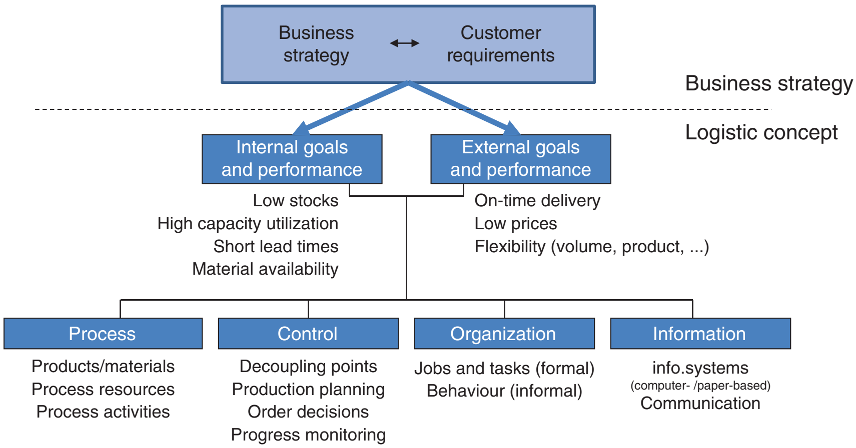

Figure 1.6 Logistic concept. Source: Adapted from Ribbers and Verstegen (1992).

Besides delivery performance, often the following two aspects are considered as well when determining the total logistic performance:

– *Flexibility of delivery*: the degree to which agreements made (like due dates) can be changed afterward without loss in delivery reliability or extra costs.
– *Logistic costs*: all costs associated with the supply of materials and capacity resources, such as inventory cost, cost of storage, and ordering cost.

In real-life situations, measuring only the delivery performance as mentioned above doesn't give an accurate and complete image. Usually, the extra costs caused by these decisions are considered. We will discuss the specific logistic costs later. This view on logistics is also known as the "logistic concept" (see Figure 1.6). The main focus of this book is the "control" part of this concept.

At this point of the discussion, it is important to understand that the logistic performance of a production process is "only" a part of the total performance of that process. Usually, the performance of a transformation process is based on three considerations:

– the quality of the product and process (*Quality*).
– the logistic performance (*Delivery*).
– the efforts that are taken to do so (*Costs*).

In this book, the focus is on logistic performance, including that part of the costs that are logistic related. The logistic performance of any production system is always the result of the choices made in the design of that system. As explained, these choices concern all four PCOI aspects of a production system. In this book, we will limit the discussion to the choices made concerning the control aspect of the system. Studying LPC of a production system requires an understanding of all aspects of the system involved. In other words, in any real-life situation, the following logic can be followed to understand the actual situation at hand:

– describe the processes, including materials, information, and resources used;
– describe the LPC structure, including all planning and control decisions;
– describe the division of tasks and responsibilities;
– describe the supporting IT systems, including the data available.

1.4 Terminology for Production Control

As already said, we will concentrate on transformation processes that take place in production organizations (transformation of the form) and thus logistics has to be interpreted with regard to physical production processes. In this section, we will define some crucial concepts used in production control (Section 1.4.1) and discuss some general characteristics of a production situation (Section 1.4.2).

1.4.1 Concepts Used in Production Control

If we consider a physical material transformation process, the transformation steps can be, for instance, bending, sawing, drilling, casting, welding, etc. which are called *operations* and are performed at *work centers* consisting of one or more (more or less) identical machines. The sequence in which the different operations are performed often is called *routing*. The routings of different products can be quite different in some production departments, whereas in other production departments, they are identical. If we have a nonphysical process, the sequence in which the different operations like for instance application, classification, calculation, and sending a mail are performed is called *workflow*. A schematic representation of a production process is given in Figure 1.7.

A *job* is a task or combination of tasks that has to be executed at a certain work center for a certain order.

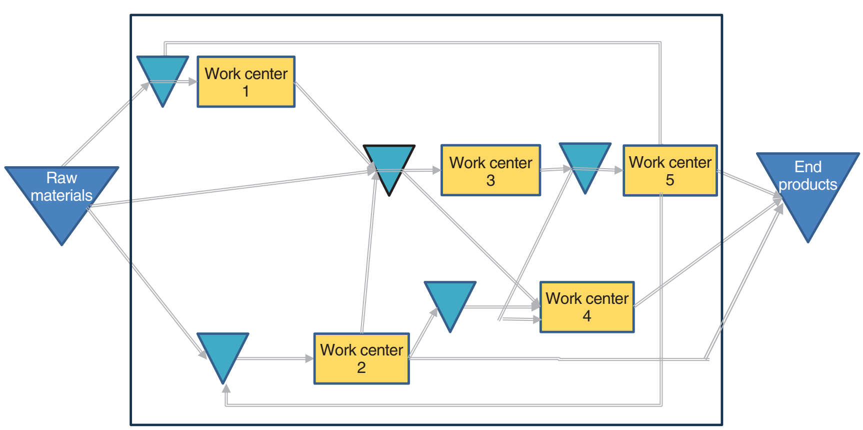

Figure 1.7 A schematic example of a production process.

