INTRODUCTION

Beamtronics is a medium sized electronic equipment manufacturer. Established in 1976 with Japanese technical collaboration, it specialized in the manufacture of a family of special electronic items called Beam Tubes (BT) which are widely used in various kinds of sophisticated electronic equipments and systems. It was licensed and approved by the government mainly because it saved foreign exchange. Beamtronics picked up sales as it started production and enjoyed considerable monopoly in the market during the late seventies and the eighties. Its customers mainly included telecommunications and electronic industry in public and private sector and government departments.

In the beginning, there was considerable fluctuation in its production programmes as it was difficult to estimate the monthly requirement of various organizations against their annual demands. As the production at Beamtronics started stabilizing, the production planning method was standardized. Currently, weekly sales forecasts are being drawn up. Since the production plans and programmes are first launched in the Assembly Department, the performance of the later becomes the key elements in their success. Efficient functioning of the
Assembly Department is dependent much upon the way in which the skilled workers are assigned to the production of sub-assemblies and assemblies. The general arrangement of the shop is shown in figure 1.1. There are some distinguishing features of the skilled man power in the assembly department.

**SKILL MIX IN MANPOWER OF THE ASSEMBLY DEPARTMENT**

The assembly shop performs not only assembly operations but also fabrication activities for intricate parts which go into the final assemblies. The workers in the shop are grouped according their skills and certain groups of workers are engaged in assembling particular types of assemblies. A few among these workers are highly versatile and can perform a wide variety of assembly operations. Certain sub-assembly operations need more skilled work then the others.

There are some cases where a certain worker cannot be assigned to a particular sub-assembly operation. The reason for this may be lack of ability, deficiency in technical knowledge, lack of training or inadequate experience.
THE PROBLEM

The present practice of assigning workers to job is mainly on hunch and the judgement of the supervisors in the shop. The difficulty in doing this mainly arises due to the differences in the capabilities of the workers. It very frequently happens then the production plan for a few products can be met completely, and completely ignored for the others. Some times assemblies in excess of the demand can also
be produced. On the other extreme, for certain assemblies the production plan cannot be met due to shortage of a particular skill, even though some manpower is available in the shop in other skills.

The supervisors in the assembly shop find it extremely difficult to strike an optimum balance between utilization of worker hours (man-hours) and maximum realization of the production plan.

At present, in the Assembly Department of Beamtronics, the overall demand for manpower is marginally higher than the available capacity to produce. The department receives rush orders at short notice and these constitute about 25 per cent of the regular orders accepted for undertaking assembly work. The particular problem facing the manager of the shop is to allocate workers to various sub-assembly operations for normal orders based on the production plan, and simultaneously handle these rush orders during each planning period.

In general, a subset of workers can perform an operation and a worker can perform a subset of different operations. However, a few workers are very versatile and can perform a wide variety of these operations. Further, certain operations can be performed by only one worker, through every worker can perform more than one operation. This obviously makes some assembly/sub-assembly operations more critical than the others.
DETAILS OF ASSEMBLY OPERATION

The Assembly Department handles many products. Table 1.1 displays comprehensively the details of the assemblies produced, sub-assembly operations involved, operators (workers-coded in numerals) performing them, quantity of sub-assemblies required per assembly. The production rate for each sub-assembly is depicted as output/day.

<table>
<thead>
<tr>
<th>Assembly Code</th>
<th>Sub-assembly</th>
<th>Workers code</th>
<th>Quantity per Assembly</th>
<th>Normal Output per day</th>
<th>Demand Output per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Tube assembly</td>
<td>9,10,12,13</td>
<td>1</td>
<td>30</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14, 19,15,7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anode assembly</td>
<td>Anybody</td>
<td>1</td>
<td>250</td>
<td>225</td>
</tr>
<tr>
<td>02</td>
<td>Tube assembly</td>
<td>9,10,12,13</td>
<td>1</td>
<td>30</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14,15,3,4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>276 Shield</td>
<td>Anybody</td>
<td>1</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Tube assembly</td>
<td>10,13,14,11</td>
<td>1</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Anode assembly</td>
<td>Anybody</td>
<td>1</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Tube assembly</td>
<td>10,13,14</td>
<td>1</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>281 Shield</td>
<td>Anybody</td>
<td>1</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Component</td>
<td>Quantity</td>
<td>Column 1</td>
<td>Column 2</td>
<td>Column 3</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>05</td>
<td>Tube assembly</td>
<td>10,13</td>
<td>1</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Anode area welding</td>
<td>5,6</td>
<td>1</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>126 Anode assembly</td>
<td>4</td>
<td>1</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Tube assembly</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>134 Shield</td>
<td>4,10</td>
<td>1</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>07</td>
<td>Tube assembly</td>
<td>10</td>
<td>1</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>186 Shield</td>
<td>4,10</td>
<td>1</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Mount 1</td>
<td>1,2,5,6,8</td>
<td>1</td>
<td></td>
<td>96</td>
</tr>
<tr>
<td>08</td>
<td>Tube assembly</td>
<td>9,10,12</td>
<td>1</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Filament FC-25</td>
<td>16</td>
<td>1</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Anchor</td>
<td>24,26</td>
<td>2</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>09</td>
<td>Tube assembly</td>
<td>4,5,6</td>
<td>1</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Anode assembly</td>
<td>19</td>
<td>1</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>10</td>
<td>Tube assembly</td>
<td>7,8</td>
<td>1</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Filament</td>
<td>12,14,16</td>
<td>1</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Grid 1</td>
<td>10</td>
<td>1</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Grid 1</td>
<td>11,15</td>
<td>1</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>11</td>
<td>Tube assembly</td>
<td>9,11</td>
<td>1</td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Filament</td>
<td>9,16</td>
<td>2</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Grid</td>
<td>9,10,15</td>
<td>1</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Anchor</td>
<td>14,16</td>
<td>4</td>
<td></td>
<td>192</td>
</tr>
<tr>
<td></td>
<td>Sealing met 1 L</td>
<td>8,9,10,11,16</td>
<td>1</td>
<td></td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>Cup assembly</td>
<td>Anode assembly</td>
<td>Tube assembly</td>
<td>FC-85 filament</td>
<td>Grid</td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
<td>----------------</td>
<td>---------------</td>
<td>----------------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td>1</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Tube assembly</td>
<td>9,10,11</td>
<td>1</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Filament</td>
<td>16</td>
<td>2</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Tube assembly</td>
<td>7,3,2</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Filament</td>
<td>2,3,1</td>
<td>1</td>
<td>6</td>
<td>10.5</td>
</tr>
<tr>
<td>14</td>
<td>Tube assembly</td>
<td>17,18</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filament</td>
<td>17,18</td>
<td>8</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Tube assembly</td>
<td>17,18</td>
<td>8</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filament</td>
<td>17,18</td>
<td>8</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Tube assembly</td>
<td>1,8</td>
<td>1</td>
<td>12</td>
<td>4.5</td>
</tr>
<tr>
<td>18</td>
<td>Filament</td>
<td>17,18</td>
<td>18</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
### Manpower for Rush Orders

The clients and the product of Beamtronics are such that the urgent or rush orders cannot be avoided and are a normal feature of the demand system; and further, they occur randomly. To allow for this situation, Beamtronics has a policy that such special rush orders be accepted and completed on priority. To this end, the Assembly Department is required to keep 25 per cent of manpower from versatile workers for each period, nationally unscheduled, for attending to this rush orders. Seventy five per cent of the manpower is assigned for the various sub-assembly operations for meeting the assembly demand as per the production plan for that week.
Non-inventoriable Nature of Sub-assemblies

The assembly shop at Beamtronics is not permitted to produce sub-assemblies in excess of the requirements. This precludes sub-assemblies being inventoried and used later. The technical reasons for this are two-fold.

