# Chapter 1
# Introduction

## 1.1 Intro

Researchers and business managers throughout the world agree that companies which combine products that customers benefit from greatly with superior logistics are especially competitive. Such enterprises often grow more quickly than the market and net particularly high profits. Here, good logistics means consistently achieving logistic targets:

- Successful enterprises require lower inventories of raw, semi-finished and finished goods. As a result, less capital is tied-up in processes for fulfilling orders and can instead be invested in developing innovative products or advanced technologies.
- Companies that are leaders in logistics deliver punctually, therefore gaining their customers' trust and avoiding the high costs resulting from delayed deliveries.
- Enterprises with good logistics deliver quickly, therefore benefiting from sales opportunities and frequently refraining from expensive storage.

Whereas there is an amazing degree of agreement about the goals and the advantages of consistently attaining logistic targets, the actual way to achieve them seems to be difficult. Already back in 1921, Hippler was insisting that the speed with which the workpiece flowed through the production was of utmost importance [Hipp-21]. The advances that have been made since then—largely due to developments in production and information technologies—are immense. Nonetheless, customers continue to complain about delivery times being too long and supplies not arriving punctually. To some extent this can surely be attributed to increased expectations, however, looking at enterprise practices also reveals that there is considerable potential for improvement.

One of the basic challenges lays in the fact that a superior level of target achievement can only be attained by combining various enterprise functions. Successful companies take into consideration logistic demands in areas as diverse as product or technology development, marketing and distribution, factory

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planning, strategic and operative production planning as well as in manufacturing control.

This book focuses on the area of manufacturing control as an essential factor for the success of logistics, but also points out connections to other functions as required. I have chosen to concentrate my observations on manufacturing control for four reasons.

### *1 Manufacturing control is a field that is often neglected both in scholarly research as well as on the shop floor*

The discussion about attaining logistic targets is clearly overshadowed by production planning. There are three main reasons for this: First, production planning offers intellectually challenging tasks such as optimization problems that can be elegantly solved with methods from operation research, artificial intelligence or other scientific disciplines. Second, there is a huge market for enterprise software in which large amounts of money can be made. Correspondingly, conferences are frequently dominated by questions about information technology. And last but not least, a realistic and solid production plan is actually a condition for consistently attaining logistic targets.

However, it is easy to overlook the fact that a good production plan only leads to reliably attaining logistic targets when the manufacturing control also manages to implement this plan. A functioning manufacturing control is therefore imperative for also practically exploiting the theoretical advantages of a progressive production planning. Consequently, considerable attention should be paid to it.

This is all the more critical because the manufacturing control workforce often fails to transfer the discussions that take place on a strategic level about the significance of logistic objectives to the daily operations. Although their personal success is frequently measured based on attaining logistic targets, a large percent of the workforce does not have a clear idea about how they can systematically influence the logistic objectives. If the planning failures of other business functions prevent targets from being attained then there is also no understandable correlation between the employee performance and the key logistic figures.

One of the important goals of this book therefore, is to demonstrate how the logistic objectives are influenced by manufacturing control.

### *2 The significance of manufacturing control for attaining the logistic targets is increasing*

Even when it cannot be emphasized enough that consistently attaining logistic targets can only be achieved through the coordinated collaboration of numerous corporate functions, manufacturing control is still a particularly important element. On the one hand, poor manufacturing control prevents the attainment of logistic targets even when the general conditions are positive, whereas good manufacturing control can compensate to some extent for mistakes made in planning. On the other hand, not attaining logistic targets creates huge problems in the areas of the supply chain that follow e.g., stock outages in an assembly. Production, therefore, takes on a key logistic position.

In addition, manufacturing control is becoming increasingly vital due to three reasons: First, continually greater expectations are being placed on attaining logistic targets. Second, as a result of the large diversity of variants and uncertain markets it has become quite difficult to reliably predict demand. Accordingly, it is continually more difficult to establish dependable production programs. Manufacturing control therefore has to be able to react quickly to changes in the production plans. And third, the scope of tasks covered by manufacturing control is constantly expanding. Whereas previously manufacturing control was limited to the sequencing on workstations, nowadays it also includes releasing orders into production and regulates capacities. In make-to-stock manufacturing, manufacturing control even takes on to some extent the responsibilities of production planning by generating orders.

