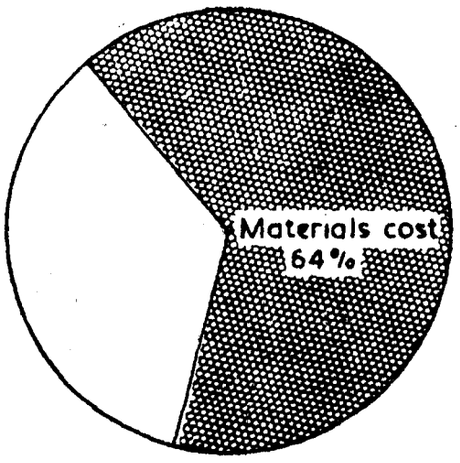
SEMINAR

on

MATERIALS MANAGEMENT

(AUGUST, 1962)



MITTEE ON PLAN PROJECTS
NEW DELHI

SEMINAR

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MATERIALS MANAGEMENT

(NEW DELHI : AUGUST 8, 9 & 10, 1962)

SUMMARY OF PROCEEDINGS

COMMITTEE ON PLAN PROJECTS

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APPENDICES

M/B293PC—2(a)

I. Introduction

A Seminar on Materials Management was organised by the Committee on Plan Projects at Vigyan Bhavan, New Delhi, from 8th August to 10th August 1962.

The Seminar was arranged for the benefit of public sector enterprises. Its primary purposes were to arouse materials management consciousness, bring the lessons and results of the studies made by COPP and private sector consultants to the notice of the participants and also to provide an opportunity for a discussion and exchange of ideas and experience among materials managers. Materials costs add up roughly to two-thirds of the total manufacturing cost. That apart, studies made by the Industrial and Mining Team of COPP have revealed that inventories are most responsive to control and, if scientific techniques are applied, it is quite feasible both to reduce investment in inventories and to minimise stockout costs.

The Economic Ministries were requested to nominate top level managers or senior executives of undertakings under their control, for participation in the Seminar. With a view to ensuring active and business-like participation by all in the discussions, it was decided to allot a limited number of seats to each Ministry. In all, 29 participants attended the Seminar. Five officers of Govt. Undertakings in Ceylon also attended. Besides, there were representatives of the Ford Foundation, Delhi Management Association, United States Agency for International Development and other agencies interested in management studies. The list of participants is appended—(*Appendix I*).

The Seminar was inaugurated by Dr. A. N. Khosla, Member, Planning Commission, on the 8th August 1962. The Inaugural Address will be found in *Appendix II*. The Seminar was divided into five working sessions. Each session opened with a talk on an important aspect of materials management by a specialist who dealt with both the theory and practice of his subject; copious illustrations were provided from actual case studies. Thereafter, general discussion followed which was guided by different Chairmen at the various sessions. The participants made valuable contributions to the discussion and also some useful suggestions. Synopses of the talks of the principal speakers which were distributed at the Seminar are reproduced in *Appendices III—VII*. A summary of the discussions at each session is given in the following pages.

II. Inaugural Session

The inaugural session started at 10·15 A.M. on August 8, 1962 with a welcome address by Shri R. N. Vasudeva, Secretary, Committee on Plan Projects. Dr. A. N. Khosla, Member, Planning Commission inaugurated the Seminar and Shri R. S. Chadda, Deputy Secretary, Committee on Plan Projects, proposed a vote of thanks.

Welcoming Dr. Khosla and the delegates, Shri R. N. Vasudeva-Secretary, Committee on Plan Projects, explained the genesis and objectives of the Seminar. He referred to the brochure on 'Scheme of Cost Reduction' published by the Committee on Plan Projects which contained the main conclusions emerging from the studies carried out by its Teams. The brochure was instrumental in focussing attention on the need and, more importantly, on the scope of cost reduction in public sector projects. Considering that cost of materials accounted for as much as 64% of the total manufacturing cost in industry (Census of Indian Manufactures—C.S.O.), it was obvious that in any scheme of cost reduction the pride of place must go to materials. He expressed the hope that the participants would explore ways and means of achieving greater economy and higher efficiency in their undertakings by the application of the modern tools and techniques of materials management to which the Seminar would be devoting attention.

Inaugurating the Seminar, Dr. Khosla emphasised the importance of cost control and pointed out that the greatest scope for cost reduction lay in materials management. The outlay on materials accounted for most of the cost in both production and construction activities.

Dr. Khosla pointed out that out of the public sector outlay of Rs. 7,500 crores during the Third Five Year Plan, the cost of construction activities would be of the order of Rs. 3,600 crores and of this amount materials would account for more than Rs. 2,000 crores. Besides, in factory establishments, the consumption of materials was anticipated to be of the order of Rs. 20,000 crores during the Third Plan period. Thus, in construction and factory manufacturing alone, the outlay on materials was estimated to be of the order of Rs. 22,000 crores. Dr. Khosla felt that if, as a result of scientific management of materials, the cost could be reduced by, say, 5 per cent, the total reduction would be to the tune of about Rs. 1,000 crores, which would indeed be a boon in that it could be utilised for financing some of the highly desirable projects which had hitherto been kept pending for want of sufficient capital resources.

Dr. Khosla was of the view that the essence of Materials Management was co-ordination of various material functions, namely, production and inventory control, purchasing, materials handling etc. all of which were extensively involved with one another.

Continuing, he said, that it was necessary to take a number of steps to improve materials control but more than that it was necessary to inculcate materials consciousness among those incharge of public sector projects. He hoped that the Seminar would serve that particular purpose.

Dr. Khosla also referred to the technique of selective control and said that the motto of materials management ought to be: "Take care of the rupee items and the naye paise items would take care of themselves."

Dr. Khosla emphasised the need for developing a broad outlook which should take a total view of every problem. A slavish adherence to rules might result in losses far greater than savings. It was necessary, therefore, that every executive should constantly remind himself that rules and regulations were a guide and not an end in themselves.

Concluding, Dr. Khosla expressed the view that if materials management received the attention that it deserved, it would help the individual enterprises and the nation in a big way. The scientific management of materials, he said, could help :

(*a*) release capital, so scarce in India;

(*b*) conserve valuable foreign exchange;

(*c*) reduce production costs; and

(*d*) increase our competitiveness in foreign markets.

The full text of Dr. Khosla's Inaugural Address is reproduced in *Appendix II*

3. Shri R. S. Chadda, Deputy Secretary, Committee on Plan Projects, thanked Dr. Khosla for inaugurating the Seminar, and for his sympathetic interest in and encouragement to the work of the Committee on Plan Projects.

SESSION I —The Scope, Purpose and Techniques of Materials Management

The theme of the seminar was introduced by Shri A. R. Palit, the Editor of the 'Eastern Purchasing Journal'. A synopsis of his talk will be found in *Appendix III*.

The essence of materials management is coordination between designing, production, stores inventory control, purchase, sales, etc. The design of a bridge envisaged the use of steel joists of a particular size. Discussion of the design engineer with the purchasing section revealed that joists of that size were not available in India and had, therefore, to be imported involving not only extra cost but also longer lead time. Taking advantage of this information supplied by the purchase section, the design engineer modified the design adapting it to sections and sizes available indigenously.

The costs of materials in Indian industry add up to about 64 per cent of the production cost on an average. Materials, therefore, offer the greatest scope for cost reduction. It is sometimes believed that there is no scope for cost reduction in regard to Government controlled materials. Such a view proceeds from confusion between purchase price and ultimate cost. It is true that there is no way of securing a reduction in the price of controlled materials but there may be scope for substituting them by more cheaply available material or by more economical use of the controlled materials themselves. In material management, we have to concentrate on the 'all-in-cost'. It may be necessary sometimes to spend a little more in one sector with a view to securing a much larger economy in another sector of materials management. Imperial Tobacco Company at Calcutta changed from elaborate packing and despatching to door-to-door delivery of their products in case of about 40 per cent of the sales. Though the company paid an additional Rs. 10 lakhs on transport, it saved Rs. 26 lakhs in packing and despatching, so that the net saving was of the order of Rs. 16 lakhs a year.

One of the potent ways of achieving economies in material cost is to reduce variety in the number, sizes and grades of materials. There is a good deal of scope in this regard. In the U. K. the number of widths of metal sheets has been recently reduced from 63 to 12.

DISCUSSION

Since materials management is a specialised subject, a suggestion was made to organize training courses and seminars to build up a cadre of men well versed in the techniques of purchasing, inventory control and value-analysis etc.

The consensus of opinion was that procedures in public sector projects were stifling and, therefore, there was need to streamline them and emphasise

the obvious truth that procedures should help rather than hinder the achievement of ultimate objectives. The existing tender and audit systems also required revision to suit the needs of modern materials management. The purchasing officer was more concerned with the objections that were likely to be raised than with the principles of sound purchasing. This clouded his judgment and restricted his usefulness to a very great extent.

In America, the status of the materials manager is being increasingly improved and he is now placed on a par with sales and production manager. The same is necessary in India if the materials manager is to make an effective contribution.

The Chairman, Shri Chopra observed that procedures were, no doubt, antiquated but, in many cases, the main difficulty was that men tried to seek shelter under the cover of rules and regulations. Many a time it was the person who was the problem and not the rules and regulations.

Dr. P. S. Lokanathan, Chairman, N.P.C., assured all help in arranging training programmes in Materials Management provided there was genuine interest on the part of the enterprises. He wanted each enterprise to depute a team of officers of sufficient seniority and authority, so that they could implement what they found useful in their training.

Shri Palit who introduced the paper suggested the formation of a National Institute for Materials Management.

SESSION II—Purchasing for the Public Sector

The principal speaker was Shri N.E.S. Raghavachari, Director General, Supplies and Disposals. A synopsis of his talk will be found in *Appendix IV.*

Shri Raghavachari emphasised, *inter alia*, the need for effecting savings in public sector purchases. He made the following four suggestions for this purpose:

(*i*) *Prompt payment*—One serious complaint against Government departments and public sector projects is that they delay payment. As a result, tenderers raise prices and at times, some good suppliers do not respond at all. While it is necessary to have safeguards, it is also necessary so to streamline payment procedures as to avoid costly delays. It was noted that advance payments could earn rebates and there should be little risk in trying them in relation to reputed suppliers.

(*ii*) *Delivery period*—There were cases of unreasonably short periods allowed for delivery. In such cases higher prices had to be paid for off-the-shelf-delivery. If the demand is really emergent, it is worth while paying an extra price for it. There were, however, cases in which delivery period was restricted for unreasonable causes, such as the anxiety towards the close of the financial year not to allow lapse of budget provision. It is wasteful to gear purchases to budget provision rather than to requirements.

(*iii*) *Specifications*—Specifications should not include unnecessary refinements or undue margins of safety.

While specifications should be detailed enough to avoid ambiguities and elicit strictly comparable tenders, they would be drawn in such a way as not to rule out competitive or alternative purchases. In this regard it should be more helpful to lay down specifications by performance. Specifications should also conform, as far as possible, to commercial standards of grades and sizes.

It is necessary for the purchase officers to undertake research with a view to explore alternative materials. They should, where possible, utilise their experience to suggest modifications in specifications to make them more realistic. As an example, a purchase officer may, from his past experience be able to advise an indentor of tested steel to accept untested steel which is both less expensive and easier to procure.

(*iv*) *Quality buying*—Looking beyond the initial purchase price, the purchaser should also take into account operation and maintenance cost as also the life of the goods to be purchased. Where, for example, the initial price is 5 per cent higher, but the goods, being of better quality, are expected to last, say, 50 per cent longer, it is advisable to pay the higher price. Government departments and public sector projects face a serious difficulty in this regard in that

the Audit would raise objections to such quality purchases based on personal judgement. In order to convince Audit, it is necessary to keep records of the performance of goods of different qualities.

DISCUSSION

The following points emerged from the discussion following the talk by Shri Raghavachari.

(*i*) Purchasing in a sellers' market is entirely different from purchasing in a buyers' market. In India, we have a sellers' market. Accordingly, the purchaser's job is not merely to invite tenders and select the lowest quotation, but also to develop new sources of supply and find substitutes for costly and scarce items, particularly imported ones. It is necessary, therefore, to train purchase officers. Training may be in-service training or before appointment or even recruitment. Unlike production or sales people, purchasers are needed by an enterprise at its very birth. Therein lies the importance of training before appointment. The Committee on Plan Projects, in collaboration with the National Productivity Council and other concerned agencies, may evolve and conduct training courses both for new entrants as well as those already working as purchase officers.

(*ii*) Normally, specifications are to I.S.I. or other standards. Sometimes, however, it is useful to lay down specifications in terms of performance.

(*iii*) In regard to many items, particularly spare parts, procurement was difficult and prices were high. There were instances where local manufacturers offered equivalents at much lower price but they could not be accepted for want of testing facilities. Two suggestions were made in this connection. One was to set up test houses at important industrial centres like Bombay, Calcutta, Madras and Kanpur; and the other was that the facilities available at Engineering Colleges should be utilised for testing purpose.

(*iv*) Some participants thought that the number of items covered by rate contracts of DGS&D was too small in relation to their requirements. The Director General, Supplies & Disposals, welcomed suggestions for placing more items on rate contracts. But, at the same time, he suggested that individual undertaking should enter into running or rate contracts of their own for items on account of DGS&D.

(*v*) It was noted that the Defence and Railways had done really commendable work in development of indigenous sources of supply to replace imported materials. It was suggested that public sector projects should pool their resources and set up a research centre for the purpose of developing indigenous and cheaper materials.

(*vi*) The participants strongly recommended frequent seminars like this, preferably once or twice a year, with a view to exchange of experience and information as also to seek solutions to common problems.

SESSION III—Operations Research

The principal speaker was Shri Jagjit Singh, Director, Traffic (Transportation), Railway Board. He had circulated before hand a paper (*Appendix V*) indicating broadly his view of Operations Research as a blend of two trends:

(*a*) A do-it-yourself research exercise into the field of one's own endeavour, and

(*b*) A repertoire of well-established techniques like linear programming, waiting models, sequencing theory, etc.