1. If the number of production of sub-assemblies is greater than that needed to produce the required number of assemblies, there would be an excess of inventory of sub-assemblies or components, which would need a costly rework operation, if not consumed immediately after production.

2. Storing of sub-assemblies only, over a period of time make them unsafe.

Hence, according to the guidelines set by various industrial safety agencies, Beamtronics requires that sub-assemblies should not be kept as inventory. Sub-assembly inventory either in an unfinished stage or as finished product in excess of requirement would be a cause for major hazard. Therefore, all sub-assemblies produced should be used up immediately. The assembly shop management is required to alert and initiate steps such that all items go through the full rework process from the start.

It follows, therefore, that all relevant sub-assemblies produced should be exactly equal in number to those required to meet a specific number of assemblies.

Further, certain categories of manpower available maybe in general, greater than the requirement and in certain other categories, maybe less than the
requirement of the forecast. Such a situation cannot be avoided as the forecast of demand may vary from week to week and a stable balanced manpower skill is not feasible. This double imbalance causes considerable problems while workers are assigned to sub-assembly/assembly operations.

To summarize, for the situation under consideration, each worker should be allotted the required time to complete the individual sub-assembly operations. The different sub-assemblies, which go into the making of the final assembly can be made in integer amounts. There would be no incomplete or completed excess items. If this is not possible to be achieved, particularly in some cases due to non-availability of allotable man-hours with a worker, the other compatible workers might be selected.

**MANPOWER ALLOCATON TO ASSEMBLY OPERATIONS**

In the event of all these considerations failing, any other different judicious amount of time can be allotted for the worker. Consequently, the production quantity in the plan for that week and for that particular assembly item, ha to be reduced.

Beamtronics was in search of an optimal procedure for allotting skilled man-hours in the department to various sub-assembly operations, to meet the production plan (demand) to the maximum extent possible, subject to the constraints and requirements given below.
1. Since notionally there are two categories of skilled workers—versatile and non- versatile a small portion (say 25 per cent) of the man hours available from versatile workers should be kept free to attend to rush orders.

2. The manpower allocation should be for the sub-assemblies so that the shop supervisors can make meaningful assignments of operators.

3. (a) No build up of sub-assembly inventory is allowed, since any unfinished sub-assembly in inventory entails costly rework.

(b) Whether or not the forecast is met, the produced sub-assemblies should be in the exact quantities required to make the assembly.

4. Production beyond the quantity on the plan for any assembly is not permitted.

5. The possibility of allocating several workers in part to a sub-assembly and several sub-assemblies in part to a worker should be considered.

**Assumptions**

1. The allocation procedure considers the weekly production plan (demand) for the shop and allocates the workers for normal production.

2. A minimum percentage of time available with skilled workers is reserved for special orders. Time this is not taken into consideration during allocation.

3. Set up time between any two sub-assembly operations is assumed to be negligible.
4. All workers who can perform an operation are considered to have the same efficiency (or in other words the same rate of production per day).

Karthi, a consultant called in for developing an optimal procedure for the solution to the problem, formulated the manpower allocation problem as a linear programme and gave the solution using simplex procedure to the problem as shown in Table 1.2

<table>
<thead>
<tr>
<th>Assembly code</th>
<th>Demand quantity</th>
<th>Completed quantity</th>
<th>Off loaded quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>(B)</td>
<td>(A-B)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>360.0</td>
<td>360.0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>255.0</td>
<td>225.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>40.0</td>
<td>40.0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>48.0</td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>15.0</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>20.0</td>
<td>4.696834</td>
<td>15.303166</td>
</tr>
<tr>
<td>7</td>
<td>15.0</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>48.0</td>
<td>45.9959</td>
<td>2.0041</td>
</tr>
<tr>
<td>9</td>
<td>48.0</td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>39.0</td>
<td>27.894291</td>
<td>11.105709</td>
</tr>
<tr>
<td>11</td>
<td>38.0</td>
<td>27.347642</td>
<td>10.652358</td>
</tr>
<tr>
<td>12</td>
<td>12.0</td>
<td>07.5282324</td>
<td>4.4717676</td>
</tr>
<tr>
<td>13</td>
<td>4.0</td>
<td>1.1999969</td>
<td>2.8000031</td>
</tr>
</tbody>
</table>
The Linear Programming Solution and its Discussion

The Linear Programming (LP) solution gives the allocation results in man-hours. Therefore, it becomes necessary to compute the number of assembly items completed, from this solution.

In essence, the results of the LP solution in man-hours have to be converted into their equivalent assembly items, to arrive at the exact number of assemblies completed.

In the process of calculating the number of such assemblies produced, if the man-hours allocated in the optimal programme equals that required in the assembly demand, than obviously the demand has been met. Thus, the demand (as given in Table 1.1) is what has been produced. If the man-hours allocated are less than those required in the forecast, than the number of assemblies completed is computed as:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>10.5</td>
<td>7.679998</td>
<td>2.820002</td>
</tr>
<tr>
<td>15</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>2.0</td>
<td>0.199998</td>
<td>1.800002</td>
</tr>
<tr>
<td>18</td>
<td>4.5</td>
<td>3.921457</td>
<td>0.578543</td>
</tr>
<tr>
<td>19</td>
<td>0.75</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>938.25</td>
<td>843.71</td>
<td>94.53</td>
</tr>
</tbody>
</table>

(100%)  (89.92%)  (10.07%)
(Man-hours allocated/hours required)* Demand

The results for the process given in Table 1.1 in terms of assemblies completed are shown in Table 1.2.

Thus, to give an idea about the nature of optimal allocation in a condensed form, a tableau representing the assembly demand quantity and that obtained from the LP model is shown in table 1.2.

