside down in your camera".

* * *

Science Teacher : What is it that changes when water freezes into ice ?

Intelligent boy : Price, Sir.

* * *

Engineer : Here in the main power house we generate electricity at 66,000 volts and feed the sub-stations which distribute power to the consumers at 220 volts.

Visitor : We have always noticed mishandlihg at the distribution centres : see, over 99 per cent of the volts gone !

OPERATIONS RESEARCH

(The CFRI branch of ASWI has set up an Operations Research (O.R.) study group in order to make the members and other scientists in the neighbourhood conscious of this important tool of research. Unfortunately most of scientists have a vague knowledge of what O.R. is. It is said that the definition of O.R. is so confusing that "the problems of defining the then O. R. was even considered by some foreign universities as a fitting subject for Ph. D. thesis. Instead of bothering about the definition of O.R., it was decided by the Branch that the elementary methods of O. R. should be elucidated through a series of seminars. For the interest of wider group of readers it was decided to publish the notes in Vijnan Karmee).

(I) Solution of Organisation Problems by Simulation

A. GHOSAL

1. Monte Carlo Method

Though many intricate problems in industry can be solved precisely, by applying the known statistical methods, there are many other problems which do not have analytical solutions; but can be solved by approximate methods. The Monte Carlo technique is such a method which gives approximate solutions to many complicated problems which do not have exact mathematical solution. This technique consists of simulating an experiment to determine some probabilitic property of a population of objects or events by the use of random sampling applied to the objects or events. Random sampling, is used to play a game with nature or a man-made system in which an experiment is simulated.

A table of 'Random Sampling Numbers' is a stock-in-trade for statistician or an O.R. scientist. If an event follows a random distribution of a known form, then with the help of the table of random numbers one can simulate data for a particular period. For example, if we know that the number of customers in a shop in a day follows the well-known normal distribution with an average of 50 and standard deviation 5, then we can, with the help of random numbers, run the shop on paper for a period of 30 days and simulate the data for each day in the period. This is elucidated by the following example.

2. A case Study

A shop which has greatly increased volume of work in the last one year is contemplating to appoint more sales girls. At present there are two sales girls who cannot cope with the business in the peak period of the business from 6 P.M. to 8 P.M. The shop closes at 8 P.M. but those who are waiting at that time are served even at late hours, but no new customers are admitted after 8 P.M.

A preliminary survey revealed that a sales girl took on an average 10 minutes to serve a customer. At each counter data were collected as given in the Table No. 1 below.

An investigation over 1 month gave the following information from the data thus collected.

(*i*) Number of customers served by each sales girl (both girls were of approximately same efficiency) each day between 6-8 P.M. followed approximately normal distribution with average 20 and standard deviation 3.

(*ii*) Number of callers per day followed approximately norma distribution with average 52 and standard deviation 5.

We run the shop, by the use of random sample numbers for the normal distribution with zero mean and unit standard deviation (Introduction to Operations Research by Churchman, Ackoff and Anroff, John Wiley, 1957, p. 181), for a period of 7 days on paper, and investigate the situation which may arise when the number of sales girls is 2 and 3. Results are given in Table 2, (page 25) which represents the situation both when the number of sales girls is 2 and 3.

Thus, by employing 3 girls instead of 2, overtime work is practically stopped.

Total idle time in the case of 3 clerks is calculated as follows:

Date	21	.. 6 x 10 mins.	=60 mins.
	22	.. 6 x 10 mins.	=60 mins.
	23	.. 23 x 10 mins.	=230 mins.
	24	.. 12 x 10 mins.	=120 mins.
	25	.. 1 x 10 mins.	=10 mins.
		Total	480 mins.

Idle time per girl =480/3 =160 mins.
Idle time per day per girl =160/7 =23 mins.

Overtime per girl =60/3 =20 mins.

In the case of 2 clerks,

Total overtime in 7 days =8.0 hrs., so that average overtime p.d. per clerk =36 mins.