Further developing at length theme (*a*) he opined that all important O.R. work of this type must always remain a creative act beyond the pale of rule-of-thumb routines. It was the outcome of wise judgement based on one's own intimate knowledge of the particular field to which it was applied. Nevertheless, he believed that a few general principles might help guide such research along fruitful lines. Listing them under five main titles *viz.*

(*i*) Hemibel Thinking,

(*ii*) Nail Nuance or Discriminating Differentials,

(*iii*) Moderate Mistrust of Plausible Reasonings,

(*iv*) Unscrambling Summaries,

(*v*) Revaluation of Old Values,

he proceeded to elaborate and explain each one of them in great detail and with a wealth of concrete examples to illustrate their application. As it is not possible to describe within the space available here all what the speaker said during his discourse, only a very brief summary of the proceedings will be given.

(*i*)* *Hemibel Thinking* is order of magnitude evaluation of the optimum performance of an operation such as submarine hunting, marshalling of trains in a railway yard, etc. in order to compare it with the actual performance. If the latter is one or more hemibel (a factor of 3 roughly) below the optimum, it is usually a pointer that a single faulty component like inadequate equipment, inadequate training of staff, or incorrect use of tools is at play. If and when the "bottleneck" is discovered and removed, the performance usually improves by a large and significant factor.

(*ii*) *Nail Nuance or Discriminating Differentials*—To a "feel" for the large, such as hemibel thinking requires must be joined a sensitivity for the small

* Hemibel is the name given by Morse & Kimball, two OR pioneers, to a unit of reckoning in the geometric (logarithmic) scale of reckoning as distinct from the arithmetic scale of daily use. The name is on the analogy of decible in such a scale which is tenth root of ten. Five decibles make one hemibel so that it is square root of ten=3.03 (Approx.).

differential. The reason is that in all self-aggravating systems like traffic congestions, cancers, etc. there is always a nail that loses a kingdom—

For want of a nail, the shoe was lost
For want of a shoe, the horse was lost
For want of a horse, the rider was lost
For want of a rider, the battle was lost
For want of a battle, the kingdom was lost.

The speaker quoted actual situations to exemplify the old proverb and tracked the evil consequences to their particular "nail". Hence the need to develop what he called "nail nuance".

(*iii*) *Moderate Mistrust of Plausible Reasoning*– While all conduct in life is based on reasonable anticipations, unfortunately our reasoning is not always infallible. That is why every reasoned theory has to be proved by actual practice. The speaker quoted actual instances like the optimum setting of depth charges in hunting submarines, painting of night bombers for U-boat sightings, etc. to show how the course of action dictated by apparently plausible reasoning had to be amended in important ways after repeated failure in the field.

(*iv*) *Unscrambling statistical summaries*—Because of the wealth of material that the modern executive has to absorb, statistical summaries are valuable aides. But now and then they are as little useful as the average depth of a river to a non-swimmer who proposes to ford it. For him not the average depth but the actual depth at every point of his course. Similar situation arose in deciding the tactics against Japanese suicide planes during the war or in judging the efficacy of manning railway level crossing gates to ward off train-truck collisions. In all such cases the statistical summaries have to be unscrambled before the appropriate course of action suggests itself.

(*v*) *Revaluation of old Values*—This becomes necessary because with change of times the aims and objectives of organisations change. The speaker recalled the classic case of the criterion of efficiency prescribed for air force squadrons before the war. During the war it was possible to make more flights with the same number of machines by an appropriate change in the prescribed criterion though it needed the penetrative eye of an OR pioneer to discern it.

DISCUSSION

The Chairman, Shri Bhoothalingam, remarked that if OR was really what the speaker said, that is, common sense reduced to calculation, he would confess that he had been doing it all his life like Mons Jourdain speaking prose without knowing it. Nevertheless, just as even an awareness of a thing called 'prose" improved its practice, he was sure that conscious thinking about OR such as the seminar had provoked would go a long way in improving one's own use of common sense along OR lines. In particular, he would advocate what the speaker called hemibel thinking with the addition that in our search

for perfect knowledge we should not defer decision. He cited concrete cases to illustrate the point that one could in most cases act then and there on the basis of such knowledge as one had and modify the action later in the light of new knowledge acquired subsequently. He had always held the view that the perfectionist approach was essentially one of mental laziness and procrastination.

Session IV—Inventory Control

The principal speaker was Shri R.S. Chadda, Deputy Secretary, Committee on Plan Projects. A synopsis of his talk will be found in *Appendix VI*.

The speaker explained the importance of inventory in the context of the large variety, complexity and urgency of modern requirements. The requirements, say, of a modern steel plant are incomparably more varied and complex than those of a steel factory in the past centuries. The three pillars of modern industry are men, machinery and materials. It is much more costly to keep men and machinery idle than to keep materials on hand. Urgency of modern requirements also adds to the importance of inventories. For example, it was not necessary for a bullock cart to carry a spare wheel but it is essential for a car to do so.

It is necessary, therefore, to keep inventories with a view to stabilise production and employment and to avoid operational upsets. At the same time, one has to remember that inventories not only tie up a good deal of capital but also cost a lot to carry them, so that carrying an "abundant" supply of inventory is no solution to the operations problem. For example, if a car manufacturer with an annual production of, say, 10,000 cars, tries to play safe with reference to an item like tyre by stocking it for a whole year, he would have to invest about Rs. 50 lakhs in tyres alone and would also have to find storage space and facilities for a number as large as 50,000. While operational needs are important, it is equally necessary to keep in view the cost factor. Inventory control lies in fixing the optimum level of inventory for each item or class of items. This level is reached when the cost of carrying inventory is equal to the probable cost of stockouts.

The need for conscious and scientific inventory control is obvious from the facts that materials costs add up to more than 60 per cent of the manufacturing cost and that industrial inventories tie up roughly 90 per cent of the working capital. It is the objective of every business to secure a high capital turnover rate and this depends, in a very large measure, on the inventory turnover ratio. With a number of examples from case studies made by the Committee on Plan Projects, it was shown that applying scientific techniques of inventory management, investment in inventories could be reduced considerably, sometimes by 50 per cent or even more.

Quoting from several of the studies made by him, the speaker demonstrated how in every class of inventory a very small proportion of items tied up most of the investment. He emphasised the need for an 'A-B-C Analysis' of each class of inventory before setting up any system of inventory control. Without such analysis, control would be either too uneconomical or too diluted to be effective. The speaker cited the example of a large plant in the public sector which carried more than 50,000 stores items and prepared a monthly statement of inventory position covering all the 50,000 odd items with the result that it took three to four months to compile the statement. This statement.

unduly long and late, served little purpose. According to the speaker, the only practical way of controlling inventory investment in the plant was to make an 'A-B-C Analysis' and then concentrate on A-items which might be anywhere between 1500 to 2000. Management must know what is happening when it is happening and not as a matter of historical interest.

If both the rate of demand and the procurement lead time were fixed and constant, a fixed quantity would be purchased at fixed intervals. Since, however, both demand and lead time are variable, it is not possible to fix both the purchase quantity and the order interval. To meet this situation, two systems of inventory control are generally followed : the two-bin system in which the purchase quantity is fixed but the order interval is allowed to vary to take up fluctuations in demand, and the review system in which the order interval is fixed but the purchase quantity is suitably adjusted to take care of variations in requirements. The speaker explained how, in certain circumstances, the two-bin system was preferable to the review system: it required a smaller safety stock, stabilised purchasing and also enabled a large measure of delegation of authority in the matter of determining when and how much to buy.

DISCUSSION

The following points emerged from the discussion following the presentation of his paper by Shri Chadda.

(*i*) The financial accounting of stores should be the responsibility of the he Controller of Stores, since, otherwise, financial control of inventories would suffer.

(*ii*) To determine economic order quantities and optimum safety stocks, it is necessary to calculate inventory carrying costs and stockout costs. The important point in this regard is not perfection in calculation, but to have some reliable estimates to go by. It was pointed out by the Controller of Stores, Hindustan Aircraft Limited, that he had calculated storage cost (excluding interest, deterioration and obsolescence) at 10 per cent per annum.

(*iii*) To keep down spares inventory, it is essential to standardise on equipment. A transport undertaking with different makes of vehicles oddly distributed over different regions had to carry very heavy inventories in each region. This could have been avoided with fleet standardisation on a regional basis.

(*iv*) The importance of codification in controlling inventory was also emphasised. Quite frequently, identical stores and spares were stocked under different na . es tats leading to unnecessary variety and investment.

SESSION V—Value Analysis & Standardisation

The speaker was Shri A.R. Palit. A synopsis of his talk will be found in *Appendix VII.*

Introducing the subject Shri Palit averred that value analysis and standardisation were two prongs of the tool of cost reduction. In the course of his talk he laid special stress on the following points:

What value-analysis has achieved?

Japan has effected 5 per cent reduction in the cost of materials, 2 per cent through improved efficiency in general and 3 per cent through value analysis. The General Electric, U.S.A., doubled their investment and sales, yet the profit rose only by 10 per cent. Value analysis enabled the company to identify areas of excessive materials costs and to raise the profit margin considerably.

Value-analysis and its selective application

Value of a material is its intrinsic worth. Value analysis ascertains whether the purpose of a material is good value for the money spent, keeping in view the function or end-use. If you concentrate on a paint as a product you have to buy paint; however, if you think in terms of 'surface protection' which is what the paint achieves, you might find a cheaper though equally efficacious chemical treatment as an alternative to painting or consider use of, say, aluminium sheets instead. In value analysis, one should think in terms of the function to be performed rather than in terms of a particular material.

To achieve significant results, one should start with items providing the maximum pay off.

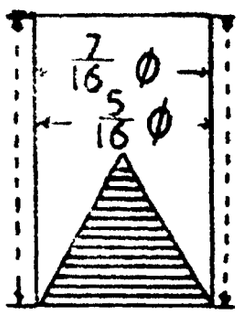
Value-analysis and price analysis

In price analysis, the design, specifications, etc. of the material to be procured are taken for granted. Value analysis, however, goes further and critically examines them with a view to assessing their essentiality and contribution to the ultimate function or the purpose to be achieved.

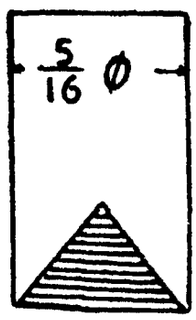
(*i*) In a sub-contract deal for the supply of components worth three quarter million dollars, components worth about $ 25,000 were rejected by the quality control department. Since the buyer company could not afford to jeopardise its good relations with the sub-contractor, a conference of top executives was called to find a suitable course of action. Surprisingly, it was discovered that the quality of the rejected components, though not upto the standards specified, was good enough for their end-use. This enabled the company to save a considerable amount of money and maintain their happy relations with the sub-contractor.

(*ii*) The case of the steel pin of 5/16″ dia. whose cost was reduced, as a result of suitable modifications in design, from 20 cents to 11½ cents per piece is described in *Appendix VI.* The original design envisaged a deep conical groove.

This was not absolutely essential. Reducing the groove to half the size, which was enough for the purpose in view, cost was reduced by about 40 per cent.



ORIGINAL SECTION
Price 20 Cents



MODIFIED SECTION
Price 11½ Cents

(*iii*) In another case the basic price of a steel item was $ 7·30 a piece but extras amounting to $ 8·50 were being paid on account of special specifications and conditions such as gauge tolerance, width tolerance, finish, temper, camber, edge, etc. A second thought was given to the necessity of these special specifications and conditions. As a result of discussions between the designers and representatives of production, sales, and purchase, it was concluded that all special conditions except that relating to width tolerance, could be eliminated. As a result, the price was brought down from $ 15·80 to $ 9·5 a piece. It is extravagance to over-specify.

Value analysis as team work

The importance of value analysis lies in team work. It is often useful if representatives of different sections and the vendor are consulted.

In one case a spacer between two steel plates was being purchased at 8 cents a piece. Consultations with one of the usual suppliers brought forth a suggestion to use a hollow tube with a bolt running through it. This suggestion was found quite feasible for the reason that the only function of the spacer was to keep the plates apart and it had not to bear any load. The hollow tube was available at 1-1/10 cents a piece. Later, another supplier suggested a rod with two shoulders priced at 8/10 cents a piece.

Geographic orientation of value analysis

Value analysis should be geographically oriented. What is good for the U.K. or Canada, need not be so for India or *vice versa*. For example, in Canada, they changed from jute bags to craft paper bags, the idea being to eliminate imports of jute bags. Such a course of action would be ridiculous in India.

Purchase of capital goods

In the purchase of capital goods it is worthwhile to lay down specifications by performance. There is a tendency sometimes to cull specifications from a

suppliers' brochure without, of course, specifically mentioning his name and this has the result of limiting competition and pre-determining the supplier. For the purpose of having a freer choice and adequate competition it is necessary to allow for a good deal of flexibility in design specifications concentrating largely on functional requirements.

STANDARDISATION

In the absence of codification one and the same material or part may sometimes be described by different names. While scrutinising stock discrepancies in a company it was found that much of the discrepancy was traceable to multiple nomenclature and lack of codification. Codification leads to simplification by which is meant variety reduction.

How to simplify ?

Simplification may be based on frequency analysis, the object being to standardise on sizes and grades of frequent use. It may also be achieved by the system of preferred numbers where sizes rise by geometric progression. Details are available from the Indian Standards Institution.

Standardisation

Standardisation should start before the design and production stages, since value analysis and simplification become rather difficult and restricted after the designs have been finalised and production undertaken on their basis.