Case 2

Oskar Manufacturing Corporation

INTRODUCTION

Oskar Manufacturing Corporation produces a wide variety of electrical items, both for the various state electricity boards in the country and for industrial use. Its product range covers motors generators, motor generators sets, switch gear and alternators. It also handles turnkey projects in electrical installation for industrial use. In the 1970’s and 1980’s, it was a well established organization with over 4600 employees and enjoyed a good share of market for its primary products—the power equipments and accessories.

ABC Control Department, One of the smaller divisions of the company, has of strength of 220 employees. It is a job shop manufacturing custom built control equipment and is a part of the larger system engineering division which
deals with large turnkey projects and industrial systems. However, the market share of the corporation for these items was rather small in the early eighties.

ABC has a fabrication shop employing 185 workers engaged in manufacturing activities and there is a highly qualified staff of twenty designers. ABC’s main products are control gears and systems for the turnkey projects and are manufactured mostly against orders from other manufacture. Most of the orders are for single units but many of them are spread over a few years. Generally all jobs call for innovative design and strict Adherences to specifications. Some orders even specify components to be used in the equipment. The division is divided in to four sections. The engineering section is a headed by a senor manager. Four manager looks after design, production, standards and engineering services. The production manager is assisted by a production control engineer. The standards manager is assisted by two engineers who look after material control function, standard, documentations and method development. The drafting section is under the engineer in charge of standards and methods (see Fig. 2.1). During the late eighties, the division was falling short of production targets and the production manager was attributing these to the inadequate production control activity and the position of production control engineer not having been filled for years. As the division was slipping in performance, the divisional manager, in 1990, succeeded in getting recruited a brilliant engineer Mani, who had also an excellent MBA to this credit, to the position of production of production control engineer Mani, on taking over as production controller realized that development of a production control system
involved not only all the managers and production employees of the division but functions like purchase, quality control, sale and maintenance (which were all centralized functions) and that coordination was the essence of control. He set about the task in a methodical manner. He study of the system used the following considerations.

1. Careful observation of actual practices.
2. Study of past data and documents.
3. Discussion with personnel belonging to different section of division.
4. Interviews with divisional heads.
5. Recording views of personnel who were actually interacting with the division.
6. Study of the division’s history.
The information obtained was carefully analyzed. He then categorized the possible problems into the following:

1. Inadequacy of the order processing system including documentation.
2. Inefficiency of the material flow.
4. High degree of rework.
5. Unrealistic production targets.
ORDERED PROCESSING SYSTEM

The customer orders are entertained by the systems engineering division (see figure 17.2). The order acceptance issued by it is the starting point for the activities in ABC division. The order normally specifies a delivery date. Often, jobs are taken up even without an order acceptance. The concerned section of the design office receives the order acceptance and design work starts if no pending work is present. Ordinarily, a fresh order is taken up for design depending on the priorities assigned by the top management.

The duration for developing a decision varies from a couple of weeks to three months and pressure during the progress from the top level usually gets the work through. In case of repeat orders of standard design, the order acceptance goes to the standardization and documentation section. This section locates the drawing and bill of materials of the item.

Material planning, as a rule, starts at the eleventh hour. The exiting procedure is that no material procurement action is initiated until the bill of material is made available. An advance bill of materials is generally sent by the design section if non-standard long lead time items are to be used. A non-standard item is one which is not under perpetual inventory control. Due to the ever prevalent pressure and short notices for supply, the advance bill of material is prepared in a hurry. The ultimate result is that more often than not, the final bill of material deviates from the advance bill.
Fig 2.2 Existing order processing system

The receipt of a bill of material triggers material procurement action for the particular item. The available stock of standard items is checked and a purchase requisition is originated should any shortage exist. The above procurement procedure is the same for non-standard items also. Generally, the procurement lead time far exceeds the time available for procurement. Such a situation has arisen partly due to monopolistic suppliers. Thus, when the pressure mounts, local purchase is resorted to, resulting in high cost and poor quality material.

When 70 to 80 per cent of the material is available, the shop is instructed to start the work. A shortage list is normally present in the job files, and these shortages
may be filled in time. The priorities and pressures from the top management are always present and the shop is forced to start work on items having material shortages. Shortages also result in localized over-loading. Semi-finished items pile up on the shop floor, resulting in poor work flow.

Once the item is completed, it is transferred to the quality assurance section for testing. If the item passes through testing, its value is credited against the department. More than 70 per cent of new orders and about half of the repeat orders are found to be faulty during inspection. Thus, rework is a normal feature of manufacturing in ABC control section of Oscar.

SHOP PRACTICES

The shop is supplied with a monthly production programme. This information is of little use as no work can be initiated in the absence of a job file containing bill of materials, product manufacturing data (PMD) sheet etc. Even in case of repeat orders, action is not taken without a job file. However, in case of priority items or in the presence of pressure from higher up, work is started without the product manufacturing data. At times job files arrive without PMD sheets. The steps involved in production are fabrication, painting, assembly, and writing.

The starting item of control board equipment is a panel structure built up of sheet metal. It is supplied by sub-contractors, and fabrication consists of making of suitable cutouts and providing supporting frames. Painting is generally done as per customer specifications. Once the painting is completed the components are assembled on the structure and are then connected together by writing. Since
almost all the components are bought-out once, any delay in component availability is reflected in the piling up of semi-finished jobs.

The bought-out components are transferred to the mid-store from central stores. The mid-store is under the control of material planning section and components are drawn from the central stores against stores indents. The material issue procedure adopted by the mid-store is an unconventional one. No material issue forms are used and a component is issued against the bill of material. Generally, workers draw the components and keep them in their personal lockers. In case of orders for which more than one unit of a particular unit are required material shortages normally occur for the last units in the order.

The monitoring system operates sporadically. Detailed dispatching or booking is also not done. Work assignment is done as and when a worker reports a completion.

On the basis of his feeling of the problem in ABC, Mani called for a meeting of the divisional manager, four managers, material control engineer, a few designers and shop supervisors to discuss what could be done to improve production control in ABC. The opinions of the participants were summarized by Mani as follows.

System engineering divisional manager: “The ABC division at present is driven by the systems engineering division. We get contracts for packages and certain portion of the work goes to your division. All the required information is generally available with us. But unfortunately, very often our package deliveries are delayed because of delays in ABC. A greater coordination, I believe, is
necessary and the divisional manager of ABC has to somehow obtain better control of its production.”

ABC divisional manager, Raman: “The position of ABC in the production organization makes it highly dependent upon other divisions. The required inputs to the division are to be provided in time, but our division becomes answerable for delays and inefficiencies caused by inadequate inputs. Examples are lack of timely information from system engineering and delays in procurement of strategic components. At present ABC throws open its doors to all customers and visitors. They force access and can stop anybody’s work. Generally, they wander from one section to another and nobody seems to be in a position to provide sufficient information. The situation takes a serious turn when a preferred customer arrives and thus causes a real chaos in the division”.