***3 New theoretical findings in modeling logistic objectives allow a more effective manufacturing control***

Since the 1980s, the theoretical understanding of the correlations between logistic objectives and how they can be influenced has clearly deepened. New theoretical findings in modeling logistic objectives can trigger new developments in manufacturing control procedures. This is illustrated by a number of examples:

- Both *Little's Law* [Litt-61*] as well as the *Funnel Formula* [Bech-84] formulate a correlation between the production's work-in-process (WIP), its output and the order throughput time. At the beginning of the 1970s, Wight already concluded [Wigh-70*] that regulating the WIP would allow throughput times to be controlled. Subsequently, numerous methods for releasing orders that consequently regulate the production's WIP were developed.
- More recently, considerable advances were made in modeling due date deviations (referred to here also as lateness) as well as schedule reliability [Yu-01]. Accordingly, the mean *lateness* of orders results from the ratio of the production's backlog and output rate. Thus, methods for controlling backlogs will evidently take on greater significance [Brei-01, Pete-96, Remp-03]. Meanwhile, the finding that the *schedule reliability* is a function of the mean and variance of the lateness has lead to the suitability of sequencing rules being reassessed.
- *Logistic Operating Curves* (LOC) describe the conflict between the logistic objectives. Logistic Operating Curves in the production area depict the correlation between the WIP, throughput time and utilization of a workstation [Nyhu-91]. In doing so they allow a Logistic Positioning within the field of conflict created by targeting low WIP levels and short throughput times on the one side and the goal of a high utilization rate on the other hand. In addition, Storage Operating Curves (SOC) quantify the correlation between store levels and the service level of a product [Gläß-95, Lutz-01, Lutz-02, Nyhu-09*]. Although production and Storage Operating Curves have not yet lead to new developments in procedures for manufacturing control, they simplify systematically setting the method parameters. They thus contribute significantly to attaining logistic targets.

***4 The practice of manufacturing control offers considerable potential for improvement***

There are enterprises that have mastered the principles of manufacturing control themselves and attain outstanding results. Generally speaking it has also been a long time since there was a one-sided transfer of knowledge between theory and practice. On the contrary, especially in the area of manufacturing control, many procedures have been developed on the shop floor. Leading scientific institutes therefore cultivate their dialogue with the practice. Nonetheless, there is considerable potential for improvement in the majority of production companies and this potential can frequently be exploited through comparatively simple measures. Thus, there is a remarkable opportunity for enterprises to reduce WIP levels and delivery times and to increase schedule reliability.

On the whole though there is an abundance of manufacturing control methods whose modes of operations and parameters are not commonly known. This book therefore introduces a selection of procedures and explains the tasks these methods fulfill and their parameters. Our focus here is on *methods* because they standardize decisions. In doing so, they help to streamline the decision process and accelerate decision making while at the same time often relieving operators from mindless routine tasks. However, they also involve considerable risks. In particular, they often take away the worker's control in the decision making so frequently, no one verifies whether or not the decision met by the method is still practical with regards to the overall targets. It is also not unusual that expectations linked to implementing a method are disappointed. There are at least five reasons for this:

1. *Lack of potential*: Partly, the production simply does not have the potential required for achieving the logistic targets. In this case, the solution lies not in improving the manufacturing control, but rather in improving the production itself (e.g., through shortening setup times) or in constructing the product to be suitable for manufacturing.
2. *Starting at the wrong point*: The cause of frequently failing to attain targets does not always lie in the area in which the selected manufacturing control method is applied. If for example, the schedule reliability is reduced by a lack of sequencing compliance and a lack of backlog control, applying a method for releasing orders cannot make improvements.
3. *Unsuitable methods*: The method is not suitable for the specific application case e.g., because the diversity of the variants is too great or the methods are not adjusted to the complexity of the material flow.
4. *Incorrectly parameterized method*: The impact of a method is considerably dependent on the parameters set for the method. Nonetheless, only a few enterprises devote enough consideration to this. Many companies wrongly estimate the significance of the parameters. Moreover, they often do not know how they should suitably set the parameters.
5. *Mistakes in implementing*: Failing to attain targets on the shop floor can, at least in part, also be explained by mistakes in implementing methods. A known example of this is the practice of many enterprises of releasing a part of the

