Normalization of Processes - Toward an Integrated View of Business Process System

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Abstract. In spite of the unquestioned importance of business process modeling in both the information systems development and the enterprise development the methodology standards in this field are still hardly insufficient. One of the most important aspects which has to be covered with the process models is the essential unity of object oriented and process oriented views of a business system. In this paper we introduce so-called Process Normalization technique, a part of the MMABP methodology, as a particular way of methodical covering of this essential unity. This technique is freely inspired with the famous 'ancient' Normalization of Data Structures technique which we regard as relevant right because of the essential unity of objects and processes in the business system. The process of the normalization of processes is explained and illustrated by example. Important connected problems of structural algorithmic thinking as well as the other ways of manifestation of the mentioned essential object-processes unity in the business system are also discussed in the paper.

Keywords: business process model·normalization·structured programming·object orientation·process orientation

1 Introduction

In spite of the unquestioned importance of business process modeling in both the information systems development and the enterprise development the methodology standards in this field are still hardly insufficient. As a good example of this insufficiency we can mention even the modeling standard – BPMN language [10]. Besides the serious internal contradictions BPMN is still able to cover just a small part of needed contents. One of the most important aspects which has to be covered with the process models is the *essential unity of object oriented and process oriented views on a business system*.

The ideas expressed in this paper are based on the Methodology for Modeling and Analysis of Business Processes – MMABP [1]. The first basic principle of this methodology is the Principle of Modeling which expresses the presumption that the objective basis for the implementation of the business system in the organization must be constituted by real facts existing outside of, and independently of, the organization. In

other words, every organization as an implementation of some business system (business idea) must be based on the model of the relevant part of the Real World.

MMABP distinguishes between two basic dimensions of the Real World: structure (object view) and behavior (process view). In both dimensions there are two basic types of model: global (system) view on the system as a whole and detailed (particular) view on just one element of the system. The main general difference between the global (system) and the detailed (particular) views is in the factor of time. System (global) view always tries to abstract this factor and focus on stable, time independent aspects of the modeled system while the detailed model respects it anyway by focusing mainly on it. Global view then can be characterized as object-oriented while detailed view as process (algorithmic)-oriented (see Figure 1).

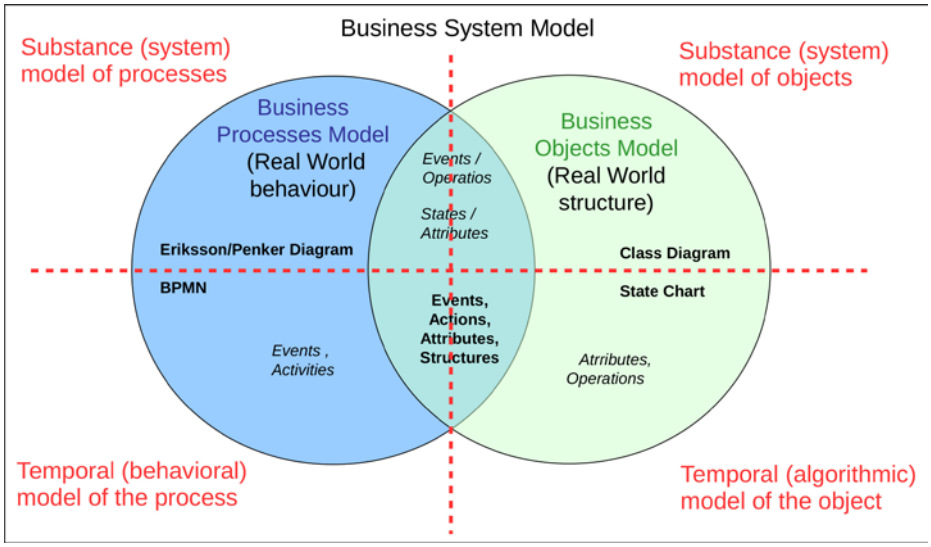

Fig. 1. Two times two dimensions of the Real World Model

Sufficient business system modeling methodology thus has to support both types of models (global vs. detailed) in both dimensions (structural vs. behavioral). Moreover, both dimensions have to be always taken in their mutual interconnections. At the same time the methodology has to integrate also both essential components of a business system: its managerial and technology contents. Proposed Process Normalization technique tries to cover all those aspects offering a *certain way of integration of the global process map with the process details, intentional processes with conceptual objects, and also the process structure with their managerial meaning.*

