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# Configuration Logic of Standard Business Processes for Inter-Company Order Management

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## 1. Introduction

Today's manufacturing companies embedded in non-hierarchical production networks are facing multiple and dynamic customer-supplier-relationships. In the course of increasing complexity of products and growing needs for flexibility and product variation companies focus more on core competencies and thus more production processes are shifted to external suppliers. This complex environment leads to growing coordination-efforts and wasteful turbulences throughout the entire network. The result is a delivery reliability of usually less than 65% within the European machinery and equipment industry generating an estimated loss of efficiency of 1 billion Euros per year. Besides additional costs the missing delivery reliability entails poor customer satisfaction and increased lead times compromising the competitiveness of individual companies as well as the entire machinery and equipment industry (Gunasekaran, 2000; Reinhart, 2006).

In order to handle the given complexity, the procurement processes have to be managed according to the needs of the respective situation determined by the ordered product and the involved supplier. That means, the design, standardization and configuration of practically applicable order management processes according to the certain business context becomes a key factor. A context-aligned process configuration would lead to a tailored capacity to act and could improve performance and delivery reliability within the machinery and equipment industry.

The issue of poor delivery reliability is addressed within the publicly funded research and development project "inTime" (Funded by the 7th Framework Program of the European Commission, EU FP7-NMP, No. NMP2-SL-2009-229132). Within the project typologies are derived based on practical input from companies which distinguish and characterize certain product / service-types as well as certain business-relationship types, which have a direct influence on the design and handling of the respective order management processes between the involved companies. These types then serve as starting point for the limitation and design of relevant reference process phases of order-handling, respectively procurement-handling. The processes are described in detail and are enriched by the detailed definition of the transferred information within the inter-company interfaces.

## 2. Types of information exchanged in the course of the order execution

The exchange of information is a basic prerequisite for the coordination of the inter-company order execution. That is to say also for the division of labor in general. According to (Schuh & Westkämper, 2006) and (Wiendahl & Meyer, 2006), the information exchanged between the network partners in the course of the inter-company order execution can be distinguished based on the typical, time-logical sequence of tasks concerning the interaction of the involved parties. In this context, the first task of interaction usually refers to a declaration of intent, which basically initiates the customer-producer-interaction or respectively the producer-supplier-interaction in the first place. The corresponding type of information exchanged at that point is consequently called intent information. This type for instance encompasses inquiries or requests in written form. The aforementioned task is usually followed by the task of clarifying the specifications of the product or service to be exchanged. The corresponding information exchanged between the network partners in this context is thus called specification information. On the one hand, this second type of information respectively encompasses order-independent master data, such as standard drawings or parts lists. On the other hand, it furthermore includes order-specific data, which basically represent the customers influence on the product or service to be provided by the producer or respectively the producer's influence on the product or service to be provided by a certain supplier. As far as the complex, highly individualized products or services of the addressed target group are concerned, existing master data is usually modified or extended to a considerable extent by order-specific data to comply with order-specific requirements.

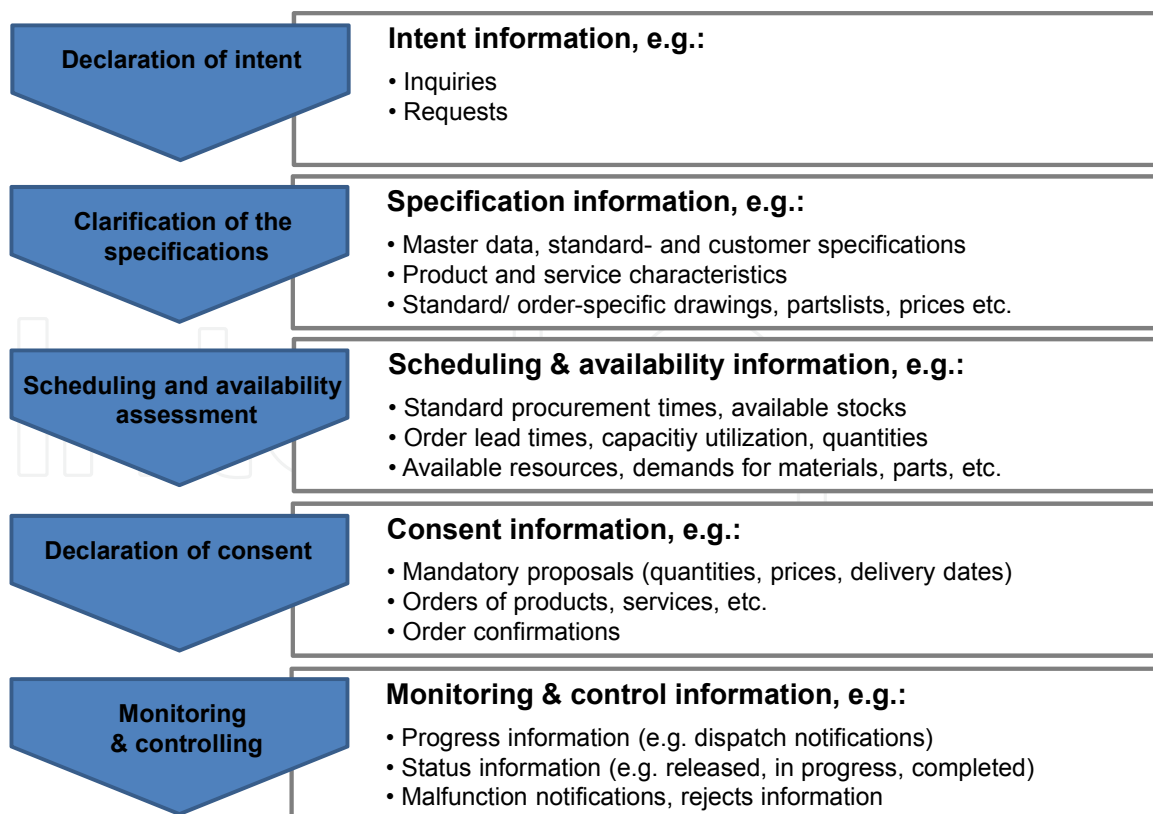


Fig. 1. Types of information exchanged in the course of the order execution

The next interaction task basically deals with the scheduling of the intended product or service exchange as well as with the assessment of availabilities. The information exchanged in this context is hence called scheduling & availability information. This type of information again includes master data, such as procurement times of standard parts, and order-specific data, such as current demands for materials or parts and required resources. In the following course of the companies' interaction, a number of written documents typically have to be exchanged in order to provide a legally binding basis for the scope of supply to be provided. These documents, among which are e.g. mandatory proposals, reservations, orders and order confirmations, mainly stipulate the terms and conditions agreed on during the clarification of the specifications as well as the during the scheduling and the availability assessment. The type of information exchanged in this context is called consent information. The final interaction task of monitoring & controlling eventually leads to the last type of information exchanged in the course of the inter-company order execution. That is the corresponding type of monitoring & control information. Monitoring & control information are for instance internal or external progress or status reports, dispatch or release notifications as well as sporadic malfunction information.

### 3. The basics of typification

A typification can basically be regarded as a process of aggregation and abstraction, which describes, structures and eventually reduces the complexity of an issue to essential aspects, via the definition types. Numerous projects from research and practice have proven the method of typification to be a suitable tool for the structuring of complex organizational situations, which include a variety of different business forms (Grosse-Oetringhaus, 1974; Büdenbender, 1991; Diemer, 1992). In this context, a type represents a number of objects with a common set of features and attributes. A conceptual and structural basis for the creation of types is typically provided by morphological schemes, also called morphologies. Morphologies are usually matrices, which visualize the set of features and their respective attributes characterizing a certain type (cf. Figure 2). A fictive "type 1" could for instance be characterized by the combination of the attributes highlighted in grey (A2, B1, C2, D2) whereas a fictive "type 2" could be described by the attributes highlighted in green (A3, B2, C3, D3).

Feature	Attribute 1	Attribute 2	Attribute 3	...
A	A1	A2	A3	...
B	B1	B2	B3	...
C	C1	C2	C3	...
D	D1	D2	D3	...
...	...	...	...	...

Fig. 2. Structure of a morphological scheme

The respective choice of features within a morphology highly depends on the requirements of the desired analysis. Since the creation of types is therefore always subject to a specific

purpose, no universally valid types can usually be derived. A derived type is in fact rather linked to the particular interest of the observer and has to comply with his goals and problems (Förster, 1988).

