THE COMPONENT CHART: A NEW TOOL FOR INVENTORY, PURCHASING, AND PRODUCTION DECISIONS

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Managerial decisions related to inventory, purchasing, and production are typically made by several different individuals in the firm. It is all too common that these decision makers, e.g., the general manager, the project manager, and the purchasing officer, have conflicting ideas about the particular decisions that need to be made for production to proceed smoothly and effectively. The source of many of the conflicts is inadequate communication, exacerbated by the absence of a commonly shared view of the main factors affecting production. Consequently, like ancient physicians having different views of the way the human body functions, the decision makers often differ substantially in their preferred remedial solutions.

We propose a simple tool which may alleviate this communication problem—the component chart. It is a pictorial representation of the components, or raw materials, used in the production of a single finished good or subassembly. The component chart (CC) contains information concerning the number of components, their prices, lead times, the number of available suppliers for each component, and the extent that each component is critical in the production process. The CC allows quick identification of the major problems which might affect production and can lead to improved coordination of purchasing, inventory, and production decisions.

The usefulness of graphically representing data is well known: graphic representations such as Gantt charts, PERT, and CPM, have been successfully used in the areas of production and operations management. For other examples, see [6].

In order to be useful, a graphical presentation of data needs to have the following properties:

- Be simple and easy to understand.
- Capture and emphasize issues which are viewed as important by the users.
- Create a medium of discussion for the users so that the effects of various decisions can be easily translated to changes in the graphical representation.

Several variations of the CC are possible and additional data may be incorporated into it, but adding too much data may result in a cumbersome and hence not very useful graph.

AN EXAMPLE

The example used is a new product—a toy robot produced by Capsella, Inc. This product consists of 13 components assembled to create the finished product. Data related to the manufacturing of this product is presented in Table 1. The column titled Lead Time shows the duration (in days) of the lag between the time of ordering the item from a supplier and the time it arrives at the manufacturer. The column titled Number of Sources shows the number of suppliers who can supply the item on relatively short notice. The column titled Criticality shows the importance of the item in the production process as assessed by the decision makers. (Critically reflects the extent to which shortage of the component disrupts production.) The data in the last three columns are fictitious, used only for the purpose of demonstrating the CC.

The data in Table 1 are represented by the component chart shown in Figure 1. In this chart every circle represents a component whose properties may be read in the following way:

- The horizontal coordinate of the circle's center point indicates the component's cost.
- The vertical coordinate of the circle's center point indicates the component's lead time.
- The radius of the circle indicates the number of sources. (When the number of sources is N, the corresponding radius is 1 / N units, where the length of one unit can be chosen arbitrarily.)

TABLE 1: Example Data

Part No.	Description	QTY	Price	Cost	Lead Time (Days)	No. Sources	Criticality
1	Motor Capsule	1	$4.50	$4.50	20	1	High
2	Speed Reduction Capsule	1	$3.00	$3.00	12	1	Low
4	Crown Wheel Capsule	1	$3.00	$3.00	10	3	High
10	Octagonal Connector	9	$0.15	$1.35	8	5	Low
14	Coupler	3	$0.40	$1.20	10	3	Low
15	Coupler Cap	3	$0.15	$0.45	10	3	Low
21	Battery Case (Small)	1	$1.00	$1.00	7	3	Low
22	Switch Box	1	$3.00	$3.00	7	1	High
23	Lead	4	$1.00	$4.00	3	5	High
25	Wheel (large)	3	$0.40	$1.20	3	5	Low
28	Tire (large)	2	$0.40	$0.80	2	5	Low
37	Float	2	$0.75	$1.50	3	5	Low
AA	AA Battery	1	$0.40	$0.40	1	10	Low
	Total Cost of Materials			$25.40			