2 Business process system and its managerial context

By the 'business process system' we mean the system of mutually collaborating business processes. To understand the 'business essence' of the collaboration of pro-

cesses in terms of ideas of process-driven management [5] one primarily has to differentiate between two basic functional types of processes: key ones versus support ones. As customer needs are constantly changing, the processes in the organization should change as well. This means that any process in the organization should be linked to the customer needs as directly as possible. Thus, the general classification of processes in the organization distinguishes mainly between:

- Key processes, i.e. those processes in the organization which are linked directly to the customer, covering the whole business cycle from expression of the customer need to its satisfaction with the product / service.
- Support processes, which are linked to the customer indirectly - by means of key processes which they are supporting with particular products / services.

The value of the key process is given by its direct contact with the value for the customer as it is its the main goal. The values of other (support) processes are given by the services by which these processes support other processes. This way every process is ultimately connected to the value for the customer either directly (key process) or through its services for other processes. Key processes thus represent a specific enterprise's way of satisfying the customer needs while support processes represent rather standard functionality often connected with some technology. Consequently, key processes are very dynamic, often changing, permanently developing, every instance is an original. Support processes are mostly static, stable, offering standardized and multiply usable services.

So the main effort in the process of creating the conception of the system of processes must be establishing the *equilibrium of needed dynamics of key processes on one hand and the necessary stability of the system ensured with its maximally standard support processes*.

3 Process normalization

Normalization of processes is a technique freely inspired with the Normalization of Data Structures technique firstly introduced by E.F.Codd in [2], then elaborated in further detail with R.F.Boyce in [3] and comprehensively explained in [9]. Although the original Codd's intention was mainly technical in terms of a database system design, this technique started uncovering the essential Principle of Modeling in the field of information systems development which has been later defined by P.Chen in [6]. As this principle is essential also in terms of its validity in all dimensions of the Real World models, it has to be valid even for process descriptions. Regarding this fact together with the aforementioned essential unity of objects and processes in the business system as it is defined in MMABP [1] we can define the goals of the Normalization of Processes as follows:

(a) Reduce redundancy of process activities.
(b) Ensure that all activities and non-initial events are dependent on the initial event.
(c) Eliminate unnecessary hidden dependency relationships within a process.

The Processes Normalization goals support mainly the basic ideas of process-driven management excellently expressed in [5]. The goal (a): redundancy of process activities means unnecessary repeating of activities, with essentially the same content and meaning in different processes. Unrecognized redundant occurrence of activities with the same contents in different processes is one of typical consequences of hierarchical organization mentioned by Hammer in [5] as a 'symptom of broken processes'. The goal (b): unconditional clear dependency of all activities on the initial event is a certain way to ensuring the relationship to the customer-oriented value of the performance of the company. This goal, together with the goal (c): no hidden dependencies, support mainly the principle of key processes as centerlines of the final meaning of all activities in the organizations. Using the Process Normalization technique the key processes are relieved of all activities which signalize the existence of possible process goals, other than the primary process goal expressed with the dependency on the initial event. These supportive process sub-goals usually signalize the existence of other, more general, sub-processes which are focused on some specific goal and are hidden in the body of the normalized process. From the point of view of the goal of the normalized process these processes represent the set of supporting actions with more general meaning which are needed as a step on the way to the final process target. Their general meaning is then the reason for their removal from the body of the normalized process and establishing them as standalone support processes. This way the normalized process is freed of all non-essential activities which are removed to more general support processes and the necessary relationships between the original process and the new ones are uncovered in terms of the meaning of support activities in the context of the goal of the normalized process.