orders before the planned start date so that they ensure a punctual completion. As a result the WIP in production increases and urgent orders compete for resources with non-urgent orders. The early completion of a few orders nevertheless inevitably delays the throughput of the remaining orders and can thus cause their lateness. Consequently, the delivery reliability decreases.

With the exception of the first case, in which there is no logistic potential, enterprises can attain their logistic targets and thus in many cases immediately and to a considerable extent increase their competitiveness by improving manufacturing control. In order to do so though, it is necessary to develop a deeper understanding of manufacturing control and the methods implemented. This book aims to promote this understanding and to point out the levers for exploiting existing potential.

## 1.2 A Manufacturing Control Model

Manufacturing control is a component of Production Planning and Control (PPC). It is the job of PPC to pre-plan the continuous production program for a number of planning periods, to derive the required materials and resources from that and to implement the production program despite unavoidable disruptions such as staff shortages, machine malfunctions, supply delays and rejects [Wien-97]. The Aachen PPC Model, which is primarily known in German speaking countries, differentiates between key tasks and cross-functional tasks (see [Lucz-99] as well as Fig. 1.1).

The key tasks of PPC are production program planning, material resource planning as well as the planning and control of external and in-house production. *Production program planning* determines which products in which quantities should be produced during the next planned periods. *Production requirements planning* derives the required materials and resources from the production program. In order to do so it determines the material requirements for components and parts, schedules the production orders and determines the load for the production's capacity groups. Generally, enterprises procure some of the components and parts from suppliers and manufacture the rest themselves. The difference between external procurements and in-house production is ultimately a question of the reference point within the supply chain: The order for a component is an in-house production for the supplier, but an external procurement for the receiving producers. The Aachen PPC Model allocates among other things tasks such as calculating the production lot sizes, finite scheduling, sequence planning and verifying availability to *in-house production planning and control*. Accordingly, tasks such as determining the order lot-sizes, obtaining and evaluating bids, and selecting suppliers belong to *external procurement and control* [Lucz-99]. The cross-functional tasks of PPC coordinate the order development across different production areas (*order coordination*), provide stock (*storage*) and measure the

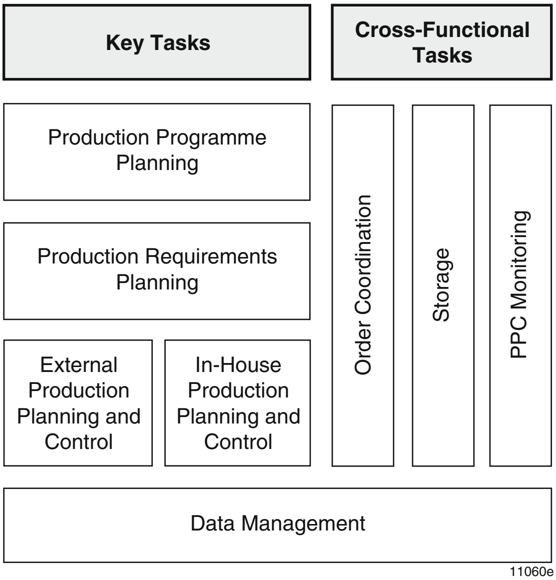


**Fig 1.1** Overview of tasks according to the Aachen PPC model (FIR)

attainment of logistic targets (*PPC Monitoring*). Both the key tasks as well as the cross-sectional tasks are dependent upon diligent *data management* [Lucz-99].

Manufacturing control which is the key task considered the most in this book is primarily referred to in the Aachen PPC Model as part of the in-house production planning and control. It thus forms only a small part of the model. Nonetheless, as already elaborated, it is highly significant for attaining logistic targets. In order to clarify the manufacturing control tasks and how they influence the logistic objectives, I would now like to introduce a manufacturing control model.