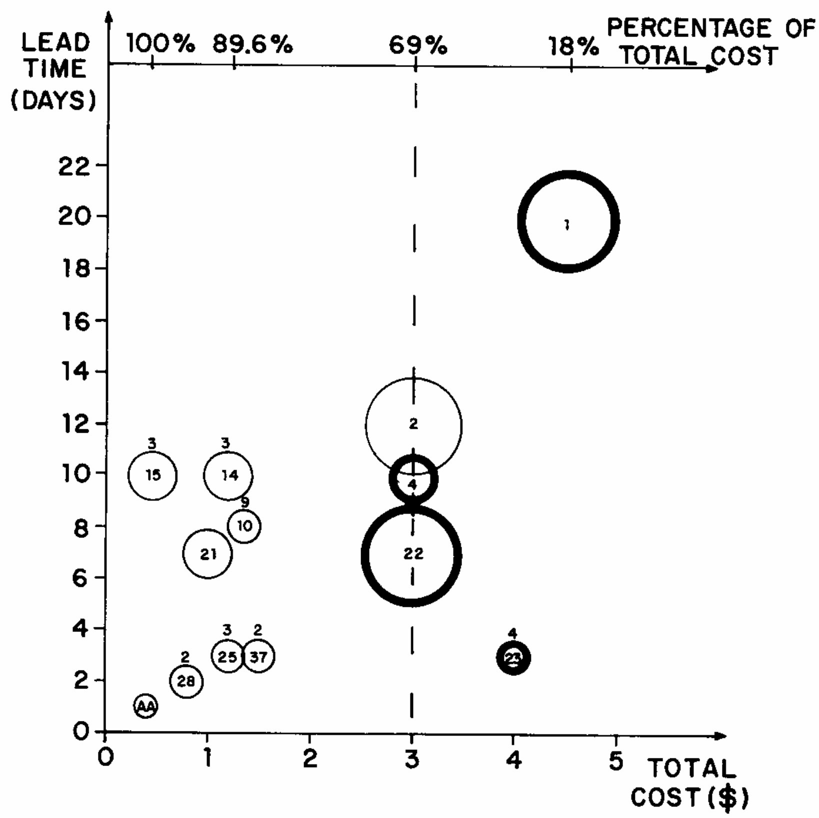

FIGURE 1: Component chart for example in Table 1.

- The thickness of the circle line indicates criticality. (A heavy line reflects high criticality.)
- The number inside the circle identifies the component. (The numbers used in Figure 1 are the components' part numbers as given in Table 1.)
- On top of the circle is the number of times that component is used in the production of one toy robot. If only one is used, then no number is written.

In addition, it is useful to add a horizontal axis on the top of the picture which shows the cumulative percentage of total cost. Consider a point on this axis, say the one denoted by 69%. If a vertical line is drawn through this point, the components represented by circles with centers on or to the right of this line account for 69% of all the costs of the components used in the finished product. The traditional ABC analysis (see, for example, Chase and Aquilano [1]) can thus be easily derived. An examination of the CC leads to some immediate insights.

Items #1 and #22

These components draw immediate attention merely because they have large sizes and heavy edges. Indeed, they deserve such attention, since they could be supplied by one source only (hence the large size), are critical in the production process (hence the heavy edge), and are also quite expensive (hence located on the right side of the CC). The decision makers should follow these items closely. If it is possible, they should try to reduce the size of the circles, lighten their edges, and push them to the southwest corner.

Items #23 and #4

These are critical and fairly expensive items. Redesigning the production process to reduce the criticality of these components (lighten their edges) may be useful.

Item #2

While not critical, it is still an important item in view of its high cost, high lead time, and dependency on a single supplier. Again, these properties are immediately observed from the CC, as item #2 is presented by a large size circle located far away (horizontally and vertically) from the "good" southwest corner.

Items #37, #25, #28, and AA

These are the "best" items from the point of view of all the decision makers. They are inexpensive, not critical, have short lead times, and can be supplied by several suppliers. In general, a small, light-edged circle, close to the southwest corner, is a "good" item. There is no particular need for monitoring these items or making decisions related to them, and their inventory level may be low. One only needs to make sure that a good item does not start to expand in size or to float to the northeast corner.

Items #21, #14, #10, and #15

They are fairly "good" items, except that their lead time is not short, hence an appropriate inventory level must be maintained.

CONSTRUCTION OF A CC

The construction of the CC should be quite uncontroversial. Any disagreement concerning the criticality of an item in production, or the number of sources, can be settled with further study of the production process or the market place, respectively. The CC draws attention to the potentially problematic components. In our example, these are items #1, #22, and to some extent #2, #4, and #23.