The col. (8) of Table 2 is an index of displeasure of the cutomers. The company

TABLE I

Period : 6-8 P.M. Counter No.

Sl. No. of customers	*Time of arrival*	*Time service begins*	*Time service ends*	*Idle time of sales girls*	*Waiting time of customers*

TABLE II

(Simulation for the period: 20 to 26 Nov.)

No. of Girls.	Date	No. of callers p. d.: Random No. (z) for N(0,1)	No. of callers p. d.: No. of callers 52+5z	No. of customers served p. d. by a girl.: Random No. (z) for N (0,1).	No. of customers served p. d. by a girl.: No. served 20+3z.	Total number served (6)×(1)	Customers waiting at 8 P. M. (4)−(7)	Overtime per Girl (8) × 1/6 hr.
1	2	3	4	5	6	7	8	9
	20	1.677	60.4	−0.486	18.5	37.0	23	1.9 hr.
	21	−0.150	51.3	−0.256	19.2	38.4	13	1.1 hr.
2	22	0.598	55.0	0.065	20.2	40.4	15	1.3 hr.
	23	−0.898	47.5	1.147	23.5	47.0	1	0.1 hr.
	24	−1.163	46.2	−0.199	19.4	38.8	8	0.7 hr.
	25	0.464	54.3	−0.508	18.5	37.0	17	1.4 hr.
	26	0.060	52.3	−0.992	17.0	34.0	18	1.5 hr.
							Total	8.0 hrs.
	20		60.4		18.5	55.5	5	0.3 hrs.
	21		51.3		19.2	57.6	nil	
	22		55.0		20.2	60.0	nil	
3	23		47.5		23.5	70.5	nil	
	24		46.2		19.4	58.2	nil	
	25		54.3		18.5	55.5	nil	
	26		52.3		17.0	51.0	1	0.06
							Total	0.36 hr.

should, therefore, minimize it, at the same time reduce cost as much as possible. So it is appropriate to appoint a third sales girl of equal efficiency.

It can be found easily that if the number of sales girl is 4 in Table 2, the total idle time becomes unusually high.

3. **Conclusions**

There is a host of practical problems which can be solved by the method of simulation as illustrated above. It is imperative, therefore, that this method should be widely used for solving problems of the industry.

(II) Solution by Elementary Methods

A. GHOSAL

The purpose of the second paper in this series is to highlight the importance of preliminary investigations for obtaining useful solutions in O.R. problems. Very often mathematical models for the particular problem is too complicated and can be tackled only by a specialist, but useful solutions are obtained by careful compilation of data and simple analysis. The first step in solving a problem is to formulate it in an unambiguous manner; the second step is to decide what minimum data to collect and the last step is to draw inference on the data. In most of the cases the decision is left to the executive who, however, cannot help being guided by an O.R. investigation.

2. **Problem 1** (Waiting Time Problem of Interviewees)

In most of the interviews for selection of posts many candidates are called, and they are directed to call at the place of interview at a specified time. For example, 15 persons may be called for an interview by a single board, all are called at 10 A.M. It is a commonsense that the interviewers are incapable of providing *bulk service* to all candidates simultaneously, so the candidates are made to wait in a hall. If on an average the interviewing time of a candidate is 20 minutes, the 15th candidate will be called after about 5 hours; if, therefore, we allow of a lunch interval of 1 hour, the interview of the 15th person will start only at 3.40 P.M. To save the interviewees from this trouble it is better to allocate roll numbers to them, and call No. 1 at 10.00, No. 2 at 10.20, No. 3 at 10.40. etc. This will also save the management from providing a large waiting space for the interviewees.

Waiting time problems are amenable for detailed mathematical analysis, but that is outside the scope of this arcticle.