According to Wiendahl it is the job of manufacturing control to implement the targets set by production planning even when there are—frequently unavoidable—disruptions [Wien-97b]. This basic understanding of manufacturing control can be transferred to a manufacturing control model (Fig. 1.2). The model consolidates fundamental knowledge from the modeling of logistic objectives, from theories of manufacturing control and from the developments of methods which were gained from research at the University of Hanover's Institute of Production Systems and Logistics. Readers who do not have any previous technical knowledge of this model may have difficulty in immediately grasping the model in its entirety. This is however not necessary as it serves here only as a frame for bringing the manufacturing control tasks logically together with the logistic objectives. The interactions will be extensively discussed in later chapters.

The model consists of four elements: production planning and control tasks, actuating variables, control variables, and logistic objectives. These elements are linked to one another by their interactions:

1. The tasks determine the actuating variables.
2. The control variables result from the deviation of two actuating variables.
3. The control variables determine the logistic objectives.

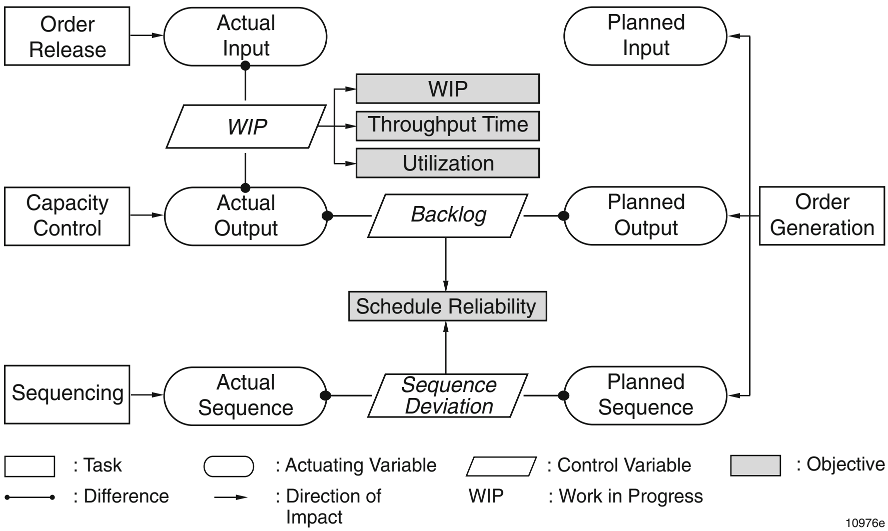


**Fig. 1.2** Manufacturing control model

The elements of the model can be clarified as follows:

1. *Tasks*: Manufacturing control tasks include *releasing orders, controlling capacities* and *sequencing*. The release of orders entails determining the time point and the sequence in which the orders are dispatched for production. It therefore sets the actual input for the production whereas the capacity control ascertains the workers' hours and how long which operator works on which machine. It thus influences the actual output of the production[1]. Sequencing determines the succession in which orders are processed on a workstation. *Generating orders* determines the planned values for the input and output of the production as well as the planned sequence and is therefore a logical component of production planning. It frequently includes many subtasks such as production program planning, material resource planning and scheduling due dates and capacities. However, in make-to-stock productions the order generation is to some extent conducted using very simple procedures, for example, the Kanban Control. These methods—especially because of how quickly decisions have to be made—are frequently classified as manufacturing control methods, although they actually carry out planning tasks. Generally they do not explicitly determine the planned values. However, based on the logic of the procedure and the choice of the parameters it is possible to derive useful planning values.

[1] The production output is essentially influenced by the capacity, however, also by the production's WIP, as well as generally by the market demand for a product and to some degree also by the sequence in which the orders are processed. Representing the output as an actuating variable thus simplifies complex correlations for the sake of greater clarity.