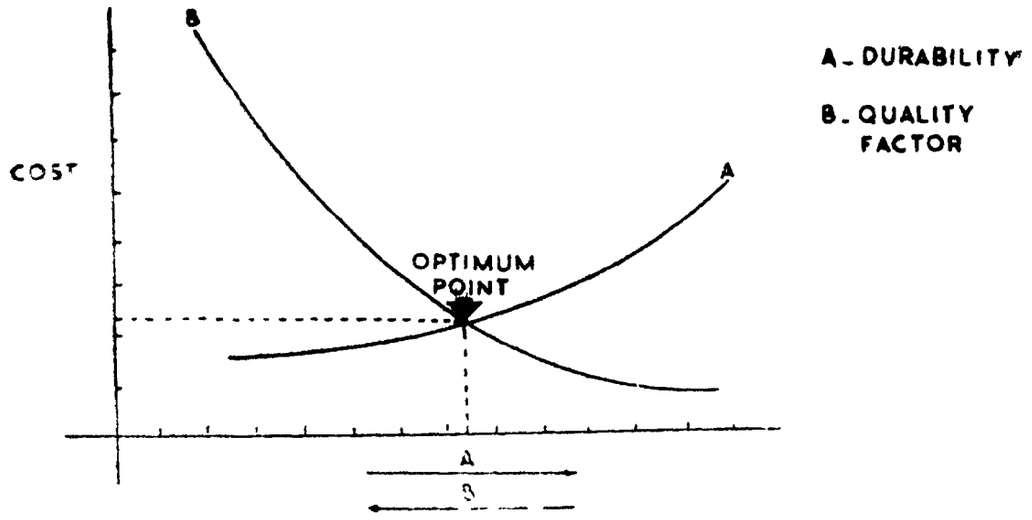
It is desirable for each industrial organisation to actively undertake preparation of "Company Standards" for their own organisation. There should preferably be a standards cell in each organisation, for standardisation and simplification, which may often result in the elimination of as much as 40 per cent of the stock items.

DISCUSSION

Value analysis is a technique of recent origin, but it is quite paying. In India, one Bombay firm set up a value-analysis organisation very recently. The results have been promising. Over a period of three months, the firm spent Rs. 6,000 on the organisation but reaped a saving of about Rs. 50,000.

In the matter of quality, we would seek the right quality rather than the best. Till recently, certain railway locomotives had a stainless steel decorative piece. A question was raised whether it was essential to have a decorative item in stainless steel which had to be imported. Ultimately, stainless steel was replaced.

The optimisation of cost and quality may be depicted graphically as follows:



Since value analysis concerns more than one section like designing, planning, purchase, stores, inspection, quality control and so on, which will be its best location? In a company at Bombay, it is attached to a purchase development cell which is entrusted with the work of development, market research on purchasing, analysis of purchases and value analysis. In General Electricals, they have a staff cell under the materials manager since materials account for more than 60 per cent of the cost of production. The cell consists of 48 experts including commodity specialists, value analysts and system specialists. Since the vendor is one of the chief sources of inspiration for value analysis, value analysis is attached to the materials manager who is in immediate contact with the vendors. Also the materials manager has got a better concept of the ultimate cost of the material than a mere purchaser. So far location is concerned, value analysis must be centralised and responsible to top management.

Standardisation

Spare parts tie up a good part of the investment in inventories. One potent way of reducing investment in spare parts is standardisation which must, of course, start with initial designing and procurement of capital equipment. A stage has been reached when the country should give serious thought to standardisation in the matter of foreign collaboration and purchase of plant and machinery.

Even under the existing conditions, some measure of standardisation can be achieved. For instance, at Bhilai five different brake locks have been standardised as one and the same is now manufactured in Bhilai's own workshop.

When organisations are established in different industries for standardising spare parts, representatives of the different industries can meet and explore the possibilities of standardising spare parts on general basis.

Scope and effect of simplification

In Railways, 400 classes of locomotives have been reduced to 35 and thereby cost has been reduced from Rs. 5·53 lakhs a locomotive to Rs. 4·35 lakhs.

In WG(Goods) and the WP(Passengers) locomotives, the boiler and tender are made identical as a measure of standardisation.

It was noted that in the automobile industry, there was good scope for standardisation in that starters, electric horns, speedometers, etc., could be common for all kinds.

A suggestion was made that the COPP should constitute a team to go round public sector projects with a view to assisting them in installing scientific systems of materials control. The team should visit such projects as have done some initial work and desire help and guidance on specific issues.

CONCLUSION

The Seminar concluded on the 10th August, 1962. Shri R. N. Vasudeva, Secretary, Committee on Plan Projects, thanked the principal speakers and the participants for making the Seminar a great success. He reminded the participants that the primary objective of the Seminar was reduction in materials costs. He hoped that the talks and discussions at the Seminar would help the participants in achieving that objective. He also invited suggestions regarding the Seminar from the participants. On behalf of the delegates, Shri S. S. Jagota thanked Shri Vasudeva and Shri Chadda of the COPP for organising the Seminar and for giving the delegates an opportunity to profit from the talks of the principal speakers and from an exchange of one another's experience.

APPENDIX I

LIST OF PARTICIPANTS TO THE MATERIALS MANAGEMENT SEMINAR

SESSION CHAIRMEN

Dr. A. N. Khosla,
Member,
Planning Commission.

Shri S. P. Chopra,
Leader,
Industrial & Mining Team,
Committee on Plan Projects.

Shri S. N. Mozumdar,
Chairman,
Industrial Consulting
Bureau (P) Limited.

Shri S. Bhoothalingam,
Secretary,
(Deptt. of Expenditure)
Ministry of Finance.

Dr. P. S. Lokanathan,
Director-General,
National Council of
Applied Economic Research.

Dr. Lal C. Verman,
Director,
Indian Standards Institution.

Shri R. N. Vasudeva,
Secretary,
Committee on Plan Projects.

PRINCIPAL SPEAKERS

Shri A. R. Palit,
Editor,
The Eastern Purchasing Journal.

Shri N. E. S. Raghavachari,
Director General of
Supplies and Disposals.

Shri Jagjit Singh,
Director,
Traffic (Transportation),
Railway Board.

Shri R. S. Chadda,
Deputy Secretary,
Committee on Plan Projects.

DELEGATES

Shri M. A. Alwar,
Controller of Stores and Purchases,
Barauni Refinery,
Indian Refineries Ltd.,
Patna.

Shri V. G. Gadgil,
Controller of Stores and Purchases,
Air India,
Bombay.

Shri M. R. Anantanarayanan,
Controller of Stores,
BEST,
Bombay.

Shri M. A. Hafeez,
Joint Director,
National Buildings Organisation,
New Delhi.

Shri R. K. Basu,
Chief Mechanical Engineer,
U. P. Roadways Central Workshop,
Kanpur.

Shri S. B. Chakrabarti,
Deputy Chief Electrical Engineer,
Chandrapura Thermal Power Station,
(Damodar Valley Corporation),
Hazari Bagh (Bihar).

Shri S. P. Chopra,
Chief Stores Officer,
Garden Reach Workshops Ltd.,
Calcutta.

Shri Lalit Mohan De,
Works Manager,
National Instruments Ltd.,
Calcutta.

Shri J. A.D'Silva,
Controller of Stores,
Indian Airlines Corporation,
New Delhi.

Shri J. K. Mukerji,
Stores Liaison Officer,
Indian Airlines Corporation,
New Delhi.

Shri A. B. Mukherjee,
Asstt. General Manager,
Hindustan Cables Limited,
Burdwan.

Shri M. R. Nanjundiah,
Controller of Stores,
Hindustan Aircraft Ltd.,
Bangalore.

Shri T. C. S. Pillai,
Chief Mechanical Engineer,
Delhi Transport Undertaking,
New Delhi.

Shri P. B. Prabhu,
Superintendent,
Heavy Electrical India Ltd,
Bhopal.

Shri S. S. Jagota,
Additional Director,
Mechanical Engineering (Production),
Railway Board,
New Delhi.

Shri J. S. Jain,
Chief Engineer,
National Projects Construction
Corporation Limited,
New Delhi.

Shri G. R. Khosla,
Addl. Asstt. Secretary,
Hindustan Insecticides Ltd.,
New Delhi.

Shri K. S. Krishnaswami,
Managing Director,
National Buildings
Construction Corporation Ltd.,
New Delhi.

Shri P. K. Lahiri,
Controller of Stores and Purchases,
Durgapur Steel Project,
Distt. Burdwan.

Shri S. Seshadri,
Chief Purchase Officer,
Sindri Fertilizer,
Sindri.

Shri S. V. Sri Ramulu,
Chief Accounts Officer,
Delhi Transport Undertaking,
New Delhi.

Shri R. B. Sujan,
Chief Stores Officer,
Oil and Natural Gas Commission,
Dehradun.

Shri R. Varma,
Controller of Stores,
Delhi Transport Undertaking,
New Delhi.

Shri R. Venkataraman,
Director of Purchase and Stores,
Bhilai Steel Project,
Distt. ~~Burdwan~~ Durg (M.P.)

Shri K. S. Rajagopalan,
Chief Controller of
Stores and Purchase,
Heavy Engineering Corp. Ltd.,
Ranchi.

Shri C. V. R. Rao,
Asstt. Controller of Accounts,
Air India,
Bombay.

Shri G. J. Rosario,
Controller of Stores,
National Coal Development
Corporation Ltd.,
Ranchi.

Shri P. K. Verghese,
Joint General Manager,
Indian Telephone Industries Limited,
Bangalore.

Shri T. M. Xavier,
Works Manager,
Hindustan Insecticides Ltd.,
New Delhi.

CEYLON REPRESENTATIVES

Shri G. U. P. Samarasinghe,
Chairman,
Cement Corporation.

Shri S. S. Silva,
Chief Executive Officer,
Ceylon Hardboard Corporation.

Shri M. R. P. Salgabo,
Central Bank of Ceylon.

Shri Godfrey Goontilleka,
Chairman,
Small Industries Corporation.

Shri H. D. R. Gharamevar Dhane,
O & M Officer,
Ceylon Transport Board.

REPRESENTATIVES OF OTHER AGENCIES

Mr. Morton G. Grossman, Consultant in Economic Planning.	Ford Foundation.
Dr. Howard K. Hyde, Chief Public Administration. Mr. Kenneth S. Levick, Deputy Chief, Industrial Division.	U.S.A.I.D.
Shri T. R. Subrahmanyan Member, Shri R. Parthasarthy, Secretary.	Delhi Management Association.
Dr. H. K. Paranjape, Professor of Economic Policy and Administration.	Indian Institute of Public Administration.

INAUGURAL ADDRESS

by

Dr. A.N. Khosla

Member, Planning Commission

MR. VASUDEVA AND FRIENDS,

I am grateful to the Committee on Plan Projects for giving me this opportunity to associate myself with this Seminar on Materials Management. In the Planning Commission we have recently constituted a Committee for Cost Reduction with which I have been closely associated. We have set up this special committee because we are convinced that cost control is a must in this country. We have an abundance of human and natural resources to exploit which, we need a large supply of capital. Unfortunately, capital is woefully scarce. Since the supply of capital is far below needs, we have to make the most economical use of it. Any avoidable expenditure not only adds to cost but also deprives the nation of some essential project or programme. In other words, the social and economic cost of waste or avoidable expenditure is much higher in this country than in a developed country. Equally, it follows that the need for cost reduction is much greater in this country than it may be in some other countries. We have to reduce cost not only from the point of view of capital conservation but also to improve our competitiveness in foreign markets, since without that, we shall not be able to step up our exports. If we cannot step up our exports, we will not be able to obtain adequate imports of essential plant, machinery and materials without which our economic progress will suffer.

Now the greatest scope for cost reduction lies in materials management for the obvious reason that the outlay on materials accounts for most of the cost in both production and construction activities. I am convinced, therefore, that materials management is a fruitful area for cost control and deserves serious attention and the Committee on Plan Projects have done a good service in arranging this seminar to which they have invited top level executives of public sector projects.

We are apt to think of materials in relation only to industries. Actually, however, materials permeate almost all spheres and activities of life. Take, for example, education. At the face of it, education seems to have little to do with materials but the actual position is different. The cost of materials including furniture, apparatus, equipment, books, stationery, fuel and light in primary and secondary education in the U. K. works out to about 20 per cent of the total cost.

What is true of education is also true of several other social and economic activities which apparently may have no nexus with material. We need materials not only for industrial production but also for constructing buildings, roads, bridges, irrigation and power projects, for maintaining our transport systems, whether they be rail, road, sea or air, for running schools, colleges, hospitals and other institutions and projects.

In manufacturing and construction, cost of materials adds up to more than 60 per cent of the total cost. Accordingly, small changes in materials cost can result in large sums of money saved or lost. So far as construction activities go, it is estimated that their total cost during the Third Five Year Plan would be of the order of Rs. 3,600 crores out of a total outlay of Rs. 7,500 crores. Materials will account for more than Rs. 2,000 crores out of this total. In factory establishments, the consumption of materials is anticipated to be of the order of Rs. 20,000 crores during the Third Five Year Plan period. Thus, in construction and factory manufacturing alone, the outlay on materials is estimated to be of the order of Rs. 22,000 crores. If, as a result of scientific management of materials, we can reduce cost by, say, 5 per cent, the total reduction would be to the tune of about Rs. 1,000 crores which will indeed be a boon in that it will enable us to take up some of the highly desirable projects which have hitherto been kept pending for want of sufficient capital resources.

Man has used materials from time immemorial. Materials management, however, is a very recent concept. Taking industry, it is that aspect of industrial management which is concerned with the activities involved in the acquisition and use of all materials employed in the production of the finished product. These activities may include production planning, purchasing, inventory control, receiving and warehousing, store-keeping, transportation, materials handling, and disposal of scrap, surplus and obsolescent material. Another recent addition to materials management is value-analysis which is concerned with ascertaining whether the materials purchased are the greatest possible value in return for money spent. It is the study of the relationship of design, function and cost of any product, materials or service, with the object of reducing its cost through modification of design or material specifications, manufacture by more efficient processes, change in the source of supply or possible elimination or incorporation into a related item.

The essence of materials management, it seems to me is co-ordination. The various material functions, I have already referred to, namely, production and inventory control, purchasing, materials handling, etc., are all extensively involved with one another. They cannot operate efficiently without some form of co-ordination—and the closer the co-ordination, the more effective the total operation. Time and again, investigation has shown that the key to decreased costs, increased flexibility and improved production processes is an intelligent, co-ordinated approach to the various functions involved in the acquisition and use of materials. An integrated approach to the various problems connected with materials management is the only sure way of securing reductions in overall costs. Suppose, for example, purchasing and inventory control are not co-ordinated. The Purchase Manager may be tempted to buy an item in bulk if it means obtaining a discount of, say, 5 per cent, without paying any regard to the effect of excessive inventories on capital investment, storage problems, deterioration and obsolescence. If, however, the functions of purchasing and inventory control are co-ordinated in a Materials Manager, he will view the problem as a whole and will very likely come to the conclusion that the advantage of discount on bulk buying is more than offset by the extra cost of carrying excessive inventory. Considering over-all costs, he may well decide that in the long run it will be more expensive to buy in bulk.