3. **Problem 2** (Ackoff's problem)

R. L. Ackoff (*Operat. Res. Quart.* 13, 1962, p. 4) cites an interesting problem in which the manager of a large office building was confronted with a large number of complaints about the poor lift service. He employed a group of consultants who specialised in the design and operation of lift systems. They found the service really bad, and found it to be expensive to implement any of the following solutions, viz. (*a*) adding lifts (*b*) replacing old lifts with new and faster ones, (*c*) controlling lifts from a central panel. A few days later, however, at the suggestion of a young psychologist, large mirrors were placed on all the walls in the lift lobies. The mirrors occupied the women in self-appraisal and it kept the men busy appraising the women without appearing to do so.

4. Elementary Statistical Analysis

There is a host of problems which can be solved by elementary statistical methods. Computations involved can be easily done by anybody, with the help of a desk calculator. A few such problems are cited below:

(*i*) A factory may own a few (say 4 or 5) trucks to carry raw materials from the railway station to the factory site or to reach finished products to the station. An investigation may be done to examine whether it is necessary to buy one or two trucks more for more efficient movement of goods. This problem can be solved by the method of simulation in exactly the same manner as has been elucidated in the first paper in the series. Here we are required to obtain the distribution of the arrivals of raw materials per day, the despatch of finished products per day, the capacity of trucks, the number of trips they are capable of doing.

(*ii*) In the experimental coke ovens at the Central Fuel Research Institute there are three ovens, their widths being 14, 16 and 18 inches. A designed experiment was performed to see whether, the source or sources of coal feed being the same, the width had any effect on the quality of coke produced. From analysis of variance of results it was found that the effect of the width was insignificant. (N. N. Das Gupta *et al*, *Coke and Gas*, December 1961).

(*iii*) A problem which an institutional investor faces is how best to invest its funds. Take the case of a life office whose liabilities are mostly long deferred, so its general policy is to invest the bulk in long and medium term securities, and hold a small proportion of cash to meet liabilities. The bulk of the investible funds is not invested in a single security — a policy of diversification is followed. If we compile from stock exchange records the list of various securities (e.g. equities, debentures, Govt. securities of medium term, etc.) and for each, record the capital value and the yield rate for a number of years, (say 8 to 10 years), we can develop a perspective of the *profitability* of each security by studying the graphs of yield and capital value. Hence a decision can be made.

(*iv*) Very often we can predict an important characteristic from the knowledge of a few factors through a regression equation. Determining a regression equation and obtaining correlation coefficient and testing whether they are significant are easy jobs for a computer, but the results are extremely useful.

Innumerable problems in research and management can be solved through elementary statistical analysis, and an O.R. scientist must know its use

A CHEMIST'S CURIOSITY...

...leads hlm to the latest advances in his field G—11 (Patent Hexachlorophene) is the only chemical proved over a decade in countless laboratory tests and by millons of individuals to retain its bactericidal effectiveness when used in soap.

Soap containing G—11 is recommended by Doctors the world over and is exclusively used in most U. S. Hospitals.

CINTHOL is the ONLY Soap in India, with amazing G—11*. Regular use of CINTHOL ensures a flawless complexion by removing blemish-spreading, odour-producing germs that thrive on the normal skin.

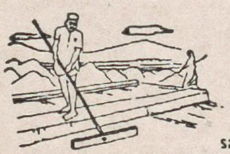
The only proved DEODORANT and COMPLEXION BEAUTY Soap.

for PERFECT PROTECTION after bathing with CINTHOL, use fragrant, soothing Godrej CINTHOL TOILET POWDER with G—11.

Godrej

THE BEST NAME IN SOAPS

What salt means to you!