2. *Actuating variables*: The actuating variables for manufacturing control are the *input* and *output* as well as the *sequence* in which the orders are processed. The model contains both the actual values determined by the manufacturing control as well as the planned values set by production planning. The input describes the work received by the production in the form of orders with a specific 'allotted time'. This actuating variable can be described by the amount and time point of the input and also includes the sequence in which the orders enter into production. Accordingly, the output can be described by the amount and time point of the work processed by a production. The sequence of the output is defined as an independent actuating variable with which the orders are processed by the production.
3. *Control variables*: The control variables of a manufacturing control result from the deviation between two actuating variables: The difference between the actual input and actual output of a production defines the production's *work-in-process* or *WIP* for short. Both of these variables are cumulatively measured over time. The WIP control variable impacts the logistic objectives WIP[2] and utilization of the production as well as the throughput times of the orders. The *backlog* is defined as the difference between the planned output and the actual output. Here too, it is necessary to measure these actuating variables cumulatively over time. With a positive backlog the planned output is greater than the actual output. The backlog decisively influences the schedule reliability of the production. The *sequence deviation* describes the deviation of the actual sequence from the planned sequencing. Together with the backlog, it impacts the schedule reliability of the production.
4. *Logistic objectives*: The model includes the basic logistic objectives *WIP, utilization, throughput time* and *schedule reliability*. The work-in-process is defined as the difference between the (cumulated) actual input and the actual output (see above). It influences how much capital is tied-up in the production's WIP and how much floor area is required in the production. The (WIP dependent) utilization describes the probability of not being able to operate a workstation because no order is available. It thus impacts the production costs. The throughput time of the orders is defined as the length of time from the release of the order to its completion. It therefore forms a lower limit for the delivery time of an order. The schedule reliability is defined as a percentage of the orders completed within a specified deviation of a planned completion date, which is smaller than a set due-date tolerance. The schedule reliability directly impacts the delivery reliability of an enterprise from the perspective of the customer.

The model can be employed for a number of purposes. For the practice of manufacturing control the following four seem to be the most significant:

[2] The WIP is both a control variable and logistic objective.

1. *Analyzing the failure to consistently attain targets*: The model makes it possible to analyze the causes for inadequately attaining logistic targets. Too high WIP levels, too long throughput times or a low WIP dependent utilization are the result of the actual input and actual output being insufficiently coordinated. The release of orders, therefore, should be coordinated with the capacity control. Low schedule reliability is caused by a positive backlog or by sequence deviations. If the backlog is positive, the enterprise's planned and actual output need to be better aligned. This concerns the order generation tasks as well as the capacity control. If sequence deviations arise, then the actual sequence needs to be aligned with the planned sequence and where necessary the planning process for determining the planned sequence should also be verified.
2. *Designing a manufacturing control*: The model indicates how a manufacturing control of the logistic objectives can be attained. A *WIP control* uses the order release to link the actual input to the actual output. The WIP, (WIP dependent) utilization and throughput times can therefore be controlled by it. A *backlog control* regulates the capacities so that the actual output constantly follows the planned output and the backlog is as close to zero as possible. This in turn increases the schedule reliability of the production. A *sequence control* impacts the schedule reliability similarly. It sets the processing sequence so that the actual sequence and the planned sequence coincide with another as much as possible.
3. *Developing an understanding of the system used for manufacturing control*: The model helps to create an understanding of the system used for manufacturing control in that it depicts the logical correlations between manufacturing control tasks and logistic objectives. A more comprehensive understanding of the system is further promoted in that the model describes all internal logistic objectives (WIP, throughput time, utilization, schedule reliability) and is not limited to a part of the objectives.
4. *Differentiating between planning and control*: The model illustrates the difference between the production planning and the manufacturing control. The production planning determines the planned values for the actuating variables, and the manufacturing control determines the actual values. This demonstrates the crucial significance of manufacturing control.

Nevertheless, the model also has its limitations, four of these I would like to mention here. All of them are generally the result of trying to keep the model clear and concise:

1. *The model does not depict any external logistic objectives*: The model only describes how the production planning and control influences the internal logistic objectives. The external logistic objectives 'delivery time' and 'delivery reliability', which are important from the customers' perspective, are decoupled from the internal objectives 'throughput time' and 'schedule reliability' where applicable by a planning parameter such as a delivery time buffer or time factor. The correlation between the external and internal logistic objectives is the focus of Chap. 3 (Modeling Logistic Objectives).