Design manager, Kelkar: “The design of control gear is always a complex activity. Each order is different. A lot of innovative work is involved. This cannot be done in an atmosphere of pressure. Synthesizing the design with the overall “package” is a highly technical task. We are further jeopardized by last minute changes of requirements in the “packages”. The whole process has very often to be repeated, thus causing considerable variation from estimated times required to complete the design and specifications. However, our products have enjoyed considerable technical popularity”.

Nandi, materials control engineer: “Unfortunately, some people think that material control and production control are separate functions. It is suicidal to segregate these two functions organizationally, particularly in the custom type
production which we are engaged in, as there is little or no raw material stock maintained”.

Sam, manager, standards: “There is a little standardization in procedures and forms used for control. I think during the past two decades we have overgrown the simple informal systems dependent on a few members. Moreover, good work flow is now vital for our division”.

Central purchasing manager: “The items required for ABC division are often special items requiring long lead times for procurement. There is no way the purchasing can get them in a short time. Advance information is required and supply commitments of ABC division should take this into consideration in a pragmatic way”.

Shop superintendent: “Poor manpower utilization is due to poor shop scheduling. Priorities change too often due to executing pressure from system engineering group. When a particular job has been taken up on priority and we are in the final stages of completion we face shortage or lack of strategic components of equipment items that force me to abandon it and take up another. This causes great difficulties in manpower deployment”.

Chandra Kumar, production manager: “Materials planning is not done in advance. The advance bill of materials is often considerably different from the final bill of materials. This makes me take recourse sometime to operating local purchase of some times underquality items, which result in increased rejection and rework which further complicates the question of scheduling and manpower deployment. But I feel the major problem is that the production targets are too
ambitious to be realistic and are thrust upon the division without careful consideration of capacity. This causes continuous failures to meet the target and makes it look chronic”.

Engineer (methods): “I have hearted that in KALI, which is one of our competitors, for a similar if not the same product the custom built division is successfully using materials requirement planning. Why can’t we try that?

Mani, the production control engineer, said “two things perplex me. The production controller being made responsible to the production manager and the non-existence of a master schedule. I think in the new system these should be adequately taken care of”.

Case 3

Solid Waste Handling at MIC

INTRODUCTION

A Metropolitan Indian City (MIC) in the north has established a corporation, which is responsible for various public services such as providing land for housing, water supply, construction of roads, school education and public health.

The corporation is governed by an elected body which is headed by a Mayor. For budget allocations to different functions, standing committees are constituted from the elected corporators. However, during the early 1990’s, as this elected body was not stable due to political reasons, the government took a
decision to dissolve it and appoint an administrator to head corporation activities. The administrator was vested with the powers of the Mayor and of the Chairman of Standing Committees.

After taking over the working of the corporation, the administrator convened many meetings during 1994. In one of these meetings the following functionaries were present - Adhikari, the administrator of the corporation, Varun, Head of the Department of Water Supply and Distribution, Upadhyaya, Director of Public Instruction, Sushrut, Director of the Department of Public Health, which is responsible for a number of primary health centers in the city, Kamraj, chief engineer, Department of Construction, Dhanpal, Commissioner, Revenue Department which is responsible for the collection of taxes from various sources, Singh, engineer incharge of the Department of Solid Waste Management which is responsible for collection, transportation and disposal of solid waste (normally termed as municipal solid waste) and the public relations officer (PRO) was also present.

Adhikari explained the purpose of the meeting. As he had taken charge of the corporation, he wanted to streamline various activities of the corporation and improve the public service. He desired to know the problems and difficulties encountered by various departments so that a plan of action could be developed to sort them out.

During further discussions, most of the departmental heads complained about two major issues:

1. Inadequacy of financial resources.
2. Uncontrolled and unplanned development of the city resulting in an unpredictable increase in the quantum of work.

After getting this information Adhikari asked the PRO’s opinion. The PRO commented that most of the public services were running reasonably well except for some minor discrepancies, which were normally taken care of by various departments after getting a feedback from the public in the form of complaints. However, as far as solid waste management was concerned, a large number of public complaints were received and there was cause for concern.

Singh, the engineer incharge of solid waste management said that he was aware of the situation. He elaborated as follows:

Sir, MIC as you know is a fast growing city. New residential, industrial and commercial areas are being added with great rapidity. The town Planning Department has been very busy for so many years in transforming, developing and beautifying the city, but unfortunately the scavenger of the city that my department is, does not get either forward information for planning or adequate financial support for executing.

While planning collection points, disposal sites and transportation requirements, certain types of data like the forthcoming areas of urban planning, the likely population growths and the broad provisions of SWM are needed. By the time this information comes to me the growth has well neigh taken place and planning becomes redundant. I have to do whatever is possible as a last resort, in haste, under pressure and with little resource.
When I am asking for a modernized technology for SW carries, I am given worn out and lifeless old vehicles from other departments. Also, the number of these vehicles is inadequate. The combined effect is that adequate number of waste clearing visits to each of the collection points cannot be made systematically and then even those which can be done are marred by breakdowns of vehicles. The vehicles are fit for a rally of outdated public transport vehicles.

Regarding the workers who are scattered all over the city, I have the greatest difficulty. The job of collecting and carrying is dirty, whatever one may say about dignity of labour. The workers are without education and, understandably, without motivation. The supervisors can't get work out of them. Added to this, the people in the city, in most areas seem to be so little conscious of keeping their precincts clean. Often, they throw the wastes anywhere other than in bins because they have to walk a few feet. To add to my problems as many as 40 per cent of the households do not have sanitary facilities. The extraordinary growth of the city makes it imperative to go in for an optimum long range plan of disposal sites and processing, and compaction of solid wastes to reduce transportation costs. As practiced now, when the city grows, the old disposal sites are discarded and new ones are located. But in my experience this almost always makes the transportation costs very large. At present we are unable to develop along range optimum plan. I have been asking for some consultancy service to be hired to help us in developing it.
Last, but the most tragic thing, is that the SWM gets a step motherly
treatment from the administration, and the left over of the budget from the other
departments is meted out to it, like the work of left over solid wastes it has to handle.

Under these circumstances the department was doing what is could possibly do, inefficiently.

Adhikari enquired from Dhanraj about the financial status of the corporation. Dhanraj informed him that as the taxation stricture was quite old the revenue collected through taxes was very little. Moreover, the government had abolished octroi and was paying some fixed grant in lieu of octroi, which was very meager. A new tax stricture was prepared and was pending with the government for the previous three years. A higher priority for funding was given by the administration to other departments such as water supply, road construction and maintenance, and primary health centers as these services were considered more essential and vital. However, there was a general feeling that this department was not working efficiently and could be somewhat improved and made to do better within the budget provided for it. Irritated, Singh asked Dhanraj his definition about inefficient operation. Dhanraj started pointing out faults in the system. He pointed out that it was a well known fact that solid waste was not removed in time from the city area. The community bins were either overflowing or their location was such that it was cumbersome to reach the bins for solid waste deposition. It was also seen that the collection vehicles were not visiting
the bins at a regular frequency. In a number of cases, the solid waste was lying for as long as one to two weeks.