Consequently, the input assumptions for the normalizing procedure are:

- The logical process represents a part of the Real World consisting of natural process chains and their relationships.
- Each activity in the process represents an activity from some natural process chain or relationship among process chains.
- Each event in the process represents an activity of some external actor or related (collaborating) process chain.
- Each natural process chain hidden in the logical process can be uniquely identified by some event or by a logical structure of events. Such event (structure of events) is called an 'initial event'.

The procedure of process normalization

The procedure of process normalization is defined as a sequence of steps by particular normal forms. The initial condition for each step is that the process is in the previous normal form (i.e. fulfills its required characteristics). Particular normal forms are defined as follows:

1st Normal Form (iterative generalizable structures free)

The process is in the 1st Normal Form if the bodies of all its repeating non-elementary structural parts (iterations) have been removed to standalone processes and replaced with process states. Each removed part of the process has been identified with the corresponding business system object. Its starting event has been defined as a request from the original process. Its product has been defined as a service and corresponding event from the point of view of the original (i.e. receiving) process.

2nd Normal Form (alternative generalizable structures free)

The process is in the 2nd Normal Form if it is in the 1st Normal Form and the bodies of all its mutually alternative non-elementary structural parts (selections) have been removed to standalone processes and replaced with process states. Each removed part of the process has been identified with the corresponding business system object. Its starting event has been defined as a request from the original process. Its product has been defined as a service and corresponding event from the point of view of the original (i.e. receiving) process.

3rd Normal Form (parallel generalizable structures free)

The process is in the 3rd Normal Form if it is in the 2nd Normal Form and the bodies of all its mutually parallel non-elementary structural parts (simultaneities) have been removed to standalone processes and replaced with process states. Each removed part of the process has been identified with the corresponding business system object. Its starting event has been defined as a request from the original process. Its product has been defined as a service and corresponding event from the point of view of the original (i.e. receiving) process.

4th Normal Form (hidden generalizable sub-structures free)

The process is in the 4th Normal Form if it is in the 3rd Normal Form and the bodies of all its non-elementary structural parts (sequences) which are not fully specific to the starting event of the process have been removed to standalone processes and replaced with process states. Each removed part of the process has been identified with the corresponding business system object. Its starting event has been defined as a request from the original process. Its product has been defined as a service and corresponding event from the point of view of the original (i.e. receiving) process.

From the point of view of the process system the Process Normalization can be regarded as a way of uncovering the natural supporting processes which are hidden in the body of the given process. In the first step all repeatedly used support services are uncovered in the process. The second step uncovers all conditionally used support services and the third step uncovers all substantially different (parallel) services hidden in the same process step. In the last step all remaining parts of the process which can be also regarded as standalone services are uncovered. Ordering of steps is important for similar reasons as it is in the normalization of data structures. To be able to correctly interpret alternative sub-structures (branches) in the process one has to remove all repeated structures of activities first (1^{st} to 2^{nd} Normal Form) as the decision about the repetition (end of the loop) might be incorrectly interpreted as a fork signalizing mutually alternative sub-structures. Seeking for parallel structures does not make sense between different alternative structures so the structure has to be in the 2^{nd} normal form before it can be transformed to the 3^{rd} normal form. Similarly, identified sub-structure cannot overstep the border between alternative nor parallel branches of

the process. These rules generally follow from the theory of structured thinking most comprehensively described in [7] and [8]. Relationships of the process normalization technique to this theory are also discussed in the paragraph *Discussion*.

Example of Process Normalization

Figure 2 shows unnormalized process *Customer Order Management* in the BPMN [10] notation. The way of process description follows MMABP methodology [1] caring especially of the communication with external collaborators. In this, unnormalized form the process collaborates just with the customer. See the process states (Parallel AND gates) at the beginning (negotiation of the order) and before the end (payment) of the process.

The notation used in example is a strong reduction of BPMN [10] standardly used by MMABP methodology as it follows from the business process meta-model [1]. To make BPMN methodically consistent with the MMABP principles it has to be reduced here just on the basic set of language constructs: activities, two essential types of events (ad-hoc and timer), decisions and logical connectors, and inputs and outputs. Events are defined as always external influences of the process. Missing concept of *process state* is compensated with the AND join construction expressing the meaning of the process state as a necessary synchronization of the process flow with the external influence (set of events). More detailed explanation of the need to improve BPMN can be found in [11].