2. *The model only depicts one aspect of the interactions*: The model is limited to depicting the strong interactions. In addition to these there are a number of weaker interactions. For example, the sequencing can impact the output rate and therefore the production's output (e.g., with sequence dependent setup times). Furthermore, the production's input impacts the WIP and thus also the possible output. We will closely examine these and other dependencies in the later chapters of this book.
3. *The model does not depict any quantitative correlations*: Although all of the depicted dependencies are based on quantitative correlations, the model itself only describes the qualitative correlations. In the following discussion it will therefore be supplemented by the Hanoverian Funnel Model.
4. *The model does not contain all of the manufacturing control tasks*: The Aachen PPC Model [Lucz-99] allocates additional tasks to manufacturing control. An especially relevant task for attaining logistic targets is the 'distribution of work' [Wien-02]. This task determines on which of a number of alternative work centres an order will be processed. Distributing the work will only be explained indirectly in the following. Generally, however, it can be shown that with identical machines and sequence independent setup times, it is practical not to allocate the orders to a specific machine ahead of time [Wien-02, Wien-97b]. Instead, it is enough that once a machine has completed an order, it always selects the order with the highest priority from a central queue. Even with different machines or sequence dependent setup times there is still a case to be made for not actively dividing work, but rather only fixing a suitable sequencing rule.

## 1.3 Book Layout

The methods described in this book fulfill all of the tasks outlined in the manufacturing control model:

1. generating orders
2. releasing orders
3. sequencing
4. controlling capacities

Although generating orders is a production planning task, it is presented here for different methods of make-to-stock production. These include procedures that generate orders quickly and are event oriented (e.g., Kanban Control) and are thus generally not a component of the periodic planning run in enterprises.

In simple cases, these tasks completely cover the controlling of the order fulfillment process from the point a customers places a demand up to the product delivery. In all cases they influence attaining the logistic targets—as described in the manufacturing control model. Figure 1.3 illustrates the interplay between the individual tasks during the order fulfillment process. Based on the customers' demand, orders are generated which are released according to defined criteria.

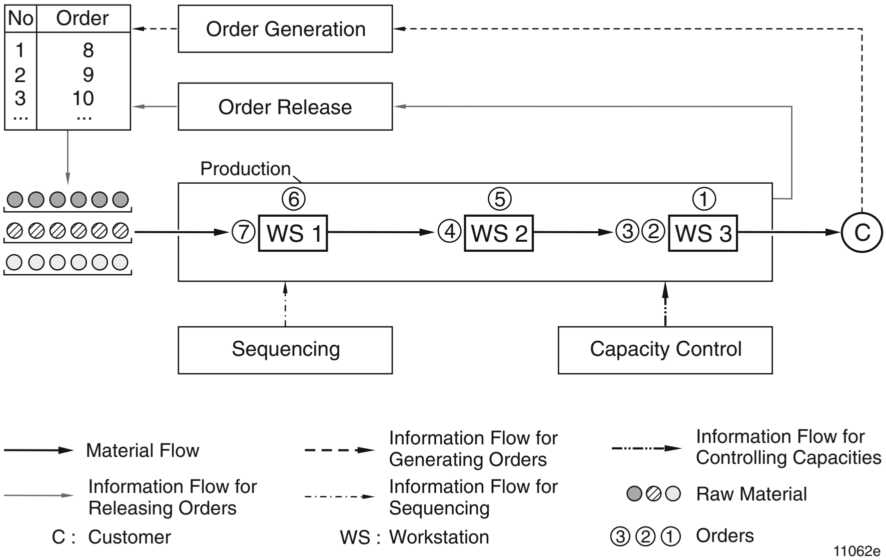


**Fig. 1.3** Flow of information for controlling the order fulfillment process

The capacities are controlled and the sequencing is set at the workstation. Flows of information pertaining to specific tasks then arise from this.

Methods which fulfill tasks other than the four mentioned will be described only briefly, when at all. This applies especially to methods which schedule orders (e.g., finite scheduling), plan capacities, determine lot-sizes, set delivery dates or make decisions about accepting orders. This choice is not intended to signify a devaluation of these methods or to call into question their suitability.