Singh explained that as the Town Planning Department was not providing any space for locating the bins, he had to manage such places as would not be objected to by nearby residents. As the transportation capacity was inadequate, he could not ensure timely removal of all the material lying at all the community bins. His estimate of the total requirement for vehicles for collection was around 400, while currently, there were only 211 vehicles and thus he was not able to do the solid waste removal the transportation work adequately.

Adhikari reviewed the situation by discussing various aspects of the system. In his opinion, as this was basically a large material handling system and was to continue for a few decades there was a lot of scope for improvement. He hired a management consultant, Dar, to study the various aspects of the system and suggest some methods to improve it. Dar first discussed the problem with Singh in great detail and prepared a report which included the data of the entire system along with other details. The following is the essence of Dar’s report.

**DESCRIPTION OF THE EXITING SYSTEM**

The city was developed into 11 zones for the supervisory and administrative control. The different functional elements of solid waste management system are given below.
Solid Waste Generation

The city consisted of residential, commercial, institutional and industrial areas. The industries generally recycled and re-used the wastes. Such industrial wastes did not reach the solid waste stream at any place. In these places community bins were being used from where a part of the waste was recycled by the owner and by unauthorized rag pickers. However, as the waste so recycled was not getting mixed with the total solid waste being handled, these did not need to be considered during the planning of the system.

While discussing the quantities being handled, Singh found that in the immediate past study, the number of trips reaching the existing disposal sites were counted, giving the approximate rate of solid waste generation. The rate of solid waste generated was found to be 0.45 kg/capita/day.

Future Projections

The city development authority had already estimated the maximum holding population densities for the planning zones. Within the existing urban limits, according to the estimates, the population was expected to increase from 54.5 lakhs to 84 lakhs, i.e 5.4 million to 8.4 million. Considering this fact, the population in the year 2001 would be 80 per cent of holding capacity. From these estimates the actual population in every future year could be interpolated.

Similarly, for the future, development in all walks of life would be reflected in an increase in solid waste generation rate. For MIC, this increase was assumed to be 1.4 per cent per annum, which is the average figure for an Indian city.
Solid Waste Collection

The waste from individual premises was being deposited in the community bins placed at convenient places at different localities. The work of solid waste collection was carried out under the supervision of an assistant sanitary supervisor in every zone. About 20-25 sweepers were supervised by an assistant sanitary supervisor.

Road sweeping was carried out by sweepers who were provided with necessary implements such as brooms and baskets. The sweeper transferred the road sweeping with the help of wheel borrow to the community bin.

Transportation

The solid waste collected at the community bin was transported by different vehicles to a processing facility or a disposal site. A total of 211 vehicles were provided by the department for this work. The vehicles could be parked at night at six different locations. At some of these locations facilities for minor repairs were available, e.g. servicing and brake and clutch alignment. The major repairs were mostly being carried out by outside agencies.

Processing

During 1980, the MIC corporation installed a mechanical composting plant with a capacity of 150 tonnes per day of solid waste processing. The non-compostable portions from the compost plant were land-filled in nearby low lying areas.

Disposal
Solid wastes were being transported daily to four disposal sites marked as 1 to 4 on the map (Fig. 3.1). The disposal operation normally carried out, was as follows. The solid waste was tipped at the working place by tipping vehicles. A hired bulldozer kept at the site, rearranged the dumped waste and compacted it by a single pass. Every day material was deposited, so that it rose to ground level. At this stage, a 30-40 cm thick layer of either sweet earth or demolition waste was spread. About three months after reclamation, trees would be planted. The reclaimed area, thus, would have an aesthetic appearance.

**Requirements of the System**

There were certain requirements of the system to be met. Collection and disposal of solid waste ought to be carried out in such a way that this would not damage public health. Hence, disposal sites were away from the residential areas and also the city area. The transfer of waste was time bound, as solid wastes which contained considerable amount of degradable matter would start decomposing in the generation point itself causing public health hazards.

The system was complex, and though it was labour intensive, it required considerable amount of capital investment in the form of a fleet of vehicles, in addition to the investment in machinery for solid waste handling. The activities of the system were scattered over the entire city. As the corporation was generally short of vehicles and equipments, it was necessary to maximize their use.
Assessment of the Existing System

Usually, community bins were placed or constructed at different places in the city. The bins were located as per the convenience of the nearby residents of the area. The capacity of these bins was fixed arbitrarily or by precedence. This resulted in either the overflow of bins due to their inadequate capacity or over investment due to their oversize. The former was more objectionable.

Disposal sites were selected on the basis of their proximity to the collection area and their capacity to accommodate the waste. Once the disposal sites were fixed, the vehicles were directed for transportation of waste from the community bins to the disposal sites. The nearest disposal site was preferably selected for disposal. Alternate disposal sites were searched out only when existing sites were completely land-filled.
Effects of Inadequate Planning

Inadequate planning was one of the basic causes of inefficient solid waste management in the city. With increased quantities of solid waste generated, the disposal sites were getting land-filled rapidly and new sites were required to be searched out more frequently.

Due to continuous addition of new disposal sites in the system, the transportation operations got upset and tended to become more costly. The situation was aggravated by the inadequacy of the number of vehicles available.
In the absence of systematic planning, the entire handling operation became more cumbersome and difficult to control. The situation ultimately resulted in the following occurrence.

(1) All the solid wastes generated and collected at various community bins were not removed at regular intervals.

(2) As the collection points were not allocated to disposal sites rationally, the sites with smaller capacities tended to get filled up earlier. This situation called for search of newer sites, which might be at much greater distances, resulting in an imbalance of disposal capacity and costlier transportation work.

(3) Allocation if different collection areas to the disposal sites were done subjectively or arbitrarily, leading to an increase in travel time and cost.

(4) As the capacity of community bins were not fixed scientifically, waste overflowing occurred too often.

(5) Such a situation resulted in the removal of solid waste from the city area at irregular intervals. The formation of heaps of unremoved solid waste on unauthorized open collection points, in turn, resulted in many complaints from the public and private organizations.

(6) In spite of heavy expenditure, the performance of the system was poor.

Dar came to the conclusion that it was necessary to develop planning criteria which would avoid the shortcomings of the system. He felt that these planning criteria should consider the following facts:
I. It is necessary to consider the system as a whole and then to plan it. This sort of planning can only be on a broad scale to decide the approximate relationship of different components.

II. The objective should be minimization of overall cost, as the corporation is short of fund.

III. If its use is to be successful it should have simplicity of application. Therefore,

(a) It should be easy to understand and easy to implement;

(b) As the data for solid waste system is not readily available, the proposed criteria should require such a data as can be easily gathered and maintained for analysis purposes.