#### **4. Type-based characterization of producer-supplier interaction**

The characteristics of the producer-supplier-interaction are substantial, both to the design of order execution reference processes and to the design of the corresponding processes of interaction. That is because those characteristics influence the time-logical arrangement of the tasks and producer-supplier-interfaces as well as the respective way of interaction between the producer and the suppliers at those interfaces.

##### **4.1 Derivation of morphologies**

Basic influencing factors on the producer-supplier-interaction are such factors, that have a major effect on when and how the main producer and his 1st-tier suppliers have to interact in the course of the inter-company order execution as well as which information have to be exchanged during their interaction.

The first basic influencing factor regarded is the type of product or service exchanged between a producer and a supplier. Complex products or services for instance typically require significantly higher efforts of coordination at earlier phases of a project than less complex products or services due to a far more distinctive exchange of specification information (Schmidt, 2008). Besides the type of product or service exchanged, it is in particular the type of business relationship between the producer and the supplier, which characterizes the producer-supplier-interaction. For instance, different levels of confidentiality between the producer and his suppliers exist and thus necessitate a very differentiated and individualized design of information flows in the context of the producer-supplier-interaction (Meyer et al., 2006).

In order to derivate morphologies of typification both product- and service-related features as well as business-relationship related features and attributes have been analyzed and determined.

##### **4.2 Product/service morphology**

The feature level of individualization of a product or service provided by a supplier describes if and to which extent customer- or producer-induced modifications are necessary in the course of the order execution to eventually comply with certain order-specific requirements (Besslich & Lumbe, 1994; Scherer, 1991; Schomburg, 1980). The feature level of specification characterizes how detailed the requirements and characteristics for a product or service to be exchanged are specified in the beginning of the order-specific producer-supplier-interaction. The higher the level of individualization and the lower the level of specification, the higher is typically the necessary effort of coordination and thus the more intense is the interaction between the producer and the supplier in the course of the inter-company order execution (Hillebrandt, 2002; Schulte-Zurhausen, 2005). Furthermore suppliers of highly individualized and poorly specified products or services have to be involved in much earlier project phases than suppliers of less individualized and more specified products or services.

		Feature		Attributes						
		Product-/service-related features	Level of individualization	Order-specific development		Order-specific modification		Standardized		
Level of specification	Requirements set, free solution		Requirements set, solution partially set		Requirements set, solution mainly set		Requirements set, solution set			
Complexity (service)	Several, heterogenous subservices			Several, similar subservices		Few, similar subservices				
Complexity (product)	Multi-part product with complex structure			Multi-part product with simple structure		Few-part product with simple structure				
Changes to the specifications	Frequent producer-induced changes		Frequent supplier-induced changes		Occasional producer-induced changes		Occasional supplier-induced changes		Changes insignificant	
Substitutability of supplier	No substitution possible			Substitution difficult			Substitution uncomplicated			
Influence on the substitution	No influence				Indirect influence (external compensation)		Direct influence (internal compensation)			

Fig. 3. Product/service morphology

The feature complexity refers to the design-based, structural characteristics of the product or service exchanged between the producer and the supplier (Scherer, 1991; Schomburg, 1980; Wildemann, 2000). The complexity of a product or service thus affects the producer-supplier-interaction in a similar way as the level of individualization and the level of specification. Moreover, complex products or services often require a rather frequent interaction of the producer and the supplier throughout the entire order execution. That is due to their typically high importance to the overall system ordered by the customer and the corresponding necessity of distinctive monitoring & controlling procedures (Rotering, 1993).

The feature changes to the specifications refers to the frequency and the initiator of the changes applied to the specifications of a product or service exchanged between the producer and a supplier. In particular frequent changes to the specifications of a product or service can, depending on the level of individualization, specification and the complexity of a product, result in considerable extra-efforts of coordination and thus in an increase of the intensity as well as the frequency of the producer-supplier-interaction. This is due to the necessity of repeating processes that have already been started or were even completed. The feature changes to the specifications therefore indicates how intense the producer-supplier-interaction is in the course of the inter-company order execution but provides little information about when this interaction is taking place.

The feature substitutability of the supplier includes if and to which extent a specific supplier can be substituted in the context of a specific project (Eberle, 2005; Scherer 1991; Schuh et al. 2006). The higher the level of individualization and the higher the complexity of a product or service, the less suppliers are typically capable of providing it (Arnold, 2004; Homburg, 1995; Schwerk, 2000). Whereas the substitution of suppliers is therefore often not possible or at least quite difficult as far as highly individualized and complex products or services are concerned, the substitution of suppliers is rather uncomplicated as far as standard products or services are concerned. The feature influence on the substitution represents the producer’s influence on the substitution of a supplier (Arnold, 2004; Eberle, 2005; Kraljic, 1988).

### 4.3 Business-relationship morphology

The characteristics of business relationships are influence the interaction of the main producer and his 1st-tier suppliers in the course of the inter-company order execution. Five features were derived and are set in the framework of a business-relationship morphology.

The feature level of institutionalization addresses the intensity of the business relationship between the participating parties in a business network. The level of institutionalization is closely related to the second feature information infrastructure. If a supplier is for instance both legally and economically independent from the producer, their business relationship is project-specifically institutionalized. In this case, the business partners often do not have a common information infrastructure but apply a rather conventional exchange of information via fax, email or telephone. However, the more intense a business relationship is and the more integrated the information systems of the partners are, the easier it is usually to cope with the need for information in the course of the order execution. The feature stipulation of the sourcing conditions determines to which extent the collaboration, concerning rights and duties as well as their enforceability, between the producer and the supplier is legally set prior to the actual producer-supplier-interaction. The legal framework, set by the governmental legislation, provides the basis for optional, far more detailed contracts and policies negotiated between the business partners (Wildemann, 2000).

	Feature	Attributes			
Relationship-related features	Level of institutionalization	Project-specific	Framework agreement	Capital participation	
	Information infrastructure	Conventional exchange of information	Standardized exchange of information	Integrated information systems	
	Stipulation of the sourcing conditions (Specifications set for...)	Conditions not stipulated	Conditions partially stipulated		Conditions fully stipulated
		Supplier and product	Supplier, product, quantities and prices		Supplier, product, quant., prices, procurement & delivery times ...
	Direction of interaction	Bilateral		Unilateral	
	Availability of planning information	On request	Direct access	Information stipulated ex ante	Information and feedback-times stipulated ex ante

Fig. 4. Business-relationship morphology

The last two relationship-related features, namely the direction of interaction and the availability of planning information, are both closely related to the last mentioned feature stipulation of the sourcing conditions (Wildemann, 2000). These two features basically determine the producer's options of accessing planning-relevant information of the supplier. An unilateral interaction implies, that relevant planning information is provided by the supplier without any further interference of the producer. It necessitate an early stipulation of information and the determination of adequate feedback-times, which results in high efforts of coordination and planning during the early phases of a project but rather

small efforts at later phases. The exact opposite typically prevails for bilateral interactions during which planning information is only available on request. The two features thus also provide information about when the producer and a particular supplier interact during the inter-company order execution.

#### 4.4 Definition of product/service types

Referring to the product/service morphology presented in chapter 4.2, four different product/service types can be identified. These types are in the following termed as the bottleneck-, the long-running-, the standard-outsourced- and the diverse-source product or service.

The standard-outsourced type refers to few-part products with simple structures. This type is not regarded as the most relevant type in the context of late deliveries since production times are comparably short, there's a huge supplier base offering those products and substitution is comparably simple. The diverse-sourcing product/service type covers products or services that can be provided by external suppliers as well as by the producer himself or at least that the producer is basically able to produce these products/services in-house. Since the producer can thus directly influence the supplier-substitution by providing the product himself, the diverse-sourcing products are less critical regarding the supply risks. Therefore standard-outsourced and diverse-sourcing products or services are not described more in detail within this paper.

Concerning the criteria mentioned above the bottleneck product or service and the long-running product or service best represent the stated problems of late deliveries in the machinery and equipment industry. Therefore these two types are presented in the following. The analysis about the information requirements in the coordination-points in the following chapters will also base upon these two product/service-types.

The bottleneck product or service, is primarily characterized by low levels of specification and high levels of individualization. This often necessitate an order-specific development or at least a substantial modification of existing product or service structures. The product/service requirements are usually set, whereas its characteristics to comply with those requirements can either fully or partially be determined by the supplier. Bottleneck products are furthermore usually very complex and consist of numerous parts. Bottleneck services typically include several, heterogeneous subservices. Those products or services are frequently subject to specification changes during the order execution, which are mainly induced by the final customer or the producer. Supplier-induced changes to the specifications are also conceivable though. This is not at least a result of the typically small number of available suppliers for bottleneck products or services and their respective market power.