Based on these initial considerations the book is divided into six parts whose contents will be expanded upon in the following (see Table 1.1).

**Part A: Fundamentals of Manufacturing Control** The first part of this book is dedicated to the fundamentals of manufacturing control and consists of five chapters:

**Table 1.1** Layout of the book

| Part | Content | Chapter |
|---|---|---|
| A | Fundamentals of manufacturing control | 2–6 |
| B | Methods for generating orders | 7–15 |
| C | Methods for releasing orders | 16–24 |
| D | Sequencing | 25 |
| E | Controlling capacities | 26–28 |
| F | Configuring the manufacturing control | 29 |

- Chapter 2 defines the logistic objectives and explains their significance for the enterprise's success. In doing so it also accounts for the importance of manufacturing control on the whole.
- Chapter 3 discusses the correlations between the actuating variables, control variables and logistic objectives represented in the manufacturing control model. In addition it depicts the connection between the internal logistic objectives and the external logistic objectives which impact the customers. The modeling is based on the theoretically and practice proven combination of the Hanoverian Funnel Model, the Throughput Diagram and Logistic Operating Curves. This chapter also plays a key role with regards to the designing of manufacturing control methods.
- Chapter 4 describes the production planning tasks. Based on the customers needs these determine the planned values on which manufacturing control orients itself. Production planning is thus tightly interlocked with manufacturing control.
- Chapter 5 discusses the manufacturing characteristics relevant to manufacturing control. On the one hand, this is necessary because the possible applications of one part of the manufacturing control methods are restricted to specific types and principles of manufacturing. On the other hand, it is shown how the logistic objectives can be influenced by different factors which lay outside of manufacturing control.
- Chapter 6 is dedicated to production planning and control across the entire supply chain. Taking up the continuing discussion about managing supply chains and/or networks it focuses on analyzing the causes of increased demand fluctuations in the supply network i.e. the so-called "Bullwhip Effect". From here, requirements especially for generating orders within the supply net can be derived.

**Part B: Generating Orders** An important class of methods generate orders and with that the planned values for the input and output of the production and the order sequencing. The feasibility of these planned values impacts the possible schedule reliability of the production. Furthermore, the methods provide the planned values for the production's WIP and the throughput time of the orders. Customer orders or store outputs usually form the basis for generating orders. Among the techniques applied for generating orders are MRP-II and make-to-stock methods (e.g., Kanban Control, Order Point System or Base Stock).

**Table 1.2** Methods described for generating orders

| Chapter | Method for generating orders |
|---|---|
| 7 | Fundamentals of order generation |
| 8 | Order point system |
| 9 | Kanban |
| 10 | CORMA |
| 11 | Synchro MRP |
| 12 | Hybrid Kanban/CONWIP control |
| 13 | Cumulative production figures |
| 14 | Base stock |
| 15 | Production authorization cards |

Procedures for generating orders are implemented both in production and commercial enterprises. Many companies also control different products using different methods. Therefore, an enterprise can employ a number of methods for generating orders.

Eight different methods for generating orders will be described here, some of which include a number of variations (Table 1.2). The first chapter of Part B describes the fundamentals of order generation. The remaining chapters explain make-to-stock methods which generate orders based on events.

When generating orders, the production's capacity is frequently considered insufficiently or not at all. This is an important reason for combining methods that generate orders along with those for releasing orders (Part C) and controlling backlogs (Part E).

**Part C: Releasing Orders** The order release determines the production's input. Many methods for releasing orders delay or accelerate the release of orders with the goal of controlling the WIP or balancing the load. They are generally implemented in order to align the load with the production's actual WIP situation. The order release can concern an entire order or individual operations of an order. Methods for releasing orders influence the WIP and the (WIP dependent) utilization of a production as well as the order's throughput time.

Eight different methods for releasing orders will be discussed here (Table 1.3). Some of these include in turn a number of variations. The fundamentals of releasing orders will be explained at the beginning of Part C.