An *order* is a general term that may refer to such diverse items as a purchase order, shop order, customer order, planned order, or schedule. In this book, we interpret it as a document that contains all the necessary information to produce a series of a (semifinished) product in the production department. Often several jobs have to be executed for one order. Releasing an order means that all the necessary materials, information, and/or tools have been collected and that a department can start working on the first job of that order.

The time necessary for an operation is called the *processing time*. Often an order occupies a resource longer than the processing time. For instance, at the beginning of the operation the order has to be administrated, the resource has to be set up and at the end of the operation, it might be that the product needs to be cooled down. All that time, the resource cannot be used for another order and we will call this "extended" processing time the *service time*.

We will call the *actual* time between the arrival of the order (at a work center) and the completion time of this order (at the work center) the (work center) *throughput time,* whereas the *planned* time between arrival (at the work center) and completion (at the work center), often needed for planning purposes, is called (work center) *lead time*. The lead time determines the *Due Date,* and the throughput time determines the *Completion Date*. The difference between these two dates, Completion Date – Due Date, is called the *lateness*; max(0, lateness) is called the *tardiness,* and -min(0, lateness) is called the *earliness*.

Remark: Often cycle time or lead time is used instead of throughput time. This can be confusing since cycle time is often used in certain industries (like process industries) with quite another meaning. In this book, we will use these words as described above and thus lead time is used for the planned time and throughput time for the actual time.

Delivery time is the time between the acceptance of a customer order and the delivery of this order to the customer. The transformation process is driven by *work orders* that are derived from *customer orders,* where a customer can also be the next stock point or department. Depending on the characteristics of the resources, customer orders might be merged into one work order or split into several work orders.

In Figure 1.7 we see several triangles before the operations. These triangles represent waiting lines (that lead to waiting times) that may occur since to perform the operation a decision is required or resources are required that are limited available. For instance, if at a certain work center, we need a drilling machine and we only have one drilling machine we can only start with a newly arriving order if the drilling machine is idle, otherwise this order has to wait. This leads to the situation that the time between the arrival of the order at a work center and the completion time of the order at this work center, which is called the (*work center*) *throughput* time, is larger than the processing time. In many instances, the waiting times are much larger than the operation times which implies that the throughput time mainly consists of waiting time.

1.4.2 Complexity, Uncertainty, and Flexibility

Production control in general can be very complex. Therefore, for developing a (specific) control concept, it is important to know how the production situation can be described in terms of:

a) complexity
b) uncertainty
c) flexibility

Ad a.: Complexity is among others caused by the variety of the products, variety in demand, variety in operations, variety in routings, variety in number of operations per routing, etc. High complexity requires a lot of coordination and therefore one of the main points for a concept for production control is that it should be directed to reduce the complexity. This can be done by *decomposition:* divide the total production control problem into several subproblems each with its own objective and decision-making autonomy. An example of this is the decomposition between production unit control and decoupling point control (also called goods flow control), which will be discussed later on. Other examples are the decomposition between control at an aggregate level and detail level and the decomposition between Sales and Production.

Ad b.: Uncertainty is caused by unpredictability and dynamics. We can make a distinction between uncertainty at the demand side and uncertainty at the process side. Uncertainty at the demand side can be caused by the kind of customers (end user; dealer; …), the kind of product (consumer product; professional product; …), etc., and uncertainty at the process side can be caused by the reliability of the machines, fluctuation in processing times, reliability of the suppliers, quality of the materials/ components, etc. These uncertainties influence the desired control concept for a certain production situation. For instance, if there are long-lasting machine breakdowns, the control is quite different than in case there are more or less frequent variations in the processing times.

Ad c.: Flexibility is important to counteract disturbances. Forms of flexibility are:

– multi-skilled operators
– machines that have small setup times and that easily can be changed
– commonality (using the same components in several different configurations)
– short lead times of components
– overcapacity
– outsourcing
– inventories (makes it possible to react quickly to changes in for instance demand)
– overtime, etc.

If there is a lot of flexibility, the effect of uncertainties can easily be downplayed so they don’t have a large effect on the desired control concept. Making the (potential) flexibility effective might involve substantial coordination, which might affect the desired control concept.

References

van Assen, M.F. (2016). *Operational Excellence*. (in Dutch). Koninklijke Boom uitgevers.

Dijkstra, L., Dirne, C.W.G.M., Govers, C.P.M. et al. (1997). *Samenwerking in ontwikkeling: productontwikkeling door uitbesteder én toeleverancier*. (in Dutch). Kluwer Bedrijfsinformatie.

MacKay, K. and Wiers, V.C.S. (2004). *Practical Production Control: A Survival guide for Planners and Schedulers*. J Ross Publishing and APICS.

Ribbers, A.M.A. and Verstegen, M.F.G.M. (1992). *Toegepaste logistiek*. (in Dutch). Kluwer.

Veeke, H.P.M., Ottjes, J.A., and Lodewijks, G. (2010). *The Delft Systems Approach – Analysis and Design of Industrial Systems*. Springer-Verlag London Ltd.