At the same time, this makes it difficult or even impossible to substitute a supplier of bottleneck products or services in the course of the order execution. The main producer thus has to face considerable market-induced supply risks as far as this type of products or services is concerned. Fig. 5 shows the described characteristics of bottleneck products or services - marked in purple.

Concerning the relevance for the producer-supplier-interaction, products or services of this type are first of all characterized by the necessity of involving the corresponding suppliers



in the very beginning of a project. This is in particular due to the prevailing risks in supply and the necessity of determining the product/service specifications according to the customer's requirements. The exchange of information in those early phases hence basically refers to specification information as well as scheduling and availability information. As far as the project monitoring and controlling is concerned, bottleneck products furthermore require stringent progress and malfunction procedures in order to reveal supplier delays as soon as possible.

		Feature	Attributes				
Bottleneck product/service	Level of individualization		Order-specific development	Order-specific modification		Standardized	
	Level of specification		Requirements set, free solution	Requirements set, solution partially set	Requirements set, solution mainly set	Requirements set, solution set	
	Complexity (service)		Several, heterogenous subservices		Several, similar subservices	Few, similar subservices	
	Complexity (product)		Multi-part product with complex structure		Multi-part product with simple structure	Few-part product with simple structure	
	Changes to the specifications		Frequent producer-induced changes	Frequent supplier-induced changes	Occasional producer-induced changes	Occasional supplier-induced changes	Changes insignificant
	Substitutability of supplier		No substitution possible		Substitution difficult		Substitution uncomplicated
	Influence on the substitution		No influence			Indirect influence (external compensation)	Direct influence (internal compensation)

Fig. 5. Characteristics of "bottleneck" products or services

Products or services counted among the long-running type, are typically standardized or order-specifically modified (cf. Fig. 6). They are however in particular characterized by considerable long procurement times. Products or services of this type are either completely or mainly specified prior to the order-specific producer-supplier-interaction. Customer- or supplier- induced changes in specifications are usually rare. In contrast to the aforementioned bottleneck type, long-running products or services cannot be distinguished according to their complexity since basically all three complexity-attributes are possible. Even for highly standardized long-running products or services, there is however a considerable market-induced supply risk due to temporary shortages in supply. Those shortages are mainly caused by unexpected, short-term increases in demand and the resulting demand-overlap, which typically leads to decisive extensions of the anyway long procurement times. Against this background, a substitution of long-running product/service suppliers is typically not possible in the course of the order execution or at least very difficult.

Due to the typically long procurement times, the corresponding suppliers already have to be involved in the early phases of a project, that is for instance during the bid preparation process. Furthermore, the availability of long-running products or services should be

continuously checked and assessed during the project planning process. The effort of coordination between the main producer and the respective supplier is, compared to bottleneck products or services, usually smaller. This is due to the typically high levels of product specification and low levels of individualization. The exchange of information in this context thus mainly refers to scheduling and availability information. However, since long-running products or services often represent critical schedule- and production-related restrictions, intense and stringent project monitoring & controlling procedures are needed.

		Feature	Attributes				
Long-running product/service	Level of individualization		Order-specific development	Order-specific modification		Standardized	
	Level of specification		Requirements set, free solution	Requirements set, solution partially set	Requirements set, solution mainly set	Requirements set, solution set	
	Complexity (service)		Several, heterogenous subservices		Several, similar subservices		Few, similar subservices
	Complexity (product)		Multi-part product with complex structure		Multi-part product with simple structure		Few-part product with simple structure
	Changes to the specifications		Frequent producer-induced changes	Frequent supplier-induced changes	Occasional producer-induced changes	Occasional supplier-induced changes	Changes insignificant
	Substitutability of supplier		No substitution possible		Substitution difficult		Substitution uncomplicated
	Influence on the substitution		No influence			Indirect influence (external compensation)	Direct influence (internal compensation)

Fig. 6. Characteristics of “long-running” products or services

#### 4.5 Definition of business relationship types

Four ideal business-relationship types can be distinguished. These are the market-autarkic type, the cooperatively-autarkic type, the cooperatively integrated type and the hierarchically integrated type.

Project-specific co-operations occur in the market-autarkic as well as in the cooperatively-autarkic type whereas in the cooperatively-integrated type the supplier is economically highly dependent on the producer and in the hierarchically-integrated type the producer and the supplier have dependent power-structures and oftentimes integrated information infrastructure. Hence, in the context of this paper focusing on the improvement of delivery- and planning reliability in non-hierarchical networks of the machinery and equipment industry, characterized by project-related cooperations, only the market-autarkic and the cooperatively-autarkic types are further analyzed.

The market-autarkic business relationship type is primarily characterized by a frame contract - free collaboration between the main producer and its supplier and shows a low intensity of binding (cf. Fig. 7). The supplier in market-autarkic business relationships is both legally and economically independent from the main producer. Their collaboration is

furthermore project-specifically institutionalized. Investments in a common information infrastructure are therefore untypical and the applied communication media rather conventional (e.g. telephone, fax, email or mail). Due to the project-specific collaboration, the sourcing conditions - such as prices, quantities etc. - are usually not set prior to the actual producer-supplier-interaction in the course of the inter-company order execution. Only the product characteristics as well as the requirements for the supplier are specified in the first place. The exchange of information is usually bilateral and initiated by requests from either side.

	Feature	Attributes			
Market-autarkic relationship type	Level of institutionalization	Project-specific	Framework agreement	Capital participation	
	Information infrastructure	Conventional exchange of information	Standardized exchange of information	Integrated information systems	
	Stipulation of the sourcing conditions (Specifications set for...)	Conditions not stipulated	Conditions partially stipulated	Conditions fully stipulated	
	Direction of interaction	Bilateral		Unilateral	
	Availability of planning information	On request	Direct access	Information stipulated ex ante	Information and feedback-times stipulated ex ante
		Supplier and product	Supplier, product, quantities and prices	Supplier, product, quant., prices, procurement & delivery times ...	

Fig. 7. Characteristics of "market-autarkic" business relationships

Concerning the relevance for the producer-supplier-interaction, market-autarkic business relationships are in particular characterized by the fact, that the main producer has got almost no options of influencing the supplier's behavior. This matter of fact results from the project-specific cooperation and thus the absence of further legal agreements or even capital participations. Due to the rudimentary specification of the sourcing conditions, the producer furthermore needs to gather a lot of additional information during the gross and detail planning phase via time-consuming bilateral question-answer-interaction. Among those information are for instance additional specification information (e.g. prices) as well as scheduling and availability information (e.g. delivery times and dates) and monitoring and control information during later project phases. The supplier's input therefore considerably effects the plans and schedules created by the producer and often represents a restriction for the further planning.

The cooperatively-autarkic relationship type is characterized by a cooperative but at the same time market-oriented collaboration (cf. Fig. 8). This means, that similarly to the market-autarkic relationship type, the supplier is legally and economically independent from the main producer. However, their cooperation is based on a legal framework agreement, which e.g. contains further sourcing conditions. In addition to the product characteristics and the requirements for the supplier, quantities and the respective prices of the product to be exchanged, are thus typically specified prior to the actual producer-

supplier-interaction (partially set sourcing conditions). Further information, e.g. information concerning delivery times etc., are usually exchanged during the order execution via reciprocal, bilateral processes of interaction. This information usually has to be specifically requested by the producer. The communication media applied in this context is rather conventional (e.g. telephone, fax, email or mail). A partially standardized exchange of information, e.g. via internet-based sourcing platforms, may however also be found in the context of cooperatively-autarkic relationships.

		Feature	Attributes			
Cooperatively-autarkic relationship type	Level of institutionalization		Project-specific	Framework agreement	Capital participation	
	Information infrastructure		Conventional exchange of information	Standardized exchange of information	Integrated information systems	
	Stipulation of the sourcing conditions (Specifications set for...)		Conditions not stipulated	Conditions partially stipulated		Conditions fully stipulated
			Supplier and product	Supplier, product, quantities and prices		Supplier, product, quant., prices, procurement & delivery times ...
	Direction of interaction		Bilateral		Unilateral	
	Availability of planning information		On request	Direct access	Information stipulated ex ante	Information and feedback-times stipulated ex ante

Fig. 8. Characteristics of “cooperatively-autarkic” business relationships

Compared to the market-autarkic type of business relationships, the effort of coordination is smaller during the order execution, due to the additional specifications stipulated within the framework agreement. such as quantities and quantity-related prices.