IV. Emphases should be on long term planning of the system. It was decided that the system was to be planned for a long duration of ten years, with due considerations to the following additional factors:

(a) Removal of the entire quantity of solid waste from the collection area.

(b) Resource utilization.

(c) Total land filling capacity of the disposal sites.

(d) The distance of disposal sites from various collection areas.

(e) The growth of city area.

(f) Rational selection of alternate sites.

V. The planning should help in obtaining the number of vehicles required and the disposal facilities required. It should determine:

(a) Allocation of different collection areas to various disposal facilities.
(b) Scheduling the disposal operation.

DATA COLLECTION

Dar, with the help of Singh, collected the following information.

Solid Waste Quantities

For the estimation of quantities, every zone was considered as a unit producing solid waste. The population of every zone, along with its estimate for every year of planning horizon, was obtained. Using this information, the solid waste quantity generated per capita every year was calculated by increasing the per capita rate by 1.4 per cent. The quantity of solid waste generated in every zone thus computed, is given in Table 3.1.
Table 3.1  **Solid Waste Quantities for Different Zones**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>645,347</td>
<td>588,479</td>
<td>96,800</td>
<td>1,074,015</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>600,565</td>
<td>547,643</td>
<td>630,000</td>
<td>698,997</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>446,216</td>
<td>406,895</td>
<td>450,000</td>
<td>499,284</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>1,232,576</td>
<td>1,123,961</td>
<td>1,388,270</td>
<td>1,540,313</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>386,761</td>
<td>352,680</td>
<td>362,725</td>
<td>402,450</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>610,560</td>
<td>556,757</td>
<td>608,821</td>
<td>675,499</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>566,204</td>
<td>516,310</td>
<td>603,311</td>
<td>699,385</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>571,701</td>
<td>521,322</td>
<td>631,638</td>
<td>700,815</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>88,875</td>
<td>70,837</td>
<td>92,585</td>
<td>89,859</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>902,785</td>
<td>823,231</td>
<td>1,007,807</td>
<td>1,118,182</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>150,359</td>
<td>137,109</td>
<td>166,383</td>
<td>184,605</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5,645,214</td>
<td>Total 7,653,404</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Distance Matrix**

The quantity of solid waste generated in every zone was assumed to be concentrated at the centroid of the zone. The distances from all the zones and to all the disposal sites and the processing sites were obtained. These are given in Table 3.2.

### Table 3.2  Distance matrix (in km)

<table>
<thead>
<tr>
<th>From zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>7.11</td>
<td>7.04</td>
<td>7.47</td>
<td>7.18</td>
<td>1.50</td>
<td>7.86</td>
<td>1.40</td>
<td>9.90</td>
</tr>
<tr>
<td>3</td>
<td>6.74</td>
<td>6.01</td>
<td>6.90</td>
<td>8.13</td>
<td>2.46</td>
<td>6.79</td>
<td>1.91</td>
<td>8.85</td>
</tr>
<tr>
<td>4</td>
<td>11.12</td>
<td>4.00</td>
<td>2.77</td>
<td>11.83</td>
<td>4.16</td>
<td>4.80</td>
<td>3.58</td>
<td>6.48</td>
</tr>
<tr>
<td>5</td>
<td>8.51</td>
<td>3.70</td>
<td>4.65</td>
<td>10.47</td>
<td>3.61</td>
<td>4.52</td>
<td>2.79</td>
<td>6.56</td>
</tr>
<tr>
<td>6</td>
<td>5.51</td>
<td>5.95</td>
<td>7.62</td>
<td>8.68</td>
<td>4.25</td>
<td>6.60</td>
<td>3.70</td>
<td>8.60</td>
</tr>
<tr>
<td>7</td>
<td>9.49</td>
<td>1.90</td>
<td>4.96</td>
<td>13.40</td>
<td>7.14</td>
<td>2.11</td>
<td>6.32</td>
<td>3.89</td>
</tr>
<tr>
<td>8</td>
<td>9.49</td>
<td>3.89</td>
<td>7.07</td>
<td>14.60</td>
<td>9.11</td>
<td>3.64</td>
<td>8.30</td>
<td>4.52</td>
</tr>
<tr>
<td>9</td>
<td>4.66</td>
<td>6.80</td>
<td>9.36</td>
<td>10.50</td>
<td>7.34</td>
<td>7.14</td>
<td>6.77</td>
<td>8.81</td>
</tr>
<tr>
<td>10</td>
<td>3.10</td>
<td>8.43</td>
<td>10.15</td>
<td>7.15</td>
<td>5.60</td>
<td>9.03</td>
<td>5.37</td>
<td>10.98</td>
</tr>
<tr>
<td>11</td>
<td>2.42</td>
<td>13.08</td>
<td>15.32</td>
<td>9.11</td>
<td>11.00</td>
<td>13.48</td>
<td>10.85</td>
<td>15.16</td>
</tr>
</tbody>
</table>

306
**Disposal Capacity**

Currently, there are four disposal sites in operation. Obviously, these would be inadequate for the next 10 years. Therefore, an additional three sites were identified for land filling and are shown as sites 5 to 7 on the map (Fig 3.1). Table 3.3 gives the capacity of different land filling sites for the planning horizon.

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Capacity in tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65,000</td>
</tr>
<tr>
<td>2</td>
<td>408,000</td>
</tr>
<tr>
<td>3</td>
<td>522,000</td>
</tr>
<tr>
<td>4</td>
<td>9,360,000</td>
</tr>
<tr>
<td>5</td>
<td>1,473,750</td>
</tr>
<tr>
<td>6</td>
<td>324,000</td>
</tr>
<tr>
<td>7</td>
<td>810,000</td>
</tr>
<tr>
<td>8</td>
<td>300,000</td>
</tr>
</tbody>
</table>

**ANALYSIS OF DATA**

Singh argued that the objectives of the analysis of data obtained should be following:

1. The long range plan should be able to indicate which site would be used for disposal over the next 10 year period so that the total handling
costs in the period are minimized. Different phases could be considered for this purpose.

2. Once the disposal sites were scheduled in the phases of the long range plan, the next important thing for the planner was to develop routings of trucks to the disposal site from the collection points, so that a minimum number of trucks are required for handling the solid waste occurring over each period (cycle).

3. A rational way locating dust bins determining their capacity should be used.
APPENDIX II

Case study-1: Speed Breakers Glore: Maruti:

When the Indian car industry opened its doors to new players, Maruti Udyog Ltd, which had till then enjoyed an enviable position in the market was suddenly faced with severe market erosion. This case study looks at the various strategies MUL adopted to regain its place in the market – particularly its price-reduction strategies and the widening of its product range.

The case also looks at the reactions and moves of other players in the industry, viz. Hyundai, Daewoo, Telco, etc.

Issues

Upheavals in the Indian small car segment in the late 1990s, Pricing strategies.