It is common knowledge that inventories in India, whether in the private sector or the public sector, are much higher than those in America and European countries; there is a reason for that and it is that the procurement position in this country is substantially different from that obtaining in industrially advanced countries. In those countries, materials are available on tap, and transport is adequate and fast. In India, on the contrary, we have to depend for materials and spare parts and, particularly for spare parts, on imports which are uncertain because of foreign exchange difficulties and also take time. Again, even in regard to nationally available materials, the supply position is difficult and transport is inadequate. We cannot, therefore, apply foreign standards and have to set up our own norms. Notwithstanding all this, there is considerable scope for improvement, particularly in the public sector. We have had some opportunity of discussing materials problems facing public sector projects. We came to the conclusion that it was necessary to take a number of steps to improve materials control. It is possible, for example, to reduce procurement leadtime, particularly administrative leadtime, to enter into rate or running contracts with a view to phasing deliveries in economic lots, to lay down norms for materials consumption and inventory holdings and to devise suitable reports enabling management to spot weak points requiring corrective action. More than all this, it is necessary to inculcate inventory consciousness among those incharge of public sector projects. I do hope that this Seminar will serve that particular purpose.

You will, no doubt, discuss the various techniques which have been developed during the past several years to secure sufficient control of materials. There is one particular technique which I would like here to mention since it is so essential and useful that it can bear emphasis. It is the technique of selective control. If you want your control system to be both economical and effective, you will have to be selective. The motto of materials management ought to be: Take care of the rupee items and the naya paise items will take care of themselves. Time and experience have proved that strict control of the comparatively few heavy-value items results in the most effective and paying control. Frequent replenishments and intensive follow-up on the few but high-consumption-value items will make it possible to reduce stocks and provide sufficient flexibility to incorporate schedule or engineering changes with little or no loss through obsolescence. On the other hand, infrequent replenishments and routine follow-up are economical so far as low-consumption-value items are concerned.

Materials Management has reached a stage when it is not a matter of intelligence alone; it must also be aided by scientific techniques. In this regard, it is necessary to evolve a system of training men concerned with materials planning, purchasing and stores control. It is also necessary to train finance officers whose approval is necessary at various stages of stores procurement. May I hope that this Seminar will throw up some concrete suggestions for instituting a system of training for officers and men in public sector enterprises?

It has been said from time immemorial that time is money. But this maxim was never truer than today. Modern industrial and other enterprises are giant establishments involving tremendous capital investment and employing a large labour force. The cost of delay or service failure in such

establishments is indeed very great. Now it does happen sometimes that a department may overlook this cost in the process of securing least cost according to certain rules and regulations. A slavish adherence to rules may result in losses far greater than the savings. It is necessary, therefore, that every executive should constantly remind himself that rules and regulations are a guide and a means and not an end in themselves. He should look at problems not only from the limited point of view of his department but also from the standpoint of the enterprise as a whole; that is the only way to achieve optimum results and secure minimum overall costs. An integrated approach, taking into account conflicting costs and diverse interests, is the answer to a number of difficult situations which arise from departmentalised thinking. I have already said that materials management is the answer to the problem of co-ordinating the various materials functions. I would like to emphasise that co-ordination should not stop there. It is equally necessary to secure co-ordination between materials managers, production engineers, financial officers and general administrators. For such co-ordination it is necessary to develop a broad outlook which takes a total view of every problem.

I am confident that if materials management receives the attention that it deserves, it will help the individual enterprises and the nation in a big way. As I have already said, materials account for most of the cost of production and accordingly, scientific management of materials can help;

(*a*) release capital, so scarce in India;

(*b*) conserve valuable foreign exchange;

(*c*) reduce production cost; and

(*d*) increase our competitiveness in foreign markets.

I wish all of you pleasant and fruitful deliberations. With these words I declare this Seminar open.

APPENDIX III

THE SCOPE, PURPOSE AND TECHNIQUES OF MATERIALS MANAGEMENT

by

A. R. Palit

What is Materials Management ? Its field and scope

This term may need some explaining. Most human activities are concerned with men and materials. This is true of all national projects, be they building construction for technical institutes or hospitals or multi-purpose irrigation and power projects, or for industries in the public and private sectors. Materials management covers all the aspects of materials costs and materials supply and utilisation. It covers the whole gamut of functions involved in converting raw materials and ancillary supplies into finished products. It is concerned with planning and programming of materials and equipment; with pre-design value-analysis; with market research for purchase; with procurement of all materials including capital goods, raw materials; components and assemblies, finishing materials, packaging and packing materials; with stores-control and inventory control; with transportation costs of materials, with materials handling value-analysis and operations research for materials.

The term 'supply management' is also used by some Government departments, and the term 'logistics management' by the Armed Forces. However, the term Materials Management has found wider acceptance, and now we generally talk of materials management when we consider the inter-related functions described above.

The General Electric Company, U.S.A., a pioneer in the field of materials management, have grouped together the following functions under the heading 'materials management' and these come under the control of a Materials Manager or Director.

(*i*) Materials planning and programming
(*ii*) Purchasing
(*iii*) Inventory control
(*iv*) Receiving and warehousing
(*v*) Storekeeping
(*vi*) Value analysis and standardisation
(*vii*) Pre-design value analysis
(*viii*) Production control
(*ix*) Transportation
(*x*) Materials handling
(*xi*) Disposal of scrap and surplus, salvage

The concept of materials management is being accepted increasingly in the industrially advanced countries. In the U.S.A, almost every week some of the new industries are switching over to materials management. According to the

reports published by the Japan Materials Management Association, the Japanese Industry is being organised into materials management and production department, the former handling materials planning and programming, purchasing, inventory control, store keeping and transportation.

The new concept has many advantages : it highlights the inter-dependence of allied functions, and keeps in view the ultimate costs and efficiency, rather than the initial costs and efficiency. For example, a Purchase Manager may like to buy a certain item in bulk if it means obtaining a discount of, say, 10 per cent; whereas if he sees the same problem as Materials Manager, he will take into consideration the storage problems and the cost of carrying extra inventory. The chances are that in many cases he will decide that it will be more expensive in the long run to buy in bulk if the discount is only 10 per cent or less.

Even if the purchase price is controlled or fixed, in many instances, saving in the ultimate costs is still possible. For example, there may be a saving in the cost of handling, transport or packing.

Another advantage of the new concept is that the accent is on 'value' rather than on 'price'. An item may be bought at a higher price for its intrinsic worth for the end use.

The importance of Materials Management

The importance of proper materials-management has not been fully realised in India. The Third Plan has been analysed according to the requirements of the various States, and the requirements of the various projects and services such as irrigation, power, agriculture, education, etc. It can, however, be analysed according to requirements of materials, labour and overheads. Even a conservative estimate shows that at least Rs. 5,000 crores will be spent during the Third Plan period on materials and equipment out of which approximately Rs. 3,000 crores will be spent by the Public Sector.

Reduction in materials costs by about 5 per cent through efficient purchasing and materials-management is possible. On the other hand, inefficiency and bungling can easily result in an extra expenditure of 5 per cent.

The aims of sound materials-management is not only to reduce the costs, but also to stabilise the price in a rising market and to prevent undue waste and expenditure.

From the national point of view, materials-management is of great importance for the success of Third Plan; it is also of prime importance for our industrial economy, both in the public and private sectors. Materials costs in Indian industries are about 64 per cent of the production costs. This value is based on an average of 29 Indian industries for the year 1954-57. In many industries, this value is higher. For example, materials costs represent 70 nps. per sales rupee according to annual report of the Tata Engineering and Locomotive Co. Ltd., for the year 1958-59. These values are similar to those in the U.S.A. and Japan, but a concentrated effort is being made to reduce the costs in these countries. In Japan, the materials costs was 61·55 per cent of the production cost during the second half of 1957. It has been reduced to 58·45 per cent over

18 months. Surely what Japan can do, India can also do. It should be remembered that Japan has to depend heavily on imports and must therefore, develop her export market.

Apart from reducing materials costs, efficient materials management can achieve the following:

(*i*) Reduce the requirements of foreign exchange by getting the maximum value out of the available foreign exchange or by reducing the value of imports, contributing substantially towards narrowing the foreign exchange gap;

(*ii*) reduce material costs and thus contribute substantially towards price stabilization; and

(*iii*) reduce cost of end products and improve their quality, thereby enabling the Indian products to compete in the foreign market on the basis of price and quality. Exports will not automatically follow trade pacts. Also, concessions from the Government alone will not make the products competitive. These have to compete in quality and price with the products from, say Japan and West Germany.

Organisation for materials management

The organisation for materials management requires integration of various functions already mentioned. These integrated functions are generally placed under the Materials Manager. The following divisions are feasible for a materials organisation :

(*i*) by function,
(*ii*) by location,
(*iii*) by product,
(*iv*) by stage of manufacture or process.

The questions of centralisation and decentralisation will arise in many organisations. They can be tackled in line with the above division of work; by serial approach and by some kind of staff and line approach, if necessary. However, the organisation has to be more or less 'tailor-made' for each industry.

Objectives of industrial pruchasing and materials management.

(*i*) To maintain continuity of production,
(*ii*) To contribute to competitiveness of the end product,
(*iii*) To contribute towards higher productivity,
(*iv*) To buy for the best ultimate value, not necessarily the lowest initial price,
(*v*) Reduction in the costs of end products,
(*vi*) Elimination of Extra Materials Costs,
(*vii*) Increase in profits.

Five Essentials of Right Purchase

(*i*) Right quality,
(*ii*) Right quantity,
(*iii*) Right price,
(*iv*) Right delivery,
(*v*) Right suppliers.

Tools and techniques in materials management

Some of the more important tools and techniques may be listed as follows—

(*i*) Integration of Materials Management functions ; enlarged scope of Purchasing and Materials Management ; teamwork between Purchasing, Stores, Production, Sales, Transport, Design, Quality Control, Inspection, Finance & Accounts Departments.

(*ii*) A-B-C analysis of purchases and regular stores items; Materials Planning and Programming; Materials and Purchase budgeting; line of balance technology ; estimating expected time ; critical path analysis ; forecasting demands ; the moving average and exponential smoothing.

(*iii*) Rationalized codification of stores ; standardization and simplification of stores ; adoption of company standards.

(*iv*) Market research for Purchasing; forecast of economic trends in materials and inventories; Purchasing and commodity research; source development; determination of correct methods of purchasing—increased use of Rate, Running and Blanket contracts, Repeat orders; negotiated orders, negotiating favourable prices; improved methods of sub-contracting ; learning curves.

(*v*) Cultivation of better supplier-relationship ; ethics of supplier relationship ; reliability in supplier selection ; co-operation of supplier in cost-reduction and in emergencies.

(*vi*) 'Make' or 'buy' studies ; analysis of supplier costs ; analysis of packing and packaging costs.

(*vii*) Value analysis ; value-analysis of tools ; pre-design analysis; pre-production analysis.

(*viii*) Selective inventory control ; level of control ; Economical Order Quantities ; E.O.Q. to fit budget—correlation analysis for inventory ; weakness of E.O.Q.; order point system versus periodic re-ordering system ; Optimum Review Period (O.R.P.); forecasting consumption ; safety stock calculations ; balancing inventory.

(*ix*) Improved lay-out of stores ; improved materials handling.

(*x*) Operations research including linear programming for source selection, economy in transportation and inventory problems ; learning curves ; exponential smoothing, E.O.Q.; O.R.P., Poisson distribution for safety stocks.

(*xi*) Data-processing, automation, computing ; business games.

(*xii*) Simplified procedure and routine ; reducing paper work and processing time ; "preventive" expediting ; effective liaison and follow-up selective reporting to management.

(*xiii*) Capital equipments analysis.

(*xiv*) Periodic appraisal of over-all performance.

The need for training in Materials Management

From what has been discussed above, it will be clear that there is need for professional training for materials-managers and for study of problems in India relating to materials-management. For this purpose the Eastern Purchasing Journal has advocated the establishment of a National Institute for Materials Management on the lines similar to the Japan Materials Management Association. The objective of such an institute should include the following—

(*i*) To provide for the study of materials management in all its aspects by organising study and training courses, conferences, seminars, workshops and discussion groups etc. to cover materials-management for Government organisations and public bodies as well as for industries in the public and private sectors;

(*ii*) to organise a School of Materials Management under the auspices of the Institute;

(*iii*) to undertake research in matters relating to materials management and to form study groups for the purpose;

(*iv*) (*a*) to publish books, periodicals, research papers, bulletins, abstracts, etc. on materials management.

(*b*) to publish classified-product-catalogue of indigenous materials and equipment with relevant information in sizes, types, standards and specifications;

(*v*) to serve as a centre for the exchange of ideas and information on materials management ; and

(*vi*) to render consulting service of a general nature to members.

APPENDIX IV

PURCHASING FOR THE PUBLIC SECTOR

by

N.E.S. Raghavachari

The total value of purchases of the DGS&D during 1961-62 was about Rs. 258 crores. This figure is expected to rise to Rs. 300 crores during 1962-63. These figures cover mainly purchases for the Central Government Departments but also include certain purchases effected by the DGS&D on behalf of State Governments and Public Sector Undertakings. If the value of purchases made by the State Governments and the Public Sector Undertakings be put together the figure may well exceed Rs. 500 crores. In view of the large amounts involved in purchase, it is essential that purchases should be effected in the most economic manner. A saving of about 1 per cent on the purchases would result in a saving of about Rs. 5 crores per year in total purchases.

Purchasing is not an end in itself. It is essentially a service function, the Purchase Officer acting on behalf of the ultimate user of the store. Therefore, a Purchase Officer has to realise that if he does not purchase the required goods and ensures timely deliveries, he would be handicapping the ultimate user, who requires the store. The Purchase Officer, therefore, has a special responsibility. Particularly in the case of Industrial Undertakings, failure of supplies will affect continuity of production. For purchasing for Industrial Undertakings, the Purchase Officer has to buy taking into consideration the best ultimate value and not necessarily, the lowest initial price. This is very important if there is to be a reduction of the cost and improvement in the quality of the end product, which will contribute to the competitiveness of the end product. Timely procurement of stores will also reduce inventory costs as it would be possible to have a smaller reserve. Thereby there will be a reduction in the working capital required.