### 5. Order-execution reference processes and inter-company interfaces

In the course of the following chapters, the reference processes for the inter-company order execution of producers in non-hierarchical networks of the machinery and equipment industry are worked out. For this purpose, the order-execution tasks will be described in detail and put in their time-logical order within the corresponding order-execution process. In addition, the points of interaction, that is the informational inter-company interfaces, between the producer and the suppliers will be pointed out. There are points of interaction between the customer and the producer as well and these are also shown in the figures. As these points of interaction are not of primary interest in the context of the paper, they are only mentioned for the sake of completeness but are not further explained. With regard to chapter 2, the types of information exchanged at the producer-supplier interfaces will furthermore be determined.

Figure 9 shows a detailed overview of the process activities within the general order-handling process in the machinery and equipment industry deviated from the Aachener Model for Production Planning and Control (PPC) (Schuh, 2006).

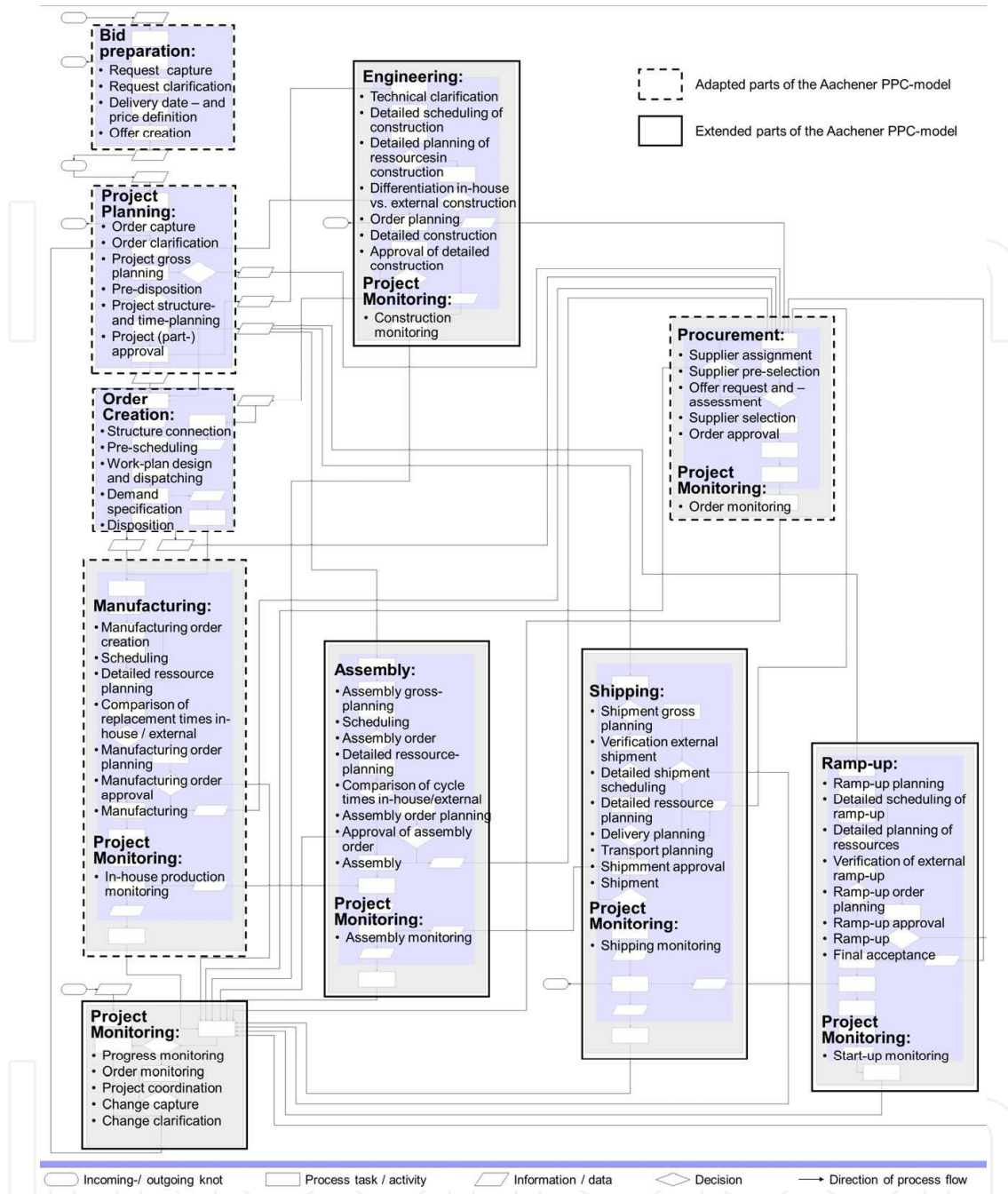


Fig. 9. Schematic overview of the detailed process-steps (Schmidt, 2008)

As stated before, the design of an optimal order-handling process is dependent on the product/service-type and the relationship type of each single transaction. The product/service-type determines the specific starting point of the order management process and its further handling. That means the product/service-type affects the consideration and order of the specific process steps performed for its accomplishment. The relationship-type determines the design and content of the coordination-points between producer and supplier. Consequently, the first step towards a configuration logic is the determination of the relevant type-specific process activities and their order on a gross level. These gross processes are visualized in Figure 10 in form of a process landscape.

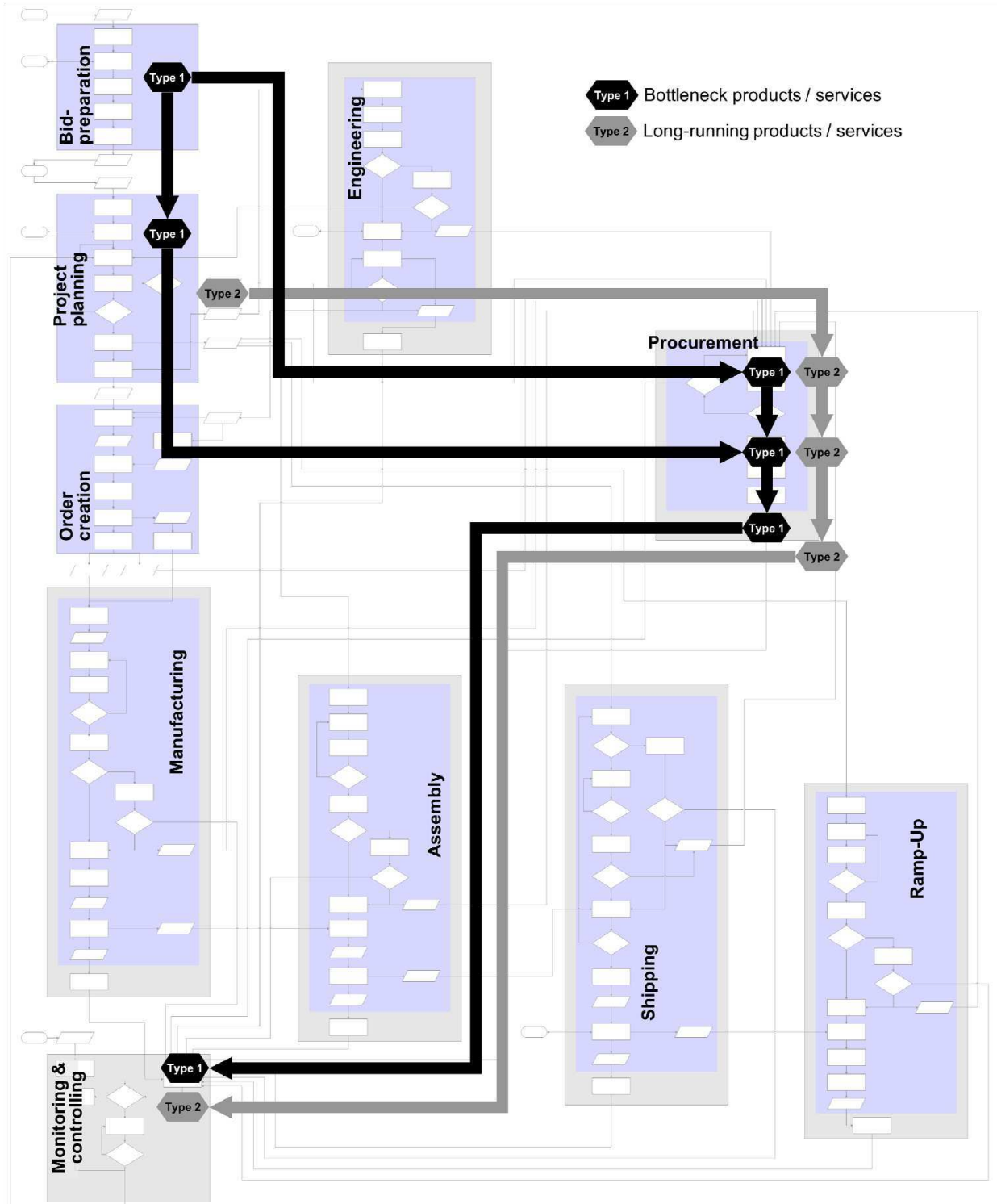


Fig. 10. Sequence of coordination points for bottleneck- and long-running products / services

The procurement of a complex bottleneck product e.g. requires the order-handling process to start already during the bid preparation phase of the producer. The procurement demand

has to be allocated via the procurement department, concretized during the project planning in terms of specification and availability and afterwards to be ordered by the procurement department and supervised in form of project monitoring. The process regarding an already known long-running product or service on the other hand starts within the project planning. When the long-running product or service has been requested and ordered by procurement, the progression of the purchased parts/services is also monitored.