Case study-2: Supply Chain Management at CGMMF:

The case discusses the supply chain practices of Gujarat Co-operative Milk Marketing Federation (GCMMF). GCMMF was owned by a chain of farmers who had formed a network of cooperative societies. Milk was collected from more than 2.4 million farmers in 11,615 villages twice a day, and tested, graded, and transported to the processing centers. GCMMF’s products were marketed through 50 sales offices located across India to 4,000 stockists. These stockists supplied the products to more than 500,000 retail outlets. The case examines in length the milk procurement, processing and distribution activities of GCMMF’s supply chain.

SOURCE: www.icmr.ifci.org
Issues

Study the unique aspects of GCMMF's supply chain management practices; Understand the procurement, processing and distribution activities of GCMMF’s supply chain.

Case study-3: Zara's Supply Chain Management Practices:

This case discusses the unique supply chain management practices of Spanish garments retailer Zara, which enabled it to gain competitive advantage over other fashion retailers in the world. Zara's vertically integrated supply chain system enabled the company to place the latest designs in any store across the world within a period of two to three weeks. The company produced garments as per the latest trends in a limited quantity. Zara introduced 12,000 designs every year, with new designs appearing in the stores globally, twice a week. The case explains in detail the design, production and distribution processes of Zara's supply chain.

Issues

Analyze Zara's way of managing supply chain; Study the design, production and distribution processes of Zara; Evaluate how Zara was able to maintain exclusivity of its products through efficient supply chain management.

Case study-4: Tesco's Supply Chain Management Practices:

This case discusses the best practices in supply chain management of UK based retailer - Tesco. Effective supply chain management can be termed as one
of the factors that helped Tesco emerge as a market leader in the retailing industry in the UK. Tesco introduced lean management solutions into its supply chain successfully. It adopted path-breaking techniques and systems like point of sales data, primary distribution, continuous replenishment and RFID technology to make its supply chain more efficient.

**Issues**

Analyze the SCM initiatives adopted by Tesco; Understand the role of SCM in retail industry; Evaluate the importance of using new technologies like RFID in supply chain.

**Case study-5: Mass Customization at BMW:**

For years BMW had a reputation for cars that combined great styling with exceptional performance. However, since the 1990s, the company has also gained recognition for its customization program, which allowed buyers to design their own cars from a set of available options. The cars were then delivered within 12 days of the order being placed. Industry analysts have termed this process 'mass customization', implying that it combined the features and advantages of both mass production and customization.

This case discusses the process and elements of mass customization at BMW. It traces the process from the time an order is placed till the final delivery of the cars. It talks about the supply chain and logistics practices that BMW followed. It also discusses the benefits of mass customization to the company and
customers, and the challenges in the implementing the process. The case concludes with a note on the future of mass customization.

**Issues**

Understand the concept of mass customization and how it differs from mass production and customization; Competitive advantages accruing to a major car maker employing mass customization; The role of suppliers in implementing manufacturing changes and lowering inventory.

**Case study-6: Global Supply Chain Management Best Practices at Li & Fung Limited:**

The case discusses the global supply chain management practices of Hong Kong based Li & Fung Limited, a global consumer goods export trading giant. It examines how Li & Fung has positioned itself as a global supply chain manager, describing its supply chain management strategy including the dispersed manufacturing technique and its global supplier network. The case also describes how Li & Fung is using the Internet as a tool to make supply chains more transparent.

**Issues**

Study the importance of efficient supply chain management for a global company.
Case study-7: Project Scorpio: The making of India’s First Indigenous Sports Utility Vehicle:

The case discusses the making of Mahindra and Mahindra (M&M's) sports utility vehicle Scorpio, which was launched in June 2002. Scorpio had been in the making for five years and M&M collaborated with first tier suppliers from around the world for its components. The manufacturing system was based on Integrated Design and Manufacturing (IDAM), which allowed the company to make vehicles flexibly, according to customers’ preferences, through quick product development. M&M also used a lean young team of 120, the average age being 27. Scorpio became an instant success when it was launched, not only helping M&M regain its slipping market share, but also to shake off its image as a maker of sturdy but aesthetically unappealing vehicles.

Issues

Cross-functional teams, manufacturer supplier relationship, automobile industry, the making of Scorpio.

Case study-8: Supply Chain Management in L & T (ECC Division):

The case highlights the main operational functions of L&T's construction division - ECC. It discusses in detail the supply chain management strategies adopted by ECC in order to streamline its supplier network and improve the efficiency of its supply chain. It also identifies the importance of information technology in ECC's supply chain. A lot of importance has been given to the
functioning of ECC’s enterprise information portal (EIP) and its web-based supply chain management solution. The case also tries to bring out the fact that implementation of Information Technology in the supply chain of ECC has helped it make its operations lean and agile.

Issues

Vendor Management, Inventory Management, Supply Chain Integration, Supply Chain Collaboration.

Case study-9: Taiichi Ohno and the Toyota Production System:

Toyota's production system has been one of the most studied systems in the field of production and operations management. The core elements of the system, like JIT, Kaizen and Kanban were emulated by several other organizations around the world, sometimes successfully and sometimes not. Taiichi Ohno was the architect of the TPS and was generally acknowledged as the father of 'lean manufacturing', which was the western adaptation of the TPS.

The case discusses the various elements of TPS and the role played by Ohno in the design and implementation of the system. Concepts like JIT, Kaizen, Kanban, and Jidoka are discussed in detail. The case also studies the benefits Toyota obtained from the TPS, as well as the main challenges in implementing the system. It concludes with a study of the applications of the TPS in other companies and the role that it is likely to play in the future of manufacturing.
Issues

Application of tools like JIT, Kanban, Kaizen, and Jidoka and their role in production management, Importance of human element in the design and operation of production systems.

Case study-10: The Ford Production System:

Ford has pioneered several innovative automobile manufacturing techniques since its inception. In the mid 1990s, Ford restructured its manufacturing operations in its efforts to induce more flexibility and enhance the efficiency of its automobile production systems. The restructuring effort was known as Ford Production System (FPS). The case discusses the keys elements of FPS and how it was implemented by Ford. The case also discusses how Ford implemented the principles of lean manufacturing through FPS at its manufacturing operations. Finally, the case discusses the benefits reaped by the company after the implementation of FPS.

Issues

Lean Manufacturing advanced manufacturing practices, just- in-time production.

Case study-11: Improving Operational Efficiency in a Bank:

The case discusses the need for improving the operational efficiency of a bank to deliver better customer service. It examines the advantages and disadvantages of automating a bank's services. It studies the ways of reducing
waiting time for customers through change in production and operations standards. It throws light on the various work methods and behavioral dimensions of job design. The case also discusses the role of technology in improving the operational efficiency of a bank.

Issues

The role of technology in providing faster and better customer service.