There are five essentials for a good purchase. The stores should be of right quality, right quantity, right price, right delivery and from right vendor. Of these, of course, the right price is the most important but if the store is not of right quality, there is no point in effecting the purchase. Similarly, the required quantities should be delivered within the time stipulated otherwise continuity of production cannot be ensured. The importance of the right vendor is linked up with the other factors. There are some suppliers, who are incapable of ensuring quality as well as delivery, and there is no point in placing an order on them merely because they are able to offer a low price. A good supplier will do his best to see that the contract is completed according to schedule.

To an outsider, the Purchase Officer's job would look comparatively simple. The general impression is that one has to merely invite tenders and place orders for the lowest acceptable offer but in a developing economy like that of ours, there are chronic shortages of capacity, shortage of raw materials and shortage of foreign exchange. A Purchase Officer has to do his best having regard to these factors. It may happen that no offer conforming to the specifications is received by the Purchase Officer in response to invitation to tender.

He will then have to persuade the indentor to revise specifications to the extent possible so that it would be possible to effect the purchase from indigenous production. In cases of shortage of capacity, the Purchase Officer has often to persuade producers to increase capacity. Similarly, he may have to assist the producer to procure the raw materials required.

I have earlier referred to the possibility of effecting savings in purchase. These can be achieved in a number of different ways. Firstly, the terms of the contract should be such as would enable a supplier to quote the lowest. One of the complaints against the Public Sector is that payments are often delayed. Firms have to incur certain expenditure for financing a transaction and to the extent that a supplier can effect a saving of financing cost, he would be able to pass on that saving to the purchaser. Therefore, timely, payments are very important if we have to effect economy in purchases. Secondly, if stores are required at very short notice, one has to pay a very heavy price. The margin may be as far as 10 per cent for an ex-stock offer as against one requiring delivery six months hence. It is, therefore, essential that purchases are effected on a long term basis, say, for a period of six months or a year at a time. This enables the producer to plan his production and, therefore, he would be able to offer an economic price to the purchaser. This of course, would require effective co-operation of the indentors. Thirdly, by purchasing quality goods, certain economy is possible. For instance, the product of a particular manufacturer may be 10 per cent costlier but it may last 50 per cent longer and it would, therefore, be economical to pay a slightly higher initial price. In respect of some items, the cost of maintenance during life-time of the store will have to be taken into account. This is the objective of value analysis. Fourthly, it might be possible to persuade the indentor to reduce the specifications. For instance for certain stores, the indentors have a very wide safety margin. For a product for which use of untested steel may be sufficient, indentor may specify tested steel, which is in scarce supply and, therefore, higher value is being paid unnecessarily for the store.

The purchaser has a very vital role in the planning of production of an Industrial Undertaking. For instance, Sales Department might be of the view that a particular packing will have a higher sales value. The Purchase Officer, on the other hand, is aware that particular packing material is difficult to procure in the market. Therefore, the Production Manager should necessarily consult the Purchase Officer before he accepts the suggestion of the Sales Department.

APPENDIX V

OPERATIONS RESEARCH

by

Jagjit Singh

For a long time I had thought I was a railwayman interested in the foundations of probability as an exercise in pure mathematics for my own amusement. But as even the purest of the pure who claim to despise applications so much are often seduced by these sirens, I was not a little intrigued when I learnt fourteen years ago that some very brilliant use of this abstract theory had been made in a new field of activity called Operations Research. But here again my interest in the subject began as a purely Platonic quest in the sense that I did not expect anything of very great practical value to my own professional work to emerge out of it. But Platonic quests like Platonic loves rarely end that way. They often lead to fertile results. This is why perhaps they are so suspected. But in this case there is a more commendable reason for my associating Plato with the subject of my talk. For I discovered to my own surprise that the first Operations Researcher in a manner of speaking was Plato himself. For Plato, as you all know, an important, perhaps man's most important, intellectual task was to distinguish appearance from reality. It is a task required not only of the contemplative philosopher or scientist but even more importantly, of the man of action, in particular the ruler, the administrator and manager of men and machines who has to find his bearings in the world of appearance and who must know what is the case, what can be done and what ought to be done. For centuries rulers have had to rely on their own judgement to discriminate between appearance and reality as best as they could before deciding their choice of action till they have now found a new guide in Operations Research in at least some spheres of their responsibility. Not that the need for judgement with the advent of O. R. is any less; quite the contrary. But the lack of O. R. aides to supplement judgement in the earlier quieter days of *laissez faire* economies when a Pope could with some justification claim

> For forms of government let fools contest;
>
> Whatever is best administered, is best.

was perhaps not quite so fatal as it is in these more hectic days of welfare states, national planning, nuclear armaments and total wars. The growing complexity of present-day rulers' daily business made it inevitable that they would sooner or later employ science to obtain valuable insights into administrative reality they seek to command and control. Such a deliberate and consistent resort to science to ferret reality as a corrective to mere subjective impressions actually came about under the duress of the second world war for exactly the same reason as created the atom bomb *viz.*, a crash programme initiated by the Allies out of fear that the "other" fellow would do it.

This new movement to associate scientists with Generals, Air-Marshalls and Admirals to find out what is the case and what should be done was naturally an immediate success. For thanks to the firmer grasp of reality that the practice

of O. R. gave it could suggest decisions that yielded quick and large payoffs. Take, for instance, the question of finding the correct tactical answer to the Japanese use of suicide planes against the allied naval vessels. The choice lay between the ship trying to avoid being hit by violent manoeuvres or continuing on a steady course trusting to its anti-aircraft fire alone to destroy the enemy's aim. What actually happens is not a question that can be guessed a priori. But it can and was ascertained by a careful collection of the results of several actual combats. In this way it was discovered that while large units like battleships, carriers and cruisers fared better under radical manoeuvring, the smaller fleet units like destroyers were safer if they pursued a steady course because of the greater distortion of their anti-aircraft gunner's aim on account of heavy pitching and rolling under violent zig-zaging of the lighter craft. In this and many other similar cases which have since become classical all that O. R. scientists did was a careful but essentially commonsense analysis of the numerical results of actual happenings in the field to deduce the correct tactical or strategic answer to the enemy moves. If you read—as I do hope you will for sheer inspiration—an account of the Operational Research problems of world war II as, for example, that summarised in a pamphlet of the same title compiled by Mehta and others of the Defence Science Laboratory, you will be surprised at the extreme simplicity of the numerical analyses and the richly rewarding strategies and tactics that they suggested. Indeed, the contributions of these "slide-rule" strategies and tactics to victory, in the Battle of Britain fully warranted the inclusion of their authors in the "few" whom Churchill immortalised in a well-known discourse at the time specially as he himself had to intervene frequently to secure their acceptance.

From such piecemeal scientific evaluation of each specific combat, reconnaisance, or supply operation to the scientific examination of the working of complex closely integrated systems in order to optimise their overall goal was but a step. It was called operations research to denote a movement that concerned itself more with ameliorating the overall effectiveness of existing weapon systems rather than the invention of new. By the close of the war the movement had, by dint of an impressive array of successes, acquired enough prestige to spill over into business, industry and civil government already so overgrown as to clamour for similar scientific aides to discover reality and decide what to do.

Soon after the spread of O. R. in diverse fields of industry, management, and administration in the West heroic efforts were made to contain such an omnibus, if sprawling, activity within the confines of a neat definition. But as such neatness in a young and growing discipline is often a sign of ossification, it is perhaps just as well that none of the numerous ones proposed has prevailed over the others. Believe it or not, this happy state of affairs had an unhappy consequence. There was actually a period, fortunately now over, when more time was spent in trying to define O. R. than doing it. Dr. R. S. Verma, of the Defence Laboratory in a recent conference recounted a score of products of this craze without exhausting them all. Most of them embody the ideas of one or other of the following two. In the first given by Stafford Beer O. R. is defined as the "attack of modern science

(*i*) on problems of likelihood (accepting mischance),
(*ii*) which arise in the management and control,

(*iii*) of men and machines, materials and money,

(*iv*) in their natural environment,

(*v*) its special technique is to invent a strategy of control,

(*vi*) by measuring, comparing, and predicting probable behaviour,

(*vii*) through a scientific model of the situation."

In the second due to Ackoff the stress is on the input and/or output of the values involved in an operation or activity. For each activity consumes some valuable resource such as men, money, machines, material, time, effort and in turn the outcome has also some value. O. R., it is claimed, is concerned with decisions which affect the relationship between the value consumed (input) and the value created (output) the chief aim being one of three things:

(*i*) minimise input, that is, the value required to achieve a specified output,

(*ii*) maximise output, that is, the value achieved from a specified input,

(*iii*) maximise some functions of input and output values *e.g.*, their difference (profit) or their ratio (return on investment).

Such views of O. R. may seem to exalt it as a sort of superscience of solving complex decision problems in terms of high principles, either a high principle of optimality or of a new logic of rational choice. The former leads, in the first place, in cases of decisions taken under uncertainty as most decisions are, to an embarrassing multiplicity of criteria between which choice ultimately depends on the subjective attitude of the decision maker. If a pessimist apprehending that nature will always thwart him, he will follow Wald in selecting his optimal strategy,—the so-called minimax criterion;—and if an optimist hoping that nature may at times be benevolent, the maximax strategy of Hurwicz. Nor is this end of it all. There are open to him two other criteria—those of Savage and Laplace—which will also be optimal in the sense that the former minimises his "regret" after the event when he evaluates his decision with hindsight wisdom and the latter distributes equally his initial ignorance of what is to come amidst all the likely alternatives before calculating the maximum payoff. Secondly, optimum principles often unrealistically oversimplify the problem. For example, the solution of the celebrated diet problem of Stigler *viz.* what quantities of available 77 foods should be bought in order to yield the minimum cost is such an unpalatable indigestible mixture that its author himself hastened to warn "No one recommends these true minimum-cost diets to anyone let alone everyone." Likewise, no one complains that milk bottles are neither spherical nor cylinderical even though these are the forms that optimise surface-to-volume relations as one may readily verify by resort to elementary calculus. The upshot of all this is that mathematical optimisation is a useful artifice but there is danger in taking all its results too seriously.

The second high-principled approach—that of a new logic of rational choice—too has its pitfalls. It often leads to the predicament of Buridan's ass if it does not so complicate the problem as to yield no solution at all. The trouble is that by posing the decision problem in the abstract in order to secure widest generality, we encounter the old well-known less-and-less-of-more-and-more dilemma. For the greater the extension of a concept, the lesser its intension. That is talk

about everything say precisely nothing. Most of O. R.'s current embarrassments stem from this over-ambition to base itself on high principles. This is why I should like to recommend that steering clear of the cloud cuckooland of high principles, we may view O. R. in the following two complimentary ways.

(*a*) As a repertoire of well-established techniques like linear programming, waiting models, sequencing theory, etc. each one of which is a major stem supporting specific methods and models as its offshoots, and

(*b*) As a do-it-yourself research exercise into the problems of your own field of endeavour by a wise exercise of judgement based on your own intimate knowledge of the particular subject to which O. R. is applied.

I am aware that view (*a*) is liable to be condemned as a "cookbookery" approach not conducive to growth of understanding which it is claimed can come only by mathematical treatment with emphasis on deductive proofs. But the problem of cookbookery is not peculiar to O. R. I submit that the housewife whose cult of cookery produces delicious dishes is not any less useful for her ignorance of the chemistry of the frying pan or the deep freeze. Nor by the same tokens are the works of field engineers any the worst merely because they are the products of "cookbook" techniques applied by men innocent of the high-faulting mathematics underlying them. I, therefore, make no apology for listing in *Annexure I* some of the better-known O. R. techniques with a brief indication of the fields of their respective coverage in the hope that some adaptation thereof may meet the needs of the field of your endeavour. I need hardly remind that it is a foolish housewife that takes her cookbook recipes too seriously and does not indulge in moderate deviation to suit her own requirements of taste, materials availability and the like.

As for (*b*) it may seem too plebian a view of O. R. to claim that field knowledge, commonsense and wise judgement allied, if necessary, to simple calculation is the most appropriate course to follow when one has a specific problem not amenable to any of the standard techniques under (*a*) to solve. But this is exactly what the great pioneers of early O. R.,—men like Blackett, Williams, Waddington and others,—did. The chief lesson that they taught was that one need be no great shakes in mathematics to do one's own O. R. as may be judged by a perusal of Mehta's pamphlet referred to earlier. A few specific examples of essentially the same but of the home-made variety are given in *Annexure II*.

The artifices employed in these cases will not avail in other fields. For in listing them I had inevitably to lean heavily on the work of men either in my own profession or personally known to me. However, the object of enumerating them here is not to demonstrate their applicability in other fields but merely to illustrate how subject-matter or field knowledge combined with commonsense, wise judgement and simple analysis of numerical data properly compiled can often help initiate O. R. with valuable insights if not actual gains. How it is to be initiated in your own sphere of activity is primarily a matter for your own discovery. But the following O. R. Panchsheel that has served others in good stead may perhaps assist the discovery:

(*i*) If O. R. is to be helpful and useful, it must be practised. There are many ways in which it can be used some good and some evil. Apart from unethical practices, the most dangerous are two—the way

of goobledygook and the way of pontification. The goobledygook way follows the smooth road of unreal assumptions, routinised techniques, arbitrary criteria and abstract results without any real attachments in preference to the rocky road of real problems that actually beset us. To the extent abstract O. R. pieces do not contribute even by a long and tortuous chain to the elucidation of some real live problem, they must be judged as pieces of pure mathematics. Work that is neither one nor the other will remain valueless.

(*ii*) The way of pontification is worse as it seeks to use mere formal procedures for sanctification, for preservation of conclusions from all criticism and for the granting of an *imprimatur*. O. R. analysis may use mathematical argument as a basis for judgement but not as a stamp of validity. Certainly the hall mark of good O. R. is precisely the same as that of good science which as Martin Wilks has remarked, "is that it uses models and 'theory' but never believes them".