The commonality of interests of the decision makers is exhibited by the fact that all of them recognize the same "good" and "bad" items. If changes in the production process and the contractual arrangement with suppliers are possible, then all the decision makers would always prefer those changes which, when exhibited on the CC, involve lightening edges, reducing sizes, and pushing the circles to the southwest corner. Of course, the general manager might be concerned mainly with the criticality and the price elements, the project manager worried about the criticality and the lead times, and the purchasing officer may be particularly concerned with the price and the lead times. The CC supplies the parties with a communication medium to help them reconcile their differences and coordinate their decisions, thus developing a mutually acceptable purchasing-inventory-production policy.

The use of the component chart described so far is static. The components of a finished product, or subassembly, are mapped in the CC and this representation serves as a basis for communications and decision making. The component chart could be also used in a dynamic fashion during a production run. Each component, upon its arrival in adequate quantities, could be eliminated from the chart, or be marked in some fashion. Thus a quick look at the chart at any given time can indicate which components have not yet arrived and need attention.

The Elements of the Component Chart

Items used in production are usually classified by the traditional ABC analysis, which emphasizes the total cost of the items. Other classifications are possible. For example, Sipper (see [3]) suggested classifying items also according to standard/nonstandard, sole source/multiple source, local supplier/foreign supplier, and critical/noncritical dichotomies. Our suggestion is to classify components according to the properties of *total cost, lead time, number of sources,* and *criticality.*

Total Cost

This is an unquestionably important property of items in production. A few inventory items usually account for most of the inventory value [5]. One can manage these few items intensively, thus controlling most of the inventory value. This is known as the Pareto rule or the 80/20 principle. The ABC analysis classifies items according to their significance. The A items are easy to spot in the CC chart. In the earlier example, they are items #1, #4, #22, and #23.

Lead Time

Reduction of cycle time is of critical importance in a competitive environment [4]. Reducing the purchased components' lead times is one of the means to reduce total cycle time. The short lead times contribute to production in several ways—they contribute better forecasting, better due-date performance, and reduced overhead and direct manpower expenses. They also allow quick response to quality-corrective actions and to market-demand changes. The components with long lead times are easy to spot in the CC; they appear on the top of the chart.

Number of Sources

The availability of several sources reduces the risk that an item might become unavailable or prohibitively expensive. We do not necessarily propose that a procurer should have a contractual arrangement with several suppliers; indeed, some authors advocate long-term relationships with a single supplier [2]. It is clear, however, that such a policy is sensible only if there exist other suppliers in the market place, ready to replace a supplier who becomes uncompetitive. In the CC the number of sources is defined as the number of suppliers capable of supplying the item within a given time period and at a given price. (This time period and the price are item-specific.)

Criticality

This is a subjective property that should be defined for each particular application with great care. An item should be assigned high criticality if a sudden shortage of this item increases significantly the cost of production, the cycle time of production, or both. For example, an item used in the critical path of production may be critical, but less so if its lead time is very short. An item with relatively high price and significant uncertainly about its future price may be critical. Similarly, an item with relatively long lead time and significant uncertainty about the lead time may be critical. An item whose performance characteristics are unknown (a nonstandard item) may also be critical. In general, an innovative development project will contain many critical items. The existence of items with high criticality should indicate that there are high risks of interruption and delay in the project.

The criticality property represents an amalgamation of all the important properties of a component other than its cost, lead time, and number of sources. Our experience indicates that decision makers usually agree on the degree of an item's criticality.

SOME CONCLUDING COMMENTS

The *quality* of the components in the production process may be of great concern. We can incorporate a quality variable into the CC. In some cases the criticality of an item could be interpreted as the item's potential for below-standard quality. Heavy lined circles then represent items which need close inspection and which may be returned to the supplier. In other cases, the quality of an item could be indicated in the chart by *color.*

The CC will work best in electronic assemblies (printed circuit subassemblies in particular), mechanical assemblies (e.g., toys), development processes, etc. The use of the chart may have practical limits based on the number of components and the manufacturing environment. Components used in several products, as well as components produced internally, may need to be distinguished from other components.

We believe the component chart is easy to understand, captures the important issues, and creates a medium of discussion for the users.

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