**Table 1.3** Methods described for releasing orders

| Chapter | Method for releasing orders |
|---|---|
| 16 | Fundamentals of releasing orders |
| 17 | Due date based order release |
| 18 | CONWIP |
| 19 | Bottleneck control |
| 20 | Workload control |
| 21 | Load oriented order release |
| 22 | Order release with linear programming |
| 23 | POLCA |
| 24 | Decentralized WIP oriented manufacturing control |

**Part D: Sequencing** Sequencing rules determine the sequence in which queued orders are processed on a workstation. They primarily impact the production's schedule reliability and therefore the delivery reliability or service level of an enterprise. In some cases the sequencing can increase the output rate of the production.

Part D introduces sequencing rules relevant to the shop floor and which influence the logistic objectives ‘delivery reliability’, ‘service level’, and ‘output rate’. Moreover, it explains the significance of a high degree of sequencing compliance.

**Part E: Controlling Capacities** The capacity control ascertains on short notice which measures are to be implemented for adjusting capacities. In particular it determines overtime, shortened work hours and other special measures related to the flexibility of capacities.

It thus primarily impacts the production's backlog and therefore influences the schedule reliability. Part E introduces different methods for controlling the capacities. They differ with regards to the set target (e.g., increasing the schedule reliability/service level, maximizing the output rate) as well as with regards to the area applied (e.g., make-to-stock/make-to-order productions) (Table 1.4).

**Table 1.4** Methods described for controlling capacities

| Chapter | Method described for controlling capacities |
|---|---|
| 26 | Fundamentals of capacity control |
| 27 | Backlog control |
| 28 | Further methods for controlling capacity |
| | Plan oriented capacity control |
| | Due date oriented capacity control |
| | Output rate maximizing capacity control |
| | Inventory based capacity control |

**Part F: Configuring the Manufacturing Control** Every production company has the task of configuring its manufacturing control. In order to do so it has to decide which methods will be implemented for generating orders, releasing orders, sequencing, and controlling capacities. Part F, therefore, explains the criteria which should be taken into consideration when selecting measures and exemplarily presents possible combinations.

**Description and Discussion About Manufacturing Control Methods** The methods described in Parts B, C and E for generating orders, releasing orders and controlling capacities form the main component of this book. Each of the descriptions follow a basic, uniform structure.

- In the first section of each chapter the procedural rules are described and illustrated using an example. A comparatively large amount of space is dedicated to describing the methods. Time and time again discussions with students and practitioners showed that a brief description of the procedure was insufficient for developing a detailed understanding of them.
- The second section discusses the procedural rules from the perspective of various aspects of logistics. In doing so both the strengths and weakness of a method will be considered. As a result important information about the conditions for applying a method arises.
- The third section of a chapter focuses on setting the method's parameters. All too often, this aspect is considered insufficiently. Nonetheless, determining the method's parameters is a decisive factor for successfully applying the method.

For each of the methods it will also be shown how the parameters are connected to the logistic objectives. This allows enterprises to determine the method's parameters in two model based steps: In the first step, the company establishes the planned values for the logistic objectives with a Logistic Positioning. This step is generally the same for all manufacturing control methods and is based on the modeling of the logistic objectives discussed in the section on fundamentals (Part A). In the second step the planned values for the logistic objectives are converted into control variables based specifically on the individual methods.

- The fourth section describes applying the manufacturing control across the supply chain. This is especially relevant for procedures employed in generating orders, which to some degree differ considerably with regards to their suitability for being implemented throughout a supply chain. In contrast, the application of methods for releasing orders and controlling capacities are usually limited to a single manufacturer.
- Finally, the fifth section concentrates on applying the method. This section differs noticeably for each of the methods. Generally, the more frequently a method is used on the shop floor, the more extensive the discussion is. Thus detailed case studies are presented for the Due Date Based Order Release and Order Point Systems. For procedures implemented less frequently however, the section—when at all present—is limited to examples and conditions for applications specified in previous literature. The examples for configuring the manufacturing control, found in Chap. 27, also have a direct relation to companies.

In order to attain logistic targets, a fundamental understanding of manufacturing control is imperative. The logistic objectives are the starting point for the discussion in the next chapter.

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