(*iii*) Far better an approximate and even a crude answer to the *right* question which is often vague, than an exact answer to the *wrong* question which can always be made more precise. O. R. progress has often been made by approximate answers to a well-put problem because our knowledge of the problem is at best approximate. It therefore follows that O. R. must seek for scope and usefulness rather than security even at the risk of moderate error inevitable when answers have often to be suggested by inadequate evidence.

(*iv*) While we dare not neglect any of the tools that have proved useful in the past such as those listed in *Annexure I*, we must be even more daring to invent new ones of our own. If algebra, analysis, linear programming, Monte Carlo methods, etc. cannot help, we must press on just the same making as good use of our intuitions and originality as we know.

(*v*) The O. R. practitioner must be willing to face up to realistic problems despite their discomfort. He may have very good reasons to *start* with a simplified or even an oversimplified version of his problem, but there never can be a good reason for *stopping* there. He must remember that while O. R. has to resort to simplifications to secure a foothold for a first peep into reality, it must continually transcend them and go beyond them by taking into account other aspects previously ignored, to get a fuller view of reality.

If we practise O.R. on these lines, it can provide a great service to all fields of planning, technology and development even more in underdeveloped countries like ours than it has already done in the advanced countries of the West. Will it? That remains to us who are charged with spending a lot of money in a short time in order to make the nation grow rich quick. Shall we dare or shall we be doubting Thomases in Kenneth E. Boulding's poetry?

Poor countries are inclined to dicker,

With those who 'ill make them richer quicker.

This gives the conflict added zest,
Between the Russians and the West.
And they might well be doubting Thomases,
Who trust in others' promises.
When all development must roll,
On Thought, Work, Thrift and Self-control.

ANNEXURE-I TO APPENDIX V

A LIST OF SOME IMPORTANT O. R. TECHNIQUES

I. LINEAR PROGRAMMING

This technique is applicable to a very wide class of problems which can all be subsumed under the following mathematical model or description.

To every one of the unknown variables $x_1, x_2, x_3, \ldots\ldots x_i \text{ — } x_n$ there correspond known constants, the so-called cost co-efficient,

$$c_1, c_2, c_3, \ldots\ldots\ldots\ldots\ldots\ldots c_i \ldots\ldots\ldots c_n.$$

The problem is to determine their values so as to minimise (maximise) the objective function $c_1x_1 + c_2x_2 + \ldots\ldots c_i x_i + \ldots\ldots\ldots c_n x_n$ subject to the restraining conditions

$$\begin{aligned} x_1 &\geqslant 0 \\ x_2 &\geqslant 0 \\ x_3 &\geqslant 0 \\ &\text{—} \\ &\text{—} \\ &\text{—} \\ x_n &\geqslant 0 \end{aligned}$$

$$\begin{aligned} &\text{and } a_{11}x_1 + a_{12}x_2 + \ldots\ldots\ldots a_{1j}x_j + \ldots\ldots\ldots a_{1n}x_n \geqslant b_1 \\ &a_{21}x_1 + a_{22}x_2 + \text{————}a_{2j}x_j + \text{————}a_{2n}x_n \geqslant b_2 \\ &\text{————————————————————} \\ &a_{m1}x_1 + a_{m2}x_2 + \ldots\ldots\ldots\ldots a_{mj}x_j + \ldots\ldots\ldots a_{mn}x_n \geqslant b_m \end{aligned}$$

where a's and b's are given constants.

By introducing additional slack variables with zero associated cost coefficients it is always possible to transform the above inequalities into equalities. As a result we need only consider the case when the restraining constraints are equalities.

For example, consider the following problem :

Three garages G_1, G_2, G_3 have 2, 6, 7 buses stationed at with them. It is required to send 3, 3, 4 and 5 buses to four points, A, B, C & D respectively. The Manager would like to distribute the buses in such a way that the total bus-time reckoned in bus-minutes from the garages to their destinations is minimum. The time in minutes taken to travel from each garage to each destination is given according to the following scheme :

		A	B	C	D
From	G_1 to	13	11	15	20
	G_2	17	14	12	13
	G_3	13	18	15	12

If X_1, X_2, X_3, X_4 are the number of buses from G_1 to A, B, C, D respectively, x_5, x_6, x_7, x_8, from G_2 to A, B, C, D respectively, and x_9, x_{10}, x_{11}, x_{12} from G_3 to A, B, C, D, respectively then in terms of our model the cost co-efficient C's are

$$c_1=13, \quad c_2=11, \quad c_3=15, \quad c_4=20 \quad c_5=17, \quad c_6=14,$$
$$c_7=12, \quad c_8=13, \quad c_9=18, \quad c_{10}=18, \quad c_{11}=15, \quad c_{12}=12$$

and the objective function to be minimised is

$$13x_1 + 11x_2 + 15x_3 + 20x_4 + 17x_5 + 14x_6 + 12x_7 + 13x_8 + 18x_9 + 18x_{10} + 15x_{11} + 12x_{12}$$ with the restraining conditions

$x_1 + x_2 + x_3 + x_4$	$= 2$	$=$ total of buses from	G_1
$x_5 + x_6 + x_7 + x_8$	$= 6$	$=$,, ,,	G_2
$x_9 + x_{10} + x_{11} + x_{12}$	$= 7$	$=$,, ,,	G_3
$x_1 + x_5 + x_9$	$= 3$	$=$ total required at	A
$x_2 + x_6 + x_{10}$	$= 3$	$=$,, ,,	B
$x_3 + x_7 + x_{11}$	$= 4$	$=$,, ,,	C
$x_4 + x_8 + x_{12}$	$= 5$	$=$,, ,,	D

ANSWER : $x_1=1$, $x_2=1$, $x_3=0$, $x_4=0$
$x_5=0$, $x_6=2$, $x_7=4$, $x_8=0$
$x_9=2$, $x_{10}=0$, $x_{11}=0$, $x_{12}=5$

Total bus-minutes under this scheme-196

There is also a corresponding problem of maximising the objective function although no one will ever use it. The solution of the problem is :

$$x_1 = x_2 = x_3 = 0, \; x_4 = 2$$
$$x_5 = 3, \; x_6 = x_7 = 0, \; x_8 = 3$$
$$x_9 = 0, \; x_{10} = 3, \; x_{11} = 4, \; x_{12} = 0$$

Here the highest total cost is 244 bus-minutes.

Although the foregoing example corresponds to what is generally called the transportation problem, i.e. allocation of buses, wagons, carriages, etc. to destinations or routes, etc. it is also applicable to a wide variety of problems like :—

(*i*) Personnel assignment problem where it is desired to assign jobs so as to maximise the total output.

(*ii*) The contract award problem. The tenders or bids sometimes include complicated stipulations and it is not always a straight forward matter to find the cheapest way of satisfying all of them. L. P. evaluation guarantees that the awards are, in fact, made in the cheapest way and makes it possible to prove objectively that this has been done.

Many other problems like Production Scheduling, routing aircraft, blending aviation gasolines, preparation of duty rosters, smooth patterns of production etc. could be handled by L. P. For concrete illustrations reference may be made to Readings in Linear Programming by S. Vajda.

II. Dynamic Programming

This technique has been developed to handle multi-stage decision processes. In such processes we seek a sequence of decisions which optimises some predefined objective function or criterion function. Such for example is the dividend problem of an industrial concern *viz.* what fraction of funds available at the beginning of the year may be distributed as dividends and what fraction used for reinvestment. Having regard to the diminishing return of the reinvested capital the problem is to so decide the split of the funds available for distribution and investment *each* year as to maximise the total payoff over a period of years. The basic idea is "that whatever the initial state and initial decisions the remaining decisions must constitute an optimal policy with regard to the state resulting from the first decision". Unfortunately unlike linear programming no general purpose preprogrammed computational algorithm has yet been devised. But the essential idea is to characterize the problem by means of a functional equation or its discrete analogue, the recurrence relation.

III. Waiting-Time Models

A waiting time problem arises when either units requiring service or the facilities which are available for providing service stand idle i.e. wait. Such problems are of two different kinds. In the first kind the arrivals are usually randomly spaced while service time may or may not be of random duration. It is required to determine the optimal number of service facilities or the optimal arrival rate or both so as to obtain an optimum balance between the costs associated with waiting time and idle time. The construction of models of such waiting-line processes usually involve relatively complex mathematics. Fortunately many such problems can be solved more simply by use of Monte Carlo procedures.

IV. Sequencing Problem

The second type deals with the converse problem where the facilities are fixed and arrivals and/or the sequence of servicing the waiting customers are subject to control. The problem is to schedule arrivals or sequence the jobs to be done so that the sum of the pertinent costs is minimised. Mathematical analysis of this type of sequencing problem has barely begun and relatively little progress has been made to date.

V. Replacement Problems

They consist of timing the replacement of an equipment that is subject to failure, deterioration or obsolescence in such a way as to minimise the sum of the cost of new equipment, the cost of maintaining efficiency on the old, and/or the cost of loss of efficiency. The replacement process is thus one of two kinds depending on the life pattern of the equipment in question. If it is liable to deteriorate or become obsolete, the problem consists in balancing the cost of new equipment against that of maintaining efficiency at the old level. If, on the other hand, it is liable to fail, the problem is when to replace

it so as to minimise the sum of the following costs:

(*i*) the cost of equipment involved;
(*ii*) the cost of replacing the units, and
(*iii*) the cost associated with failure of the unit such as loss of earnings due to unusable equipment.

At one extreme we may as a matter of policy decide to replace items only when they actually fail but such drinking of our cup to the last dreg carries the nemesis of having to face the cost of failure which may be very high. At the other extreme all items might be replaced when (or before) the first one fails. The equipment cost will be high but the failure cost will be low. The optimum policy is naturally a *via media* between these two extremes. Such optimal policies have been devised by close and extensive studies of the life spans of failure-prone items so as to yield distributions of probabilities of failure as a function of the duration of time the item has been in use.

VI. Gaming Models and Game Theory

A new mathematical theory of games has recently been created in an attempt to provide a new approach to economic questions as yet unsettled. It has also been employed to the war game. Their nearest analogue is a game like bridge or poker played by a number of players according to a set of rules specifying the payoffs associated with each outcome of the game. Likewise war is treated as a sort of game played by several players sitting down to a map of some area, using pins or pencil markings to represent armies facing each other in combat. These various armies are manoeuvred in much the same manner as a real army might be expected to be manoeuvred in a real field of battle. The rules that specify how far an army may move in a given period of time are specified and a general problem is assigned to be solved in the best possible way, the ostensible object being to provide premeditated solutions to problems which may otherwise in the heat of the battle be handled in a disastrous manner. A serious limitation of the game theory, however, in these applications is the largely unrealistic nature of assumptions underlying the mathematical superstructure. Nevertheless, the theory of games has considerable value in that it is intimately related to the theory of linear programming, statistical decision theory, test ng of hypotheses, war games and O. R. in general.

ANNEXURE-II TO APPENDIX V

I. **Mughalsarai Bottleneck**—When with the onset of the planning era about 10 years ago the need for a substantial increase in rail movement *via* Mughalsarai was felt for the first time, it was possible to meet it immediately by a close study of the yard operation. Such a study revealed that there was a gap of about 10 to 15 minutes between the marshalling of two successive trains. The reason was that the shunting engine had to return from the crest of the hump to the rear of the next train by a clear line before it could commence the next shunting operation. By providing a second overlapping shunting engine in rear of the next train it was possible to eliminate this gap almost entirely. But as in a closely integrated cycle of activities a change in one component involves corresponding changes in all the rest, it was necessary to take other collateral steps to ensure that all the other components in the operation like clearances from marshalling and departure lines, examination of trains for damaged wagons, etc. were also accelerated adequately to match the faster tempo of shunting. In this way it was possible to marshall forty-four trains against the earlier theoretical capacity of only thirty-two trains with yet a spare margin for six more trains.

II. **Speeds of goods trains**—The continually declining trend of speeds of goods trains over several years led to a deeper analysis of the concept of average speed. It was shown that there were two distinct concepts of average speed of goods trains,—*viz.* the average speed of trains on a *single* section and that of trains run on a group or aggregate of sections—which had somehow tele scoped into each other to create confusion. New norms of speed evaluation were evolved to appraise speed performance of railways on the basis of the new insight provided by the analysis. This insight and the related appraisal techniques were considered sufficiently valuable to attract even international notice with the International Railway Congress Association's request for permission to reprint the study in the English and French editions of their Monthly Bulletin.

III. **Location of a major bridge on the Ganga**—When the proposal to construct the Rajendra Bridge over the Ganga was first mooted, two alternative sites, *viz.* Patna and Mokameh were proposed. By an ingenious analysis it was possible to assess the overall difference between the quanta of traffic hauls by the two routes and thus provide a basis for rational choice. It was shown that all the hundreds of thousands of pairs of points between which traffic moved could be grouped into seven zones of constant load difference which enabled the aforementioned computation in a simple straight forward manner. Such a rational study helped persuade even the last-ditch protagonists of the Patna site to agree to the Mokameh site where it was eventually built.

IV. My colleague M. S. Gujral of the Eastern Railway has recently studied the problem of traffic flow in the Karanpura coalfields of the Eastern Railway. He found that the loads of both empty and loaded trains had been determined by the hauling capacity of engines to move trains in the loaded direction as is indeed the usual practice. In this case, however, it caused two difficulties.

Firstly, since the only source of empty wagons was from Mughalsarai and the coal wagons loaded moved in both directions, that is, towards and away from Mughalsarai even though the former was the bulk, it was necessary now and then to send light engines to bring empties on account of this imbalance. Secondly, due to capacity limitations of single line it was not always possible to move the required number of empties. He overcame both the difficulties at one blow by increasing the loads of empty trains though the loads of loaded trains had perforce to remain the same. The average load of an empty train was thus raised from about 70 wagons to 84.

V. He has also applied extensively rationalisation principles to the loading and marshalling of coal, stone and other traffic moving in bulk. For instance Pakur stone of which about 100 wagons a day used to be loaded and moved to a motley crowd of consumers in various localities is now being loaded in bulk to single points like Chitpur, Howrah, Bandel, etc. *at a time*. Likewise coal for the three Power Houses in Calcutta area which used to move piecemeal is now collected into one train in Andal Yard by pooling the wagons of all the power houses. The train is then consigned to the power house nominated having regard to its requirements, wagons already on hand awaiting release etc. In this way the flow is regulated without bunching and congestion which used to occur previously.