Figure 11 illustrates which process steps are accordingly relevant for the order-management process to be analyzed – namely the bid preparation process, the project planning process, the procurement process and the monitoring and controlling process are illuminated as these process steps incorporate the main variables and leverages influencing delivery reliability in the focus of the determined product/service types of bottleneck- and long-running-products/services.

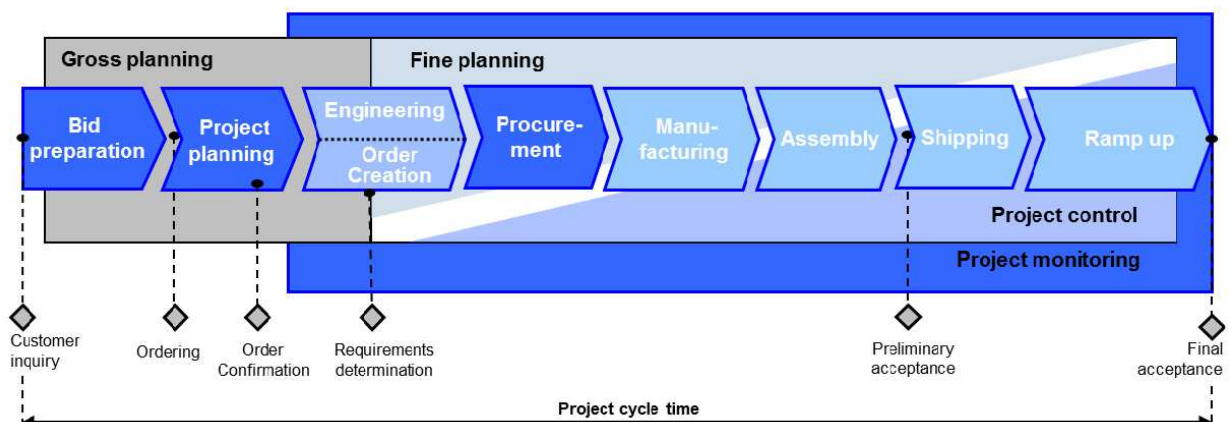


Fig. 11. Gross structure of planning and order-handling processes in the machinery and equipment industry

### 5.1 The bid preparation process

In the machinery and equipment industry, the process of bid preparation is typically initiated by a single customer inquiry. Accordingly, the first task within this process is usually the inquiry entry, during which the customer inquiry is registered and usually administrated in an IT-based information system (Cuber & Schmidt, 2012).

The inquiry entry is typically followed by the inquiry clarification & assessment. In the course of the inquiry clarification, it is of primary interest to transfer the more or less detailed customer requirements into adequate product specifications. The inquiry assessment serves the purpose of determining at what risks and benefits and to which extend the requested product or service and the therewith related project is realizable (Schuh & Schmidt, 2006).

Especially regarding rather complex structures, during the determination of the delivery date it is hard to obtain precise planning data. Therefore in this task at first empirical data or knowledge, such as data from comparable proposals and projects or the experience and

practical knowledge of the project team, has to be drawn in instead. The resulting project gross design already includes first make-or-buy decisions, which refer to main components and services. At that point, the feasibility of the components or services intended to be subcontracted, has to be discussed with potential main suppliers. This bilateral interaction and the corresponding bidirectional exchange of information between the producer and potential suppliers is the first producer-supplier-interface in the course of the inter-company order execution (cf. KL 1 in Fig. 12).

Proposals, which include all necessary schedule-, price- and specification-related information, have to be obtained by the producer at this point as aside from prevailing in-house restrictions, the available resources of the potential main suppliers and their ability to deliver have to be taken into account when determining the date of delivery.

In the following, an outside-purchasing suggestion concerning the reservation of external production capacities and critical outsourced items is already forwarded to the procurement department.

The next task in the course of the bid preparation process deals with the determination of the tender price and other commercial conditions based on in-house calculations and information derived from the supplier proposals. Within the final task of proposal creation, the commercial and legal conditions for the making of the requested product or equipment as well as for its delivery are set and all relevant information (e.g. technical specifications, commercial and legal conditions as well as the basic project schedules) are eventually consolidated in a final proposal. The process of bid preparation is terminated as this final proposal is submitted to the customer.

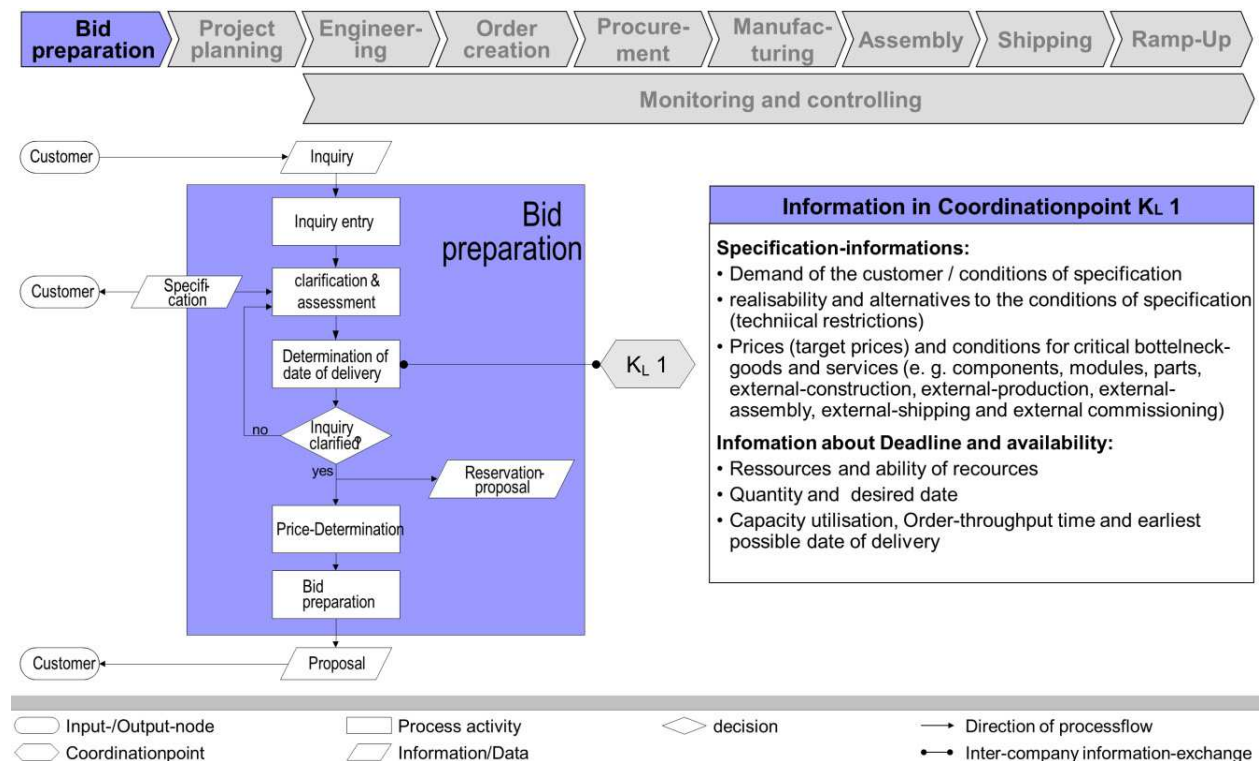


Fig. 12. Detailed structure of the bid preparation process (Schmidt, 2008)



## 5.2 The project planning process

The first task within the project planning process is the order entry, which deals with the registration and IT-based handling of the incoming order. In the course of the following task, the order clarification, the contents of the final proposal and those of the actual customer order are compared and assessed (Schuh & Schmidt, 2006). The specification, scheduling & availability information exchanged at that time between the customer and the supplier refer to a far more detailed and committing level compared to those exchanged in the course of the inquiry clarification & assessment.