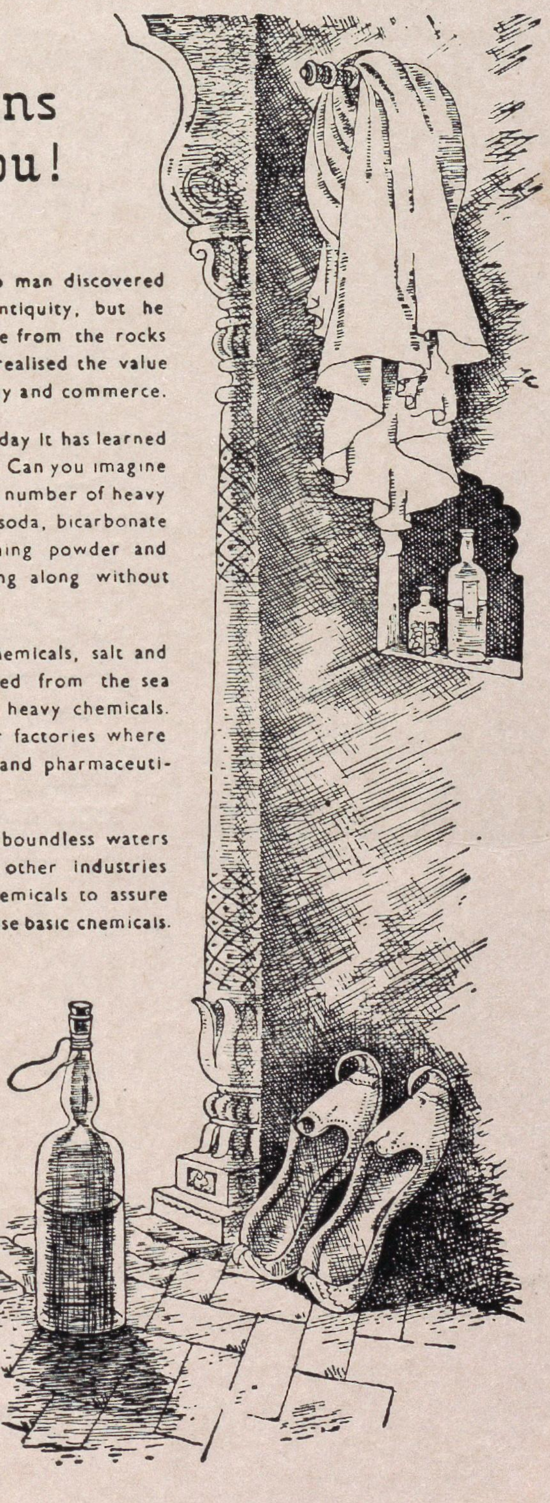
How long ago man discovered salt is lost in antiquity, but he learnt that it came from the rocks and the sea. As he realised the value of salt, he made it an article of currency and commerce.

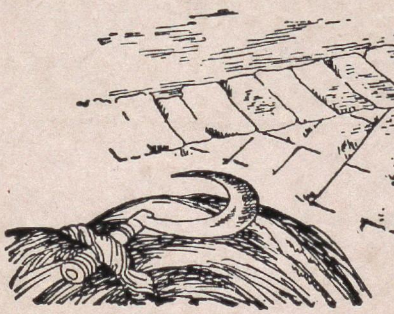
Science has gone far since then, and today it has learned to make many and varied uses of salt. Can you imagine your common salt being turned into a number of heavy chemicals, such as soda ash, caustic soda, bicarbonate of soda, magnesium chloride, bleaching powder and bromides? Can you imagine getting along without salt in the twentieth-century?

At the Mithapur Works of Tata Chemicals, salt and other marine products are extracted from the sea and converted into these alkalis and heavy chemicals. They find their way into many other factories where paper, leather, soap, glass, textiles and pharmaceutical products are made.

Here, then, is an industry using the boundless waters of the sea to keep the wheels of other industries moving. It is the aim of Tata Chemicals to assure the country of a national supply of these basic chemicals.

Tata Chemicals
LIMITED
BOMBAY HOUSE, BRUCE STREET, BOMBAY 1





Printed and published by Shri K. Ray at the United India Press, Mathura Road, New Delhi.

Regd. No. A-1468