APPENDIX VI

INVENTORY CONTROL

by

R. S. Chadda

I. INTRODUCTION

Inventory is as old as man, its range and importance depending upon his requirements. The primitive man's inventory consisted of a few tools; as a shepherd, man had to tend his flocks and herds; later, he had his granaries and warehouses; today, with industrialisation, his inventories cover a very wide range. As man has progressed and his needs and activities have multiplied, the range of inventory has become larger and more diversified.

In past centuries, an individual's wealth was usually assessed by the size of his flocks, herds, granaries and warehouses. In other words, wealth and stocks were well-nigh synonymous terms and money was considered as merely an additional class of merchandise. Accordingly, inventories greatly in excess of the amount needed to carry on the processes of production and distribution were welcome as a sign of prosperity and respectability. Since the advent of modern industrialism, however, wealth has become more and more identified with money. An increased emphasis on liquidity has led businessmen to hold cash and securities in preference to inventories. There has been a strong tendency towards holding the means to purchase goods and services rather than the goods themselves. Large inventories are now viewed with alarm, whereas, in former times, no one would ever have doubted that such surpluses were beneficial. Inventories are now often referred to as the graveyard of business, as surplus stocks have been a principal cause of business failures.

There has thus been a complete change in the outlook in regard to inventory holdings. Several factors account for the transition to conscious and scientific inventory control; these include the increasing size of business establishments, the wide variety and complexity of modern requirements, the urgency of present-day requirements, and the vital difference between industrial economics of the present century and trading and agricultural economics of the past centuries.

II. THE NEED FOR CONTROL

Materials costs add up to more than 60 per cent of the manufacturing cost. Accordingly, small changes in materials costs can result in large sums of money saved or lost.

The objective of a business enterprise is to secure a reasonable return on its capital investment.

$$\text{Return on capital} = \frac{\text{Profit}}{\text{Capital Investment}}$$

Return on capital is a product of two factors, profit margin (profit/sales) and capital turnover rate (sales/capital). In other words,

$$\text{Return on capital} = \frac{\text{Profit}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Capital}}$$

Profit margin depends so largely on external factors that management has not much control over it. Moreover, the interests of Government being invariably broader than those of private enterprise, the price policy followed by some at least of public sector enterprises may be such as to leave little or no profit margin. In the case of Hindustan Insecticides Limited, for example, the product of the D.D.T. Factory at Delhi is sold on a 'no profit no loss' basis. But whether a business enterprise belongs to Government or to private individuals and whether it is run purely as a commercial concern or to subserve broader national interests, it must be run efficiently and there is no index of efficiency of management more significant and comprehensive than the capital turnover rate. For a given volume of business, this rate is maximum when the capital investment is minimum. Now, capital is partly fixed and partly working. Capital investment is fixed assets, such as buildings, plant, machinery, etc., is fixed anyway and very little can be done to reduce it. That leaves us with working capital by far the most of which is invested in inventories. Fortunately, inventory investment is most responsive to control. Studies made by the Industrial and Mining Team of COPP indicate the feasibility of considerable reduction in inventories, sometimes as much as 50 per cent or even more. Inventory investment is, therefore, a fruitful area for control with a view to reducing capital investment. It also follows that a satisfactory capital turnover rate means, in practice, a satisfactory inventory turnover rate.

Inventories not only tie up a sizeable part of the total capital, but also cost a good deal to carry them. Inventory-carrying-cost is a hidden cost but nonetheless it is considerable. The annual cost of carrying inventory—this cost includes interest on capital, storage and insurance, handling and distribution, physical deterioration or its prevention, obsolescence, etc.—may vary from 15 to 25 per cent of the value of inventory. Apart from this cost, there is the question of finding finance. A business concern may be willing to pay 6 per cent or even a higher rate of interest, but it cannot raise unlimited funds. Capital being scarce, its opportunity cost is much higher than the market rate of interest. By opportunity cost is meant the cost that we incur in withdrawing funds from a productive activity to invest them in inventories. If the rate of profit in an industry is, say, 20 per cent, then the opportunity cost of capital in that industry is 20 per cent and not the out-of-pocket cost of obtaining funds. Capital is in short supply in this country. There arises, therefore, the question of priorities and of making the best use of the limited available funds. It is desirable then that in calculating inventories to be carried, we should adopt the opportunity cost of capital rather than the market rate of interest.

A reduction in inventory investment secures a double gain. As has already been said:

$$\text{Return on capital} = \frac{\text{Profit}}{\text{Capital Investment}}.$$

With inventory investment reduced, the denominator in the above equation diminishes, raising the rate of return. Again, as inventory investment declines, inventory-carrying-cost (which is a revenue cost) also declines, raising both profit and the rate of return on capital. One of the potent ways of raising return on capital is to control inventories.

Inventories are carried with a view to minimise idle time caused by shortages of raw materials and spare parts and to maximise customer service. This is necessary because breakdowns, shutdowns and failure of customer service are costly. At the same time, it is also costly to carry surplus inventories. Since both shortages and surpluses are costly, it is necessary to balance one against the other. Arriving at the happy medium between too much and too little stock is a tremendous feat. Left to themselves, inventories have a tendency to grow and to grow beyond economic limits. There is a reason and that is that breakdowns and shutdowns are not only costly (as surpluses too are) but also very conspicuous, so that they attract immediate and adverse attention and criticism. Excessive stocks, on the other hand, attract little attention and give no warning signs. Surpluses are in a way pleasant and not painful; production is unhampered by material shortages, purchasing is easy and sales managing is a delight. There is a tendency, therefore, to avoid shortages at all cost and ignore surpluses until they become unbearable. Therein lies the need for conscious inventory control with a view to keeping inventories at optimum levels.

The need and scope for control is particularly great in public sector enterprises where, for various reasons, inventory levels are much higher than in the private sector. A recent study by the Committee on Plan Projects discloses that inventories in the public sector enterprises in full operation are proportionately much higher than those in the private sector.

III. Inventory Characteristics

A general characteristic of most inventories is that some items have a much higher annual usage value than others. Inventory-control must, therefore, be preceded by value-analysis. A very effective tool for this is "A–B–C Analysis", which separates inventory items into three classes:

"A" items are the few major ones that tie up most of the inventory investment;

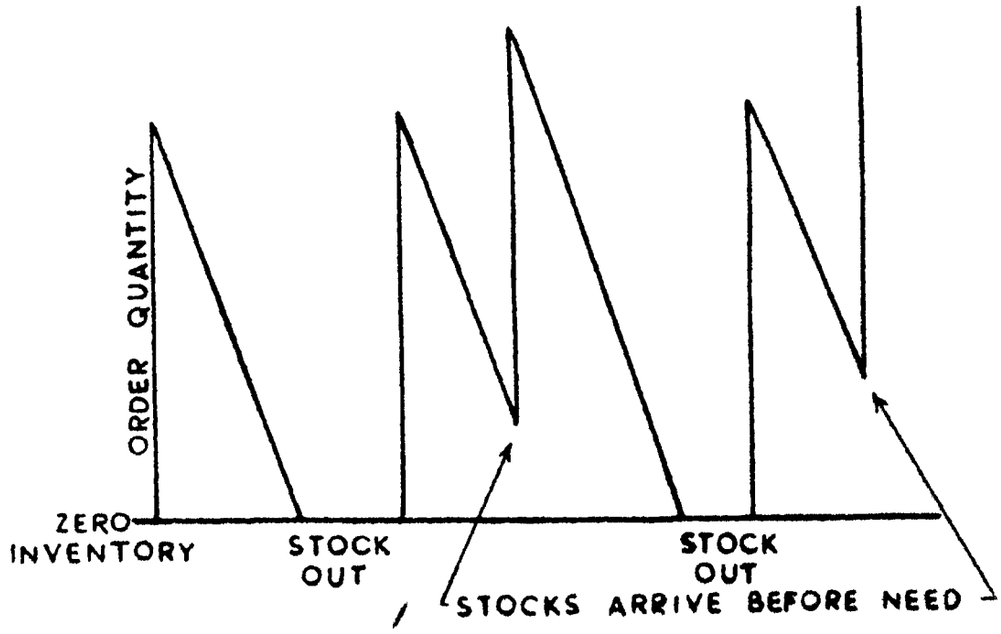
"B" items are those of secondary importance; and

"C" items are the numerous but inexpensive ones that make up only a minor part of the inventory investment.

"A–B–C Analysis" helps to concentrate effort in areas which need it most. In respect of 'A' items, careful attention is paid to estimates of requirements, purchase-scheduling, protective stocks and prompt receipt and inspection. Their deliveries are arranged on weekly, daily or even hourly basis. The safety-stock of these items is minimised. The inventory-investment required to eliminate (*a*) stockouts and (*b*) the need for expediting would be relatively large; therefore, these items are frequently reviewed and a close watch is maintained on the progress of replenishment orders. It is worthwhile to spend the money for detailed control and expediting of these items to avoid running out of stock while still reducing the need for large safety-inventories.

On the other hand, on the numerous but inexpensive 'C' items, control is comparatively relaxed. An abundant buffer-stock is set up because it can be carried quite economically and six months' or a year's supply is ordered at a time. The inconvenience and expense of expediting receipt or manufacture of items, or of holding up production in the event of a stockout, makes it worthwhile to hold large safety stocks. In the process of relaxing control over these low-value items, some companies go to the extent of even dispensing with inventory-records. A 'C' item bin is physically divided into two unequal sections, the larger carrying the working inventory, and the smaller the buffer-stock. No receipt-withdrawal-balance records of the item are kept, so that bin cards and stock ledgers are dispensed with. When the larger section of the bin is emptied and the storekeeper is obliged to draw upon the smaller part, he initiates action for placing another order. Thus, detailed paper-control is substituted by simple visual control. The time, effort and money saved on 'C' items is more usefully spent on 'A' items.

Another characteristic of inventory is that it may be divided into two parts. One is "working" stock, created by the quantities ordered. If we depend entirely on "working" inventory, the result would resemble the following figure:



Because leadtime or usage, or both, will vary, our new order would sometime arrive before it is needed and sometimes after. As a matter of fact, we would expect one to happen as often as the other. In other words, the probability of stockouts would be 50 per cent when there is no safety-stock. So, we maintain safety-stock, and re-order at a point where the stock on hand equals the leadtime usage plus the safety-stock.

If no safety-stock is provided, stockouts arise inevitably whatever be the purchase quantity with which we start. Now stockouts are not only costly but highly embarrassing in that they attract criticism and adverse attention. The result is a scare. This scare leads to inflation of estimates of requirements. In the end, safety-stock does get provided but in an unscientific way and the result

is that while some items are excessively stocked, others continue to face shortages. In other words, shortages and surpluses go hand in hand. What we have to realise is that shortages and surpluses are the obverse and reverse of the same coin—the coin of poor inventory control. If we do not pay adequate attention to the provision of safety-stock, we have to face shortages and stockouts which are both costly and embarrassing and also excesses which tie up unnecessary capital, add to storage and handling costs, involve obsolescence losses and, last but not the least, lead to wasteful practices. When an item or a spare part can be had for the asking, no one is careful about its use. Overstocking leads to higher consumption, partly unconscious and partly even conscious.

IV. Economic Order Quantity

The average stock of an item is given by $I = S + Q/2$

Where

S—is the safety stock and

Q—is the usual order quantity.

The economic order quantity can be calculated by using an "economic lot size" or "economic purchase quantity" formula. One of the simplest and most commonly used formula is in the following terms:

$$OQ = \sqrt{2AS/I}$$

where

OQ=Optimum lot size or purchase quantity,

A=Annual usage in rupees,

S=Cost of placing an order (for purchased goods) or set up cost (for manufactured goods), and

I=Percentage of total inventory value spent annually to maintain inventory.

The value of 'S' can be determined for purchased goods as the cost per item of requisitioning, purchasing, receiving and the like; for manufactured goods, it would simply be the unit set up cost. The value of 'I' which is expressed as a percentage, is derived by adding up the various costs associated with owning an inventory for a year and dividing the same by the average value of the inventory for the year. Inventory-carrying-cost includes such constituents as interest on investment, deterioration, obsolescence, handling and storage charges, insurance, etc. Since buying cost and carrying charges vary only with the number of orders and with the value of purchases and not with the nature of the item to be purchased, it is not necessary to calculate the economic order quantity for each and every individual item. For everyday use, it is possible to incorporate economic order quantity data for different levels of annual usage into tables which need not be changed so long as the values of 'S' and 'I' remain the same

An illustrative table incorporating economic order quantity and cost data for only seven values of annual usage is given below. (Assuming S=Rs. 10 per order and I=20 per cent.)

Annual Usage	Economic Order Quantity	
Rs.	Rs.	Time Supply
40,000	2,000	18 days'
10,000	1,000	5 weeks'
8,100	900	6 weeks'
4,900	700	7½ weeks'
1,600	400	3 months'
900	300	4 months'
100	100	one year's

The following conclusions flow from a study of the table:

(*i*) In respect of low unit value items with relatively low usage rate, the cost of possession is small and for optimum results, buying cost has to be brought down to the level of that cost so that purchases have to be made infrequently. On the other hand, in respect of items with high usage value, between buying cost and inventory cost, it is the latter that is really significant and to bring it down to the level of the former, inventories have to be carried at a low level, and consequently, purchases have to be made frequently in small lots.

(*ii*) In regard to costly items, involving substantial annual consumption, the only way to keep to economic order quantities is to enter into running or rate contracts with standing arrangements for frequent but short term supplies. If this is not done, and consequently for every purchase quotations are invited to determine the most suitable supplier and the best price, purchases will have to be made in lot sizes much larger than optimum and, therefore, highly uneconomical.

(*iii*) Barring low unit value items whose annual consumption is insignificant, there is little prospect of an industrial unit in India buying in quantities lower than the economic order sizes. For this reason and also for the reason that total buying cost is generally fixed so that reduction in total overall cost reduces itself to reduction in inventory-carrying cost only, the ideal should be to achieve as high a rate of turnover as practicable.