In the course of the following task of project planning and order creation the overall project is segmented into subprojects and these are allocated to the various involved in-house departments and the chosen subcontractors. This task thus includes further make-or-buy analysis extending and detailing those made in the course of the bid preparation - which were basically limited to main components and services. According to the results of this make-or-buy analysis, potential suppliers furthermore have to be found, preselected and finally chosen. The task of project planning and order creation hence necessitates an intense interaction between the producer and various 1st-tier suppliers (cf. KL2 in Fig. 13), during which intent information, specification information as well as scheduling & availability information have to be exchanged. To determine the availability of time-critical buy-components or services restrictions of downstreamed external processes are taken into account in this task as well (Cuber & Schmidt, 2012).

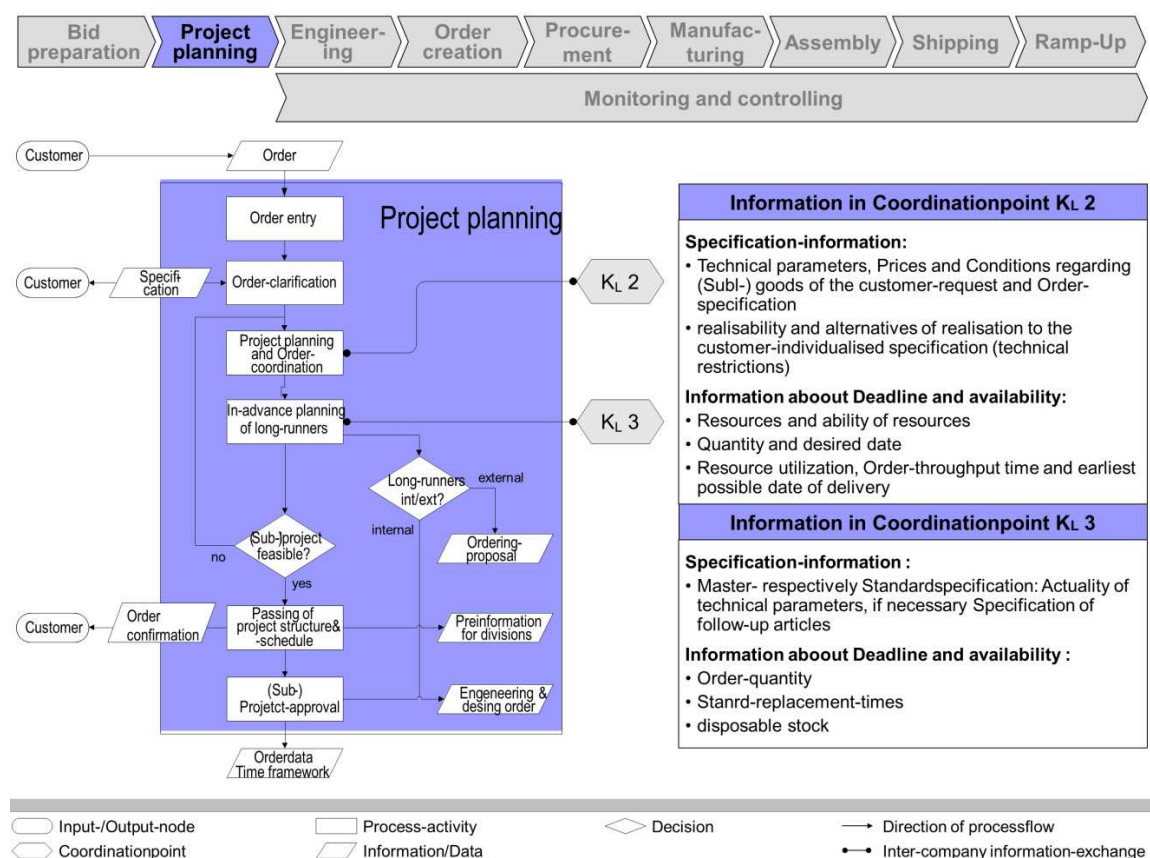


Fig. 13. Detailed structure of the project planning process (Schmidt, 2008)

The next task in the course of the project planning process is the in-advance planning of long-running parts & materials, which includes the identification of those parts and materials as well as the planning of their sourcing. "Long-runners" are those parts or materials, whose standard procurement times exceed the planned lead time of the corresponding order-execution process and which therefore have to be procured in advance. To assure a high quality of planning data, technical parameters as well as master- and standard-specifications have to be updated and the standard procurement times have to be checked (cf. KL3 in Fig. 13). Depending on whether the long-runners are produced internally or externally a production- respectively order-proposal is forwarded to the manufacturing- or procurement-department.

The in-advance planning of long-runners is followed by the assessment of whether the project is feasible as planned or not. If the project is considered as feasible, its project structure and schedules are subsequently passed. In the course of the passing of the project structure and schedules, the written order confirmation is send to the customer in which the commercial conditions as well as the confirmed deadline is binding stated. The final task within the project planning process, the (sub-)project approval, eventually launches the respective subprojects according to the project schedules and initiates the corresponding detail engineering & design order. In this context, each detail engineering & design order successively concretizes the project structure in terms of a continuously growing part list. Furthermore the sub-project approval triggers the transmission of order data and time framework to the process of order creation.

### 5.3 The procurement process

The question of where the needed materials, components or services should be purchased – that is the assignment of suppliers – is the starting point for the procurement process (Cuber & Schmidt, 2012). While some suppliers might be known for instance due to already existing business relationships, others still need to be found and chosen. Thus, the search for suppliers is the next task within the procurement process, if an appropriate supplier of a certain material, component or service is in fact unknown. Hence, this task basically serves the purpose of identifying potential suppliers. To determine whether a supplier is generally capable of providing the required materials, parts or services, a corresponding exchange of specification information is necessary at this point. This interaction between the producer and potential suppliers is represented by a producer-supplier-interface in the course of the inter-company order execution (cf. KL4 in Fig. 14).

The suppliers are asked – in form of bid requests - to submit a respective proposal. That means intent information as well as consent information are exchanged. After the suppliers' bids have been received, those are assessed according to company-specific criteria such as lowest price or earliest date of delivery. If it turns out in the following, that the created order plans do not comply with the overall project requirements, the created plans will have to be adjusted and the described activities need to – at least partially – be executed again. If the requirement of the producer is satisfied by the request of the supplier, the bid is classified as realizable and the respective supplier is assigned. Within the following task of order-approval, the producer first of all dispatches the orders to the involved suppliers. The corresponding exchange of consent information leads to the

producer-supplier-interface KL5 in the course of the inter-company order execution (cf. Fig. 14). Each order is eventually monitored and controlled in the course of the order monitoring & controlling, during which monitoring & controlling information have to be exchanged (cf. KL6 in Fig. 14).