Case study-12: Employee Satisfaction Survey:

The case focuses on the need to measure employee productivity and employee satisfaction at the workplace. It examines the reasons for the automation of production processes and also evaluates the performance of people after automation. The case also studies the reasons for drop in productivity after automation and the ways in which the efficiency of workers could be increased to maximize the output. It also throws light on the behavioral dimensions of job design and the ways in which employees' psychological needs can be met.

Issues

The need for motivating the employees of an organization.

Case study-13: Dilemma of a Manufacturer: Standardized v/s Customized Products:

The case discusses the dilemma a furniture manufacturer faces in striking a balance between the production of customized and standardized products. It
also examines the various factors that affect the plant layout in such a condition. It also throws light on the various policy decisions that need to be considered when finalizing the design of the plant layout.

**Issues**

Difference in plant layouts for standardized and customized products.

**Case study-14: Operations at Whirlpool:**

This case discusses the operations management processes adopted by Whirlpool. The case begins with a detailed description of the history of Whirlpool. It describes how Whirlpool grew from being a small firm manufacturing wringer washers in 1911, to becoming one of the most well-established brands in the world appliance market by the early-2000s. The case explains the various initiatives on operations management taken up by Whirlpool. It also explains the reasons behind the company changing its manufacturing strategy from a 'push' system to a 'pull' system and further to a 'hybrid push/pull' system.

**Issues**

Supply Chain Management in a global company.

**Case study-15: Carrefour: Managing the Global Supply Chain:**

France based Carrefour (the second largest retailer in the world) is believed to be the most global retailer with its operations spread out all over the world. Managing a global supply chain is a very difficult and complex task. The case examines the supply chain management practices of Carrefour and
describes how it managed its supply chain including procurement, logistics and warehouse management, globally. It explains how the company customized its supply chain operations according to the countries in which it operated. The case also discusses the use of IT by Carrefour to enhance its supply chain efficiency.

Issues

Global supply chain management practices of a leading retailing company.

Case study-16: PepsiCo’s Distribution and Logistics Operations:

The case discusses in detail the distribution and logistics operations of the US-based PepsiCo, one of the world's leading beverages and snack foods companies. The case details the distribution system of the company clearly explaining the significance of various distribution channels used including supermarkets/retail stores, fountain/restaurant, convenience stores, vending machines and others for distributing beverages and snack foods. The case also describes the logistics operations of PepsiCo’s bottler (Pepsi Americas) and elaborates on how by employing the latest wireless technology solutions it enhanced the efficiency of its distribution and logistics operations significantly.

Issues

Distribution operations of a leading beverages and snake food company.

Case study-17: Revamping the Supply Chain: The Ashok Leyland Way:

The case gives an overview of the issues concerning the revival of Ashok Leyland effected through a thorough revamp of the supply chain. It outlines how
Ashok Leyland, which was reeling under the weight of recession, staged a comeback by of supply chain management and emphasizes its importance in the context of cost management with specific reference to Ashok Leyland. The case seeks to understand the components of supply chain and their critical importance and how it can be reengineered to help organizations save costs.

**Issues**

Revival of Ashok Leyland, revamping of supply chain.

**Case study-18: The Crompton Greaves’ Operations Overhaul:**

The case presents the changes introduced by Crompton Greaves, an electrical equipment manufacturer in India, on the operational front at one of its plants in Nashik, Maharashtra. Examining in detail the changes made in operational and human resources practices at the Nashik switchgear factory, it discusses the efficacy of these changes in boosting productivity.

**Issues**

Crompton Greaves and single price flow system; Operations overhaul.

**Case study-19: Tata Indica: The Making of a Small Car:**

The case provides an understanding of the issues concerning the supply chain management system at Telco in regard to its small car, Indica. It outlines how Telco, built the supply chain for the car by leveraging its existing competencies and how it transformed itself from an integrated truck manufacturer to an automobile integrator and from a product centric company to competence-centric company. The case discusses various components of the supply chain
and emphasizes how Telco orchestrated them with the objective of minimizing costs.

**Issues**

Concept with the supply chain and its practical dimensions.

**Case study-20: McDonald’s Food Chain In India:**

McDonald's is a fast food chain with restaurants all over the world. It serves burgers and other fast food customized to local tastes. Its philosophy has been 'one world, one burger;' which meant that the burger must be consistent in terms of cost and quality. To meet such high standards, it was essential to have an excellent supply chain management system. In India as in other parts of the world, McDonald's had a very well orchestrated supply chain, called the 'Cold Chain.' The case study looks at McDonald's supply chain management system in India and discusses in detail its outsourcing mechanism.

**Issues**

Benefits repeated by McDonald's because of its supply chain strategies.

**Case study-21: Unilever Restructure its Supply Chain Management Practices:**

The case examines the supply chain management (SCM) restructuring initiative undertaken by Unilever, one of the world's largest food and consumer goods companies. It explains in detail how the company restructured various components of its SCM practices including supply chain organization, procurement, warehousing and distribution. The case also examines how
Unilever used the Internet and various information technology tools to improve the efficiency of its supply chain. It concludes with a discussion on the benefits reaped by Unilever due to these measures.

**Issues**

Importance of an efficient SCM system for improving operational efficiency.

**Case study-22: TISCO: The World’s Most Cost Effective Steel Plant:**

The case talks about the operational changes at TISCO that enabled the company to become the lowest cost producer of steel in the world. TISCO initiated a five-phase modernization program in the early 1980s, to overcome problems in the steel-making process. The program’s primary objectives were to enhance the operational processes and reduce costs. The operational aspect were addressed in the Phase III of the program with the help of consultants McKinsey and Booz Allen-Hamilton. McKinsey designed a program called Total Operational Performance (TOP). TOP’s main objective was to impact the bottomline with minimum expenditure and minimum time. TOP enabled TISCO to improve its performance.

**Issues**

Factors that enabled TISCO to become the world’s lowest cost steel producer.

**Case study-23: Gujarat Ambuja: Redefining Operational Efficiency:**

The case examines the initiatives taken by the Indian cement major Gujarat Ambuja Cements Ltd. (GACL) to maintain profitability and market share despite adverse industry and market conditions. The company’s efforts to
improve its operational efficiency through productivity enhancement, quality control, pollution control and cost-cutting measures are explored in detail. The case also discusses the future prospects of the company in light of the fact that the company might not be able to continue to reap the benefits of the above measures.

**Issues**

Innovation and operational efficiency improvements in the cement industry.

**Case study-24: Mahindra & Mahindra: Implementing BPR:**

The case examines the reasons behind automobile major Mahindra & Mahindra’s decision to implement a Business Process Reengineering (BPR) program. The case explores in detail the implementation procedure at the company and the benefits that accrued from the BPR program. In addition, the case discusses the concept of BPR, its benefits, and the steps that need to be taken to ensure the success of such initiatives.

**Issues**

Benefits that a BPR program can offer when it is effectively implemented.