V. Optimum Review Period

There are essentially two re-ordering systems. One is the two-bin system or the system of fixed order quantity. Under this system, each item is stored in two bins, the first bin containing stocks to satisfy demand between the arrival of one order and the placing of the next order. When the supply of stock in this bin is depleted, a re-order is placed for a pre-determined quantity. The second bin provides supplies during the procurement period. The total amount of stock in the second bin may be divided into two components, namely, (*i*) the amount intended to satisfy mean expected demand during the procurement period, and (*ii*) a safety allowance. In the other system, the order quantity varies but the order interval is fixed. A fixed period of time is established at the end of which the item concerned is re-ordered in quantities varying with the current demand for that item. When this system is used, inventory of any item can be divided

into (*i*) the amount intended to satisfy mean expected demand during the interval between the placing of two consecutive orders or the review period, and (*ii*) a safety allowance.

Of the two systems, the fixed order quantity or the two-bin system is the better to adopt. The most desirable quantity to re-order for any given item or its economic order quantity has already been discussed in the preceding part of this paper. Under the fixed order interval system what is necessary is to determine the optimum reivew period or interval between two successive orders. This period (in months) is given by the following formula:

$$N = \sqrt{\frac{24S}{IM}}$$

in which

N=Length of review period in (months),

S =Ordering cost (in rupees),

I =Holding cost as a percentage of inventory value, and

M=Average monthly usage (in rupees).

Having determined the order interval 'N' according to this formula, the order quantity 'Q' in rupees, may be determined quite easily by the formula

$$Q = MN$$

$$\text{or } Q = M\sqrt{\frac{24S}{IM}} = \sqrt{\frac{24MS}{I}}$$

Since 12M=A (annual usage),

$Q = \sqrt{\frac{24S,}{I}}$ which is the economic order quantity formula developed in the preceding part.

VI. Provision of Safety Stock

Safety stock, defined as the difference between the amount stocked to satisfy demand during a certain time interval and the mean expected demand for that period, is for the purpose of providing protection against depletion. If demand remained constant and lead time were invariable, there would be no shortages. A fixed amount would be re-ordered at fixed intervals. However, where demand is uncertain or fluctuating, it is not possible to keep both the size of orders and the interval between orders fixed. A common way to approach re-ordering problems in the face of uncertainty is to fix the size of the order placed, and then let the ordering frequency vary to take up fluctuations in usage. This is the fixed order quantity system. Another common method is to fix the ordering frequency or the length of time between orders and then let the size of orders vary with usage. This is the fixed order interval system. In either case, an extra amount of inventory must be carried to fill unexpected demands resulting from surges in usage rate and/or delays in obtaining replenishments. Consider, for example, the two-bin system. If usage rate rises, the re-order point will be reached sooner than expected. But it will also cause stockouts in the leadtime period if the re-order level is just equal to expected normal

demand during the period. The position will be further aggravated if the leadtime period itself lengthens as a result of delays. That is the reason why the re-order point usually consists of the following two elements:—

(*a*) the average volume of use during the normal leadtime, and

(*b*) the additional quantity or safety factor to cover any unanticipated increase in the rate of use or in the leadtime.

The exact quantity of safety stock of an item depends upon its leadtime, usage value, variability of leadtime demand, carrying charges and the importance of the item which may be measured in terms of its stockout cost.

The optimum level of safety stock is determined by consideration of the costs and benefits of storing additional units. As units are added to safety stock, the probability of stockout is reduced, and hence costs resulting from stockout are incurred with a smaller probability. But holding costs such as interest, deterioration, obsolescence, storage, handling etc., rise as the safety level is raised. At some level of safety stock the costs of holding an additional unit are balanced by the expected savings through avoidance of stockout. This level is the optimum level, for a net loss results from moving away from it in either direction. The optimum safety stock level is given by the formula:

$$P\ (Z \geqslant x) = \frac{C}{C+S}$$

where

C=Cost of carrying a unit of stock for a unit of time,

S=Out-of-stock cost per unit for a unit of time, and

P ($Z \geqslant x$) = The probability with which the demand 'Z' will be $\geqslant x$, the level of inventory.

$\frac{C}{C+S}$ gives the allowable rate of stockout.

In the fixed order interval system, safety stock has to provide protection against random variations in demand in the review period as well as in leadtime. On the other hand, in the fixed order quantity or two-bin system, there is built-in safety in that the replenishment interval between two successive orders varies to take care of variations in the rate of demand. For example, if the economic order quantity is six months' supply at anticipated demand so that the expected replenishment interval is six months, it will be reduced to three months if the demand rate rises two-fold. In other words, the re-order level will be reached in half the expected time. Similarly, the replenishment interval will lengthen if the rate of demand goes down. In the result, safety stock has to provide protection against variations in demand in leadtime only. Between the two systems, therefore, safety stock is higher in the fixed order interval system than in the fixed order quantity system.

APPENDIX VII

VALUE ANALYSIS AND STANDARDISATION

by

A. R. Palit

I. VALUE ANALYSIS

What is value analysis?

Value-analysis is concerned with ascertaining whether the materials or item purchased is good value for money for the required purpose or end use. For example, the purchaser may be paying quite a reasonable price for an article, and yet it may be too expensive for the ultimate objective.

Suppose someone were building a house and wanted hinges for the doors. He may be able to procure silver hinges at bargain prices, but silver hinges would be too expensive for the purpose. Hinges of aluminium or brass would obviously be more economical.

It should also be remembered that for value-analysis one should think in terms of 'function' rather than think of just buying an item. For example, one does not buy paints *qua* paints, one buys surface protection.

The technique of value-analysis requires investigation to ensure that the buyer is obtaining the most economical material or equipment suitable for the end-product or end-use. The approach is concerned less with price-negotiation and bargaining than with the right quality, design, specification, standards, and methods of manufacture, it naturally involves the substitution of material or component obtainable at a lesser price or of better quality.

The concept of value-analysis is not new. It is used almost unconsciously by all shrewd purchasers in many transactions. Take the case of the housewife. She goes to the market to buy a kilo of tomatoes but finds their quality poor and their prices high. She may bargain with the seller and get the cheapest market-price, which may be, say, Rs. 1·50 per kilo. While according to prevailing market-rates she would not be paying too high a price, it will be too high for the purpose for which she requires them—making soup. She might find that peas are cheaper, and excellent in quality. By changing from tomatoe soup to pea soup, she can make soup at, say, half the price or even less. This is value-analysis in practice.

Nevertheless, there is a difference between value-analysis used without a conscious realisation of its objectives as against its full implication being understood and its techniques being applied systematically and deliberately.

Value-analysis is a comparatively recent aid to purchase-management, but it has already become popular in many countries. In India, it has not found wide application yet, but it offers excellent scope for cost reduction. One of the major applications of value-analysis in India will be in the substitution of

indigenous materials and components and equipment for imported ones. Purchase-organisations, large or small, should be able to find at least a few items suitable for value-analysis. Some time cost-reduction on one item alone may pay handsome dividends.

In practice, it will be advisable to start with simpler items and to work up to more complicated ones. It is more than likely that for a number of items, cost-reduction by value-analysis may not be possible; but with proper indoctrination in its techniques and objectives, not only among the purchase personnel but also among the using departments and engineering and design departments, more and more items will yield profitable results. All those concerned with cost-reduction—purchase officer in particular—should always be on the watch for the possibility of applying value-analysis.

Questionnaire for value-analysis:

A list of 10 questions was formulated by the General Electric Company, U.S.A., for value-analysis. These were expanded as follows for use in India by the Eastern Purchasing Journal:

(*i*) Does this item add anything desirable to the end product? If not, can it be eliminated altogether?

(*ii*) Is this item the only one suitable for the end use? If not, what are the alternatives, and are any of them better or cheaper?

(*iii*) Is this item a standard one as regards specification, size, shape, type etc.? If not, will a standard item serve the purpose?

(*iv*) If several types are to be purchased, is it necessary to buy all the different shapes, sizes, type, etc., or can the number of sizes, shapes, etc. be reduced?

(*v*) Is the cost of the item reasonable in terms of its contribution to the end product or end operation? If not, can it be modified (for greater economy or usefulness) or substituted by something cheaper?

(*vi*) Is the quantity purchased the most economical in view of the ultimate cost and long term benefits?

(*vii*) Is the item of the right design? Are the specifications and toleranoes too strict? Does the item need all of its features?

(*viii*) Is the method of manufacturing the item too expensive and can a useable item be manufactured by a cheaper method? Is the item being made by using proper tools? Can it be manufactured at a lower cost by the supplier if the quantities procured at a time are increased or if long term contracts are placed for large quantities, enabling the supplier to use better tools or method of production?

(*ix*) Does the analysis of the reasonable costs of material and production and profits roughly equal the price quoted? If not, further investigation is needed.

(*x*) Can the item be manufactured more profitably in one's works? Alternatively, can an item which is being manufactured in one's works be purchased more profitably from outside.

(*xi*) Is the present source of supply the best? Can another dependable source supply at lesser price or better material at the same price? Is any other organisation buying it for less, and if so, from where?

(*xii*) If the item is being imported, is it possible to get an indigenous source by

(*a*) substitution,

(*b*) lowering or amending the specifications,

(*c*) changing shapes, sizes, types, etc.,

(*d*) changing manufacturing and tooling methods,

(*e*) by placing bulk orders on a long term basis,

(*f*) by combining the requirements with other manufacturers and jointly placing bulk orders,

(*g*) financing a suitable potential source,

(*h*) by assisting a suitable source to acquire 'know-how' wit foreign collaboration and otherwise,

(*i*) by contacting the Development Wing of the Ministry of I dustry for the latest developments relating to the item or i substitutes?

(*xiii*) If the item is obtainable indigenously but from a distance, can a local manufacturer be interested on the lines as indicated in item (*xii*) above?

(*xiv*) If the item is being manufactured indigenously, but is either in short supply or available only at an unreasonable price, can another source of supply be developed on the lines as indicated in item (*xii*) above?

Other questions will come to the mind of the value analyst with experience. In the end, each organisation will have to develop its own technique.

I would like to emphasise that value-analysis can reveal the possibility of a reduction in price which price analysis cannot, even in a competitive market. The approach is quite different. Heinritz mentions a typical case: a firm was buying certain steel pins of 5/16 in. diameter at 20 cents per piece from the lowest tenderer, others having quoted 22 to 27 cents. However, when the Purchase Officer applied value-analysis and tried to find out what the price should be in terms of reasonable cost of material and manufacturing cost and reasonable profit (see item *ix*) he came to the conclusion that the item was overpriced. However, he found that the pin could not be produced in his company's own works for less than 30 cents. According to the normal rules of purchasing, therefore, 20 cents was a bargain.

Nevertheless, in accordance with the principles of value-analysis, the Purchase Officer investigated at the manufacturer's works. He found that the pin was machined in two operations from a 7/16 in. diameter rod. This wasteful and costly operation was necessary to provide the required sharp pointed hole. After a thorough examination of the problem it was found that an impression only half as deep would suffice. This could be manufactured directly from a 5/16 in. diameter rod saving nearly half the metal. The price of the item was eventually reduced to 11½ cents which meant a saving of 38 per cent.

What could be value-analysed ?

The question may arise as to what type of items may be subjected to value-analysis. The answer is that almost any type can be value-analysed.

In a study on 350 items by General Electric Company, the following were included:

(*i*) Raw and semi-processed materials;

(*ii*) components, parts, fixtures and fittings and supplies;

(*iii*) production tools;

(*iv*) plant and machinery;

(*v*) ancillary equipment;

(*vi*) finishing materials;

(*vii*) packing materials;

(*viii*) maintenance, repairs and operational materials;

(*ix*) office equipment and supplies;

(*x*) materials handling equipment; and

(*xi*) transportation costs.

Examples of value-analysis :

We have collected a number of examples of value-analysis from both Indian and foreign sources which have been displayed in charts in the lecture room. It will be seen that in some instances value-analysis actually suggested purchase of a higher priced item for achieving reduction of ultimate costs.

Organisation for value-analysis :

Unless there is a formal set-up for value-analysis satisfactory results will not be achieved. Recently, a firm in Western India has started a value analysis cell. In the first two months it has been able to save over Rs. 50,000 at an outlay of less than Rs. 1,000 per month.

It must be remembered that value-analysis should be recognised as a team work and that it should be the responsibility of someone who is not tied up with normal routine duties. It should also have firm support of the top management.

As far as possible, value-analysis should be started at the pre-design and pre-production stage. In many instances it will be difficult to organise value-analysis once the design of an item has been approved for production and it has been engineered for production.

II. Standardisation

Here we are concerned with standards not so much from the quality point of view but from the cost point of view. A large number of value-analysis queries are concerned with standardisation. For example, question Nos. iii, iv, vii, xii xiii and xiv on value-analysis. Standardisation whether national, industry-wise or company-wise, can reduce costs in a very large number of cases.

There is another aspect of standardisation which may be called simplification or variety reduction. Whereas value-analysis programmes are usually designed to reduce the cost of an item, a standardisation programme may eliminate the item entirely. Brynt Electric Company, Bridgeport, Connecticut,

reviewed 1,447 items carried in stock and found it could eliminate 794 of them. (Source: Materials Management by Dean S. Ammer). In the two years since the standardisation was started, their saving was estimated at $ 102,000.

We have collected a large number of examples of simplification both in India and abroad. Some of the spectacular contributions in India have been made by the Indian Standards Institution.

Co-operation with the Indian Standards Institution for the evolution of suitable Indian standards, development of company standards and simplification of unnecessary items are essential for any cost-reduction programme.

There is another aspect of standardisation that is pre-design and pre-production standardisation. Very often value analysis becomes difficult after an item has already been designed and its production has been engineered. Preventive value-analysis and examination of standards before perpetuating the design or production programme will go a long way towards reducing the materials costs and improving quality.

The quality factor :

Last of all, as we know, out of the five essentials for purchasing, 'quality' is the foremost and that is where standardisation comes in. It enables us to get the best quality at the lowest price and with assurance of quality compliance. One of the major objectives of materials management in future will be to produce quality items at lower costs. Active cooperation with the Indian Standards Institution is, therefore, of utmost importance.

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