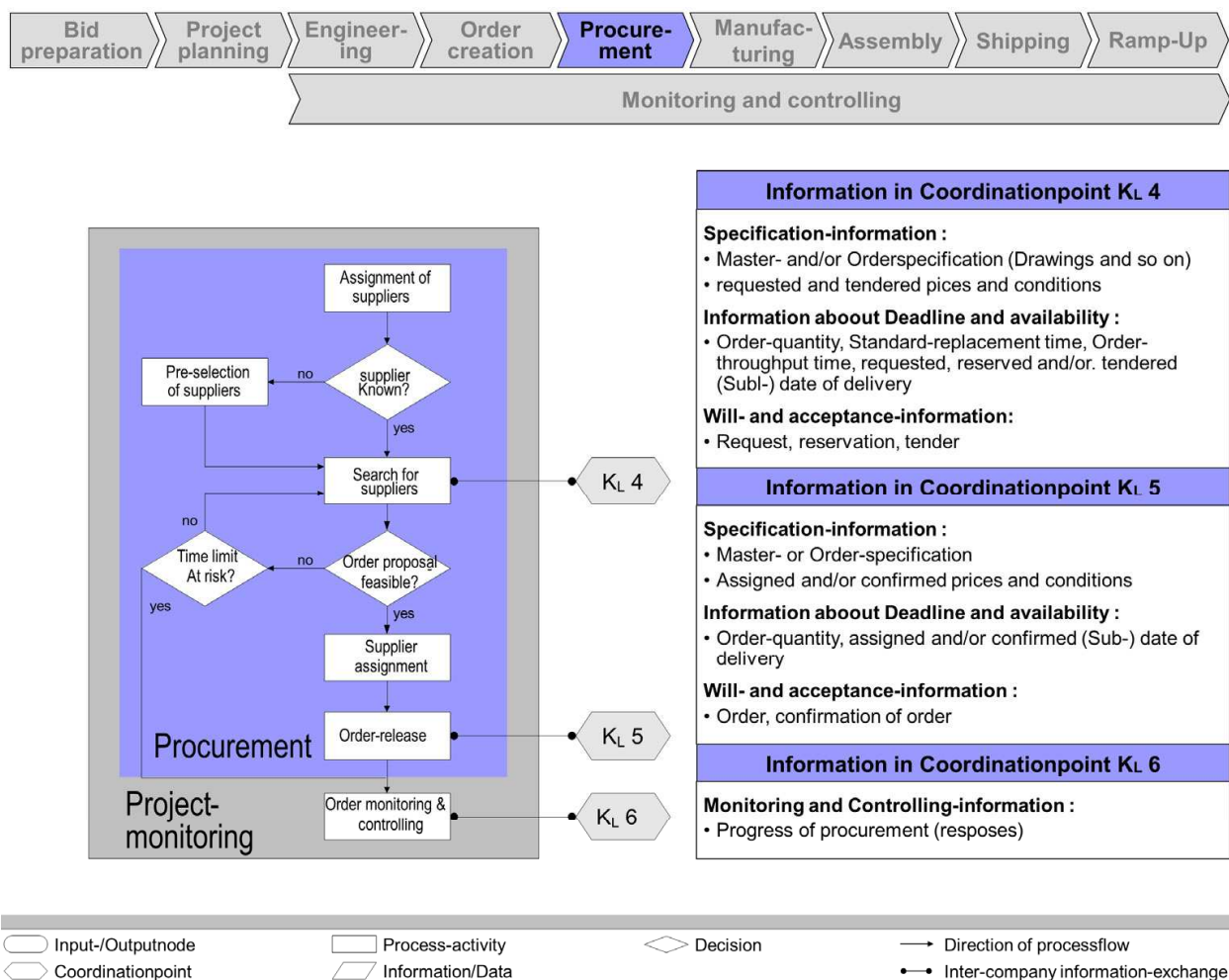


Fig. 14. Detailed structure of the procurement process (Schmidt, 2008)

#### 5.4 The monitoring and controlling process

The monitoring & controlling process is initiated upon completion of the project gross planning and timely ranges from this point on to the end of the order execution. This process thus basically accompanies the order-execution processes of engineering, order-creation, procurement, manufacturing, assembly, shipping and ramp-up. The created detailed plans provide the basis for the monitoring of progress. The monitoring of progress basically serves to track the overall project at all times and to thereby provide an up-to-date overview of the project situation, concerning costs-, quality- and schedule-related aspects, based on monitoring information provided by the involved in-house departments and suppliers. It is in particular subject to the monitoring of the progress in this context to identify divergences between the primary project plans (to-be performance) and the actual project performance (as-is performance). The monitoring of suppliers furthermore

necessitates a regular exchange of monitoring information in the course of order-monitoring, which is represented by a further producer-supplier-interface (cf. KL7 in Fig. 15). Another important task within the process of monitoring & controlling is the Entry of Change Requests. Those changes mainly refer to specification- or schedule-related aspects. During the following clarification of Change Requests, the feasibility of the requested changes is assessed together with the customer in due consideration of the current project situation. Since unexpected events such as the mentioned changes or delays due to malfunctions or labor slacks are naturally unpredictable, the primarily set project plans have to be adjusted continuously according to the information created in the course of the monitoring of progress and the clarification of Change Requests. That is in fact the main content of the project coordination. Upon the coordination of the project plans, it is subject to the project coordination to anticipate the occurred changes, as well as to compensate and counter their effects. In order to still realize the guaranteed delivery dates, the modified project schedules and schemes have to be forwarded to the respectively affected in-house departments or suppliers, where the detailed plans should be adjusted accordingly. If the delivery date is no longer realizable, the process-activity of project planning and order coordination of the project planning process has to be carried out again (Cuber & Schmidt, 2012).

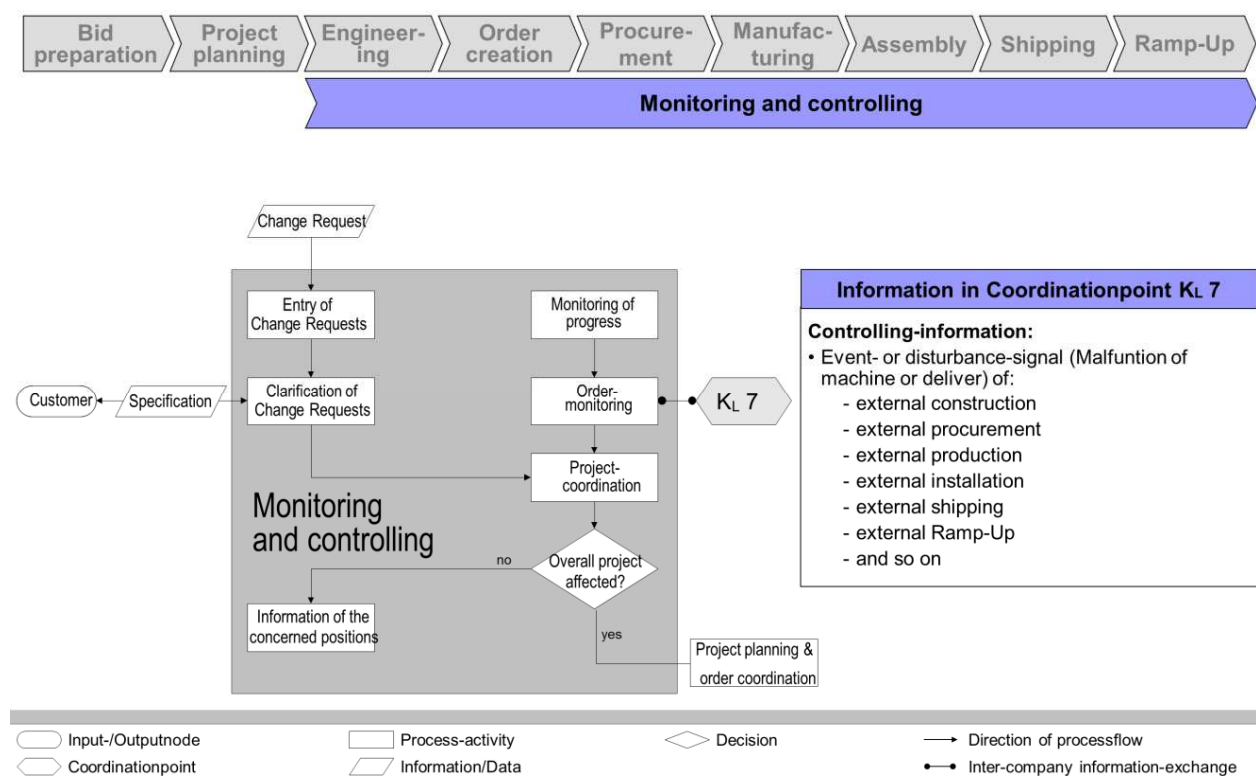


Fig. 15. Detailed structure of the monitoring and controlling process (Schmidt, 2008)

### 6. Information requirements in the coordination points

The product/service-type-related sequence of order-handling-processes is in combination with the different product/service-types as well as the different business-relationship types

the basis for a mapping of the concrete contents to the specific interaction processes. Regarding the relevant contents it is necessary to distinguish whether information from the producer's point of view serves as an input or as an output for his coordination-processes. If an information is both Input and Output, it is a bilateral update of existing planning information. The discussion of the business-relationship-type specific classification of the contents that are relevant for the coordination of the processes of order-handling, interaction and planning will be held in the following using again the example of the bottleneck and the long-running products or services.

The bilateral clarification of the specification between the producer and his supplier within the "Determination of date of delivery" (KL 1) as well as within the "Project planning and order coordination" (KL 2) is a fundamental part of the coordination process for a complex bottleneck product or service. First of all the technical realizability of the product or service has to be verified independent of the relationship-type. In the course of the specification clarification specific function parameters of the specification (output) of the customer specification and the technical restrictions (input) are verified. In addition in market-autarkic relationship- types target prices (input) and other procurement conditions are agreed between the supplier and the producer based on the individual order specification (cf. Figure 16). The examination of the availability with regard to dates is as well carried out in the coordination points KL 1 and KL 2. In both relationship-types the required order quantity (output) and the desired date of delivery (output) are requested by the producer. The supplier replies with a first estimation of a possible delivery date (input).

The clarification of the specification and the delivery date, is followed by the declaration of intent. This happens within the coordination-points "search for suppliers" (KL 4) and "order approval" (KL 5). First of all the technical specification of the product or service (e.g. figures, specification sheet), the preferred date of delivery and the target price of the producer are merged in a inquiry, reservation or order (output). Afterwards this will be sent to the supplier. The producer thereupon receives a proposal respectively a confirmation of reservation and an order confirmation from its supplier (input).

Because of the very high risk of date for a bottleneck product or service the progress- and incident messages in the course of "Order monitoring & controlling" (KL 6) and "Order monitoring" (KL 7) are of particular importance when considering bottleneck products- or services. In both relationship-types the producer generates a request of progress (output) and receives thereupon a corresponding message of progress (input) from its supplier. In case of unexpected events the supplier proactively delivers a message about a possible delivery-failure to the producer.

In case of long-running products/services, the "Determination of date of delivery" is replaced by the "In-advance planning of long-runners" (cf. KL 3 in Figure 17). In this case the master specification and the determination of standard prices is clarified between the producer and his supplier in a bilateral process. Considering long-running products/services in contrast to bottleneck products or services, in the coordination-point KL 4 instead of sending an inquiry or reservation, there is always a reservation send. In the opposite direction of information-flow there is no proposal but directly a confirmation of reservation send. The coordination-point of "Projectplanning and order-coordination", which is relevant considering bottleneck-products/services (cf. KL 2 in Figure 17) is not relevant in case of long-running products/services.

Bottleneck product/service		market-autarkic		cooperatively-autarkic	
		Output	Input	Output	Input
1	Determination of date of delivery (KL 1)	<b>Specification</b> • function parameters • techn. restrictions • Target price/conditions <b>Availability</b> • Order quantity • Desired date • possible delivery date	●	●	●
		<b>Specification</b> • function parameters • techn. restrictions <b>Availability</b> • Order quantity • Desired date • possible delivery date	●	●	●
2	Search for suppliers (KL 4)	<b>Declaration of intent</b> • Inquiry/reservation • proposal/confirmation of reservation	●	●	●
		<b>Declaration of intent</b> • Inquiry/reservation • proposal/confirmation of reservation	●	●	●
3	Projectplanning and order coordination (KL 2)	<b>Specification</b> • function parameters • techn. restrictions • Order price <b>Availability</b> • Order quantity • Desired date • possible delivery date	●	●	●
		<b>Specification</b> • function parameters • techn. restrictions <b>Availability</b> • Order quantity • Desired date • possible delivery date	●	●	●
4	Order-approval (KL 5)	<b>Declaration of intent</b> • Order • Order confirmation	●	●	●
		<b>Declaration of intent</b> • Order • Order confirmation	●	●	●
5	Order monitoring & controlling (KL 6)	<b>Progress message</b> • Request of progress • Progress message	●	●	●
		<b>Progress message</b> • Request of progress • Progress message	●	●	●
6	Order monitoring (KL 7)	<b>Incident message</b> • Message delivery failure	●	●	●
		<b>Incident message</b> • Message delivery failure	●	●	●

● Information is Input respectively Output for the producer

Fig. 16. Exchanged information in the context of bottleneck products or services (Schmidt, 2008)

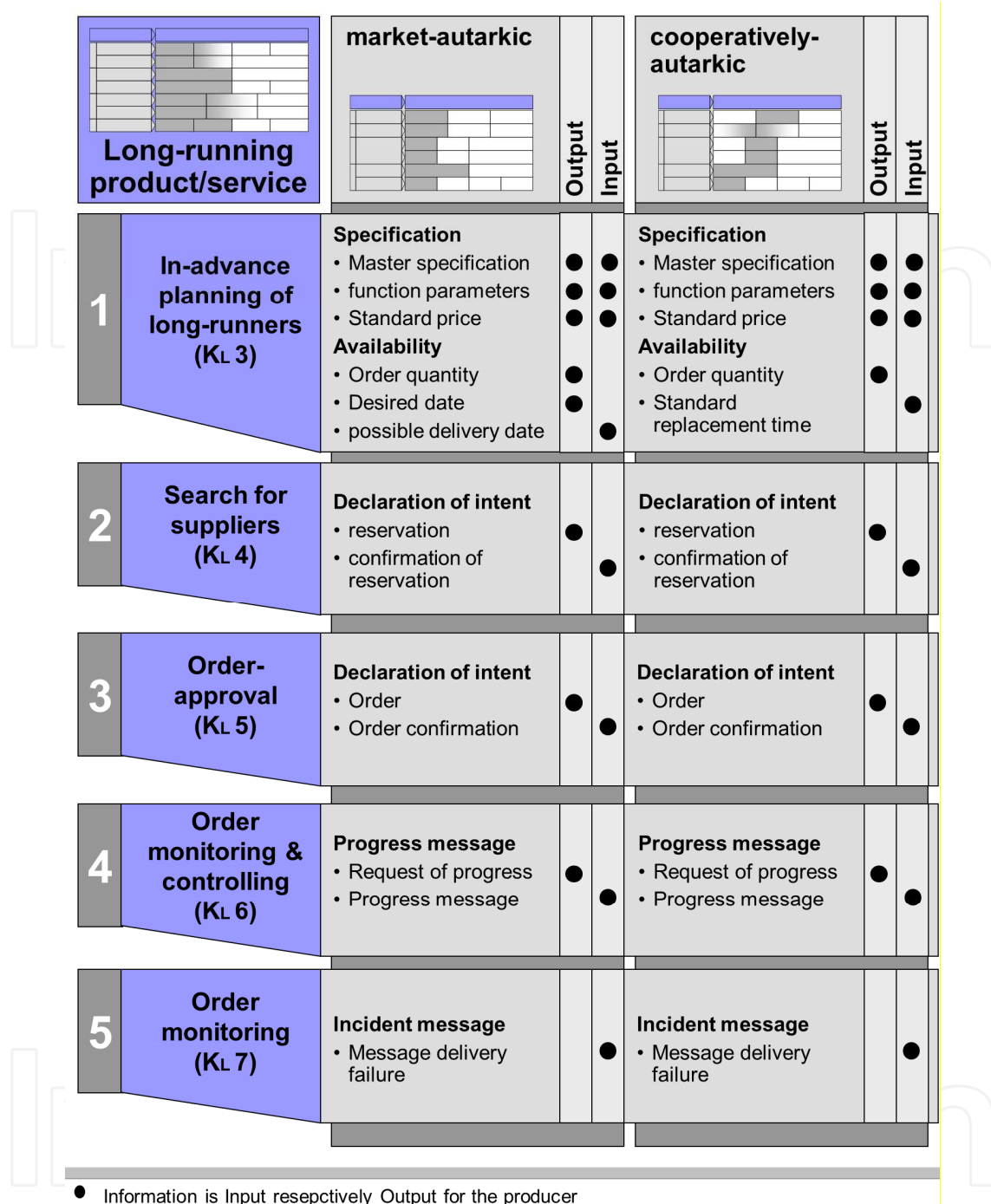


Fig. 17. Exchanged information in the context of long-running products or services (Schmidt, 2008)

### 7. Conclusion

A considerable part of the problem of late deliveries has its origin in unsound process structures and little process control internally but even more regarding inter-company coordination. However, dealing with a transparent process structure and being able to manage each process according to its requirements and status in the overall project, can already prevent a good portion of late deliveries or at least of uncertainty in the process.

When the target process is structured, it can be managed like a workflow with checklists at the coordination points. By doing so, the transfer of incorrect or incomplete data and information transfer can be reduced. Even though a part may still be late, a delay can earlier be anticipated by a consistent process control. An adjustment of project plans can earlier take place which may provide further options of reaction. Hence, as more transparent and controlled a process is managed, as faster a company is able to realize deviations and as faster it can react to those disturbance variables.

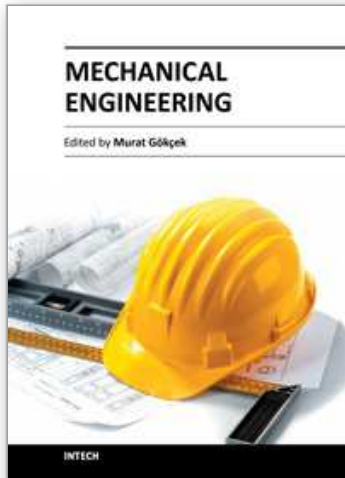
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