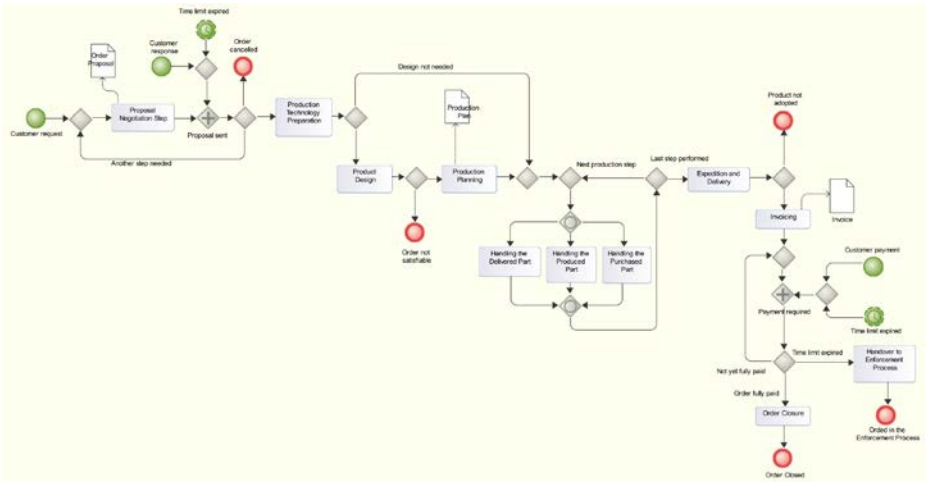

Fig. 2. Example - Unnormalized process Customer Order Management

Figure 3 shows the changes in the process caused by transforming it into the first normal form. Repeating parts which represent handling the objects *Order*, *Product* and *Payment* have been identified, removed to standalone support processes and replaced with the new process states each representing the waiting for the external service.

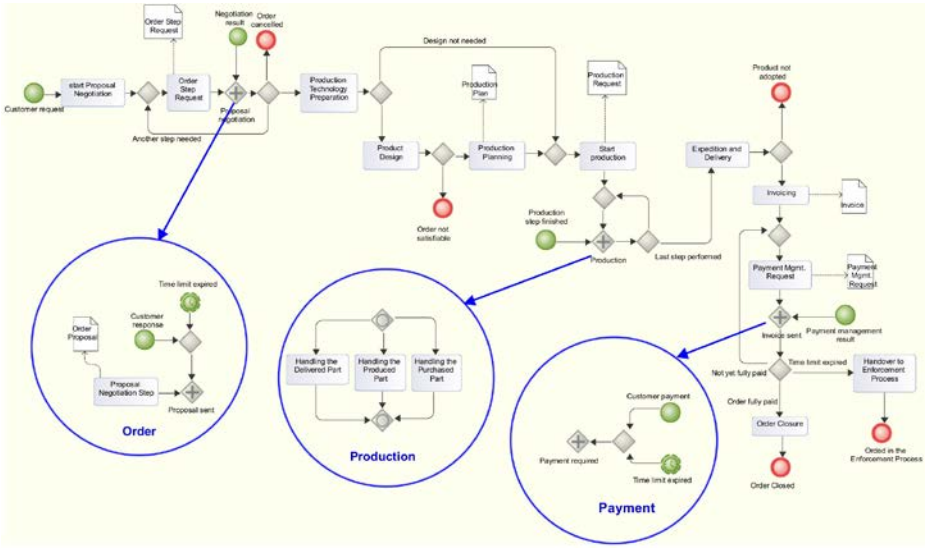

Fig. 3. Example - Process in the 1st Normal Form

The process at Figure 4 is in the second normal form after the removal of two conditional parts which can be regarded as standalone standard support services. *Product Preparation* is performed only if the customer requires nonstandard product and *Order Finalization* branch only if the customer adopted the delivered product. As there are no remaining parallel parts in this process it is also in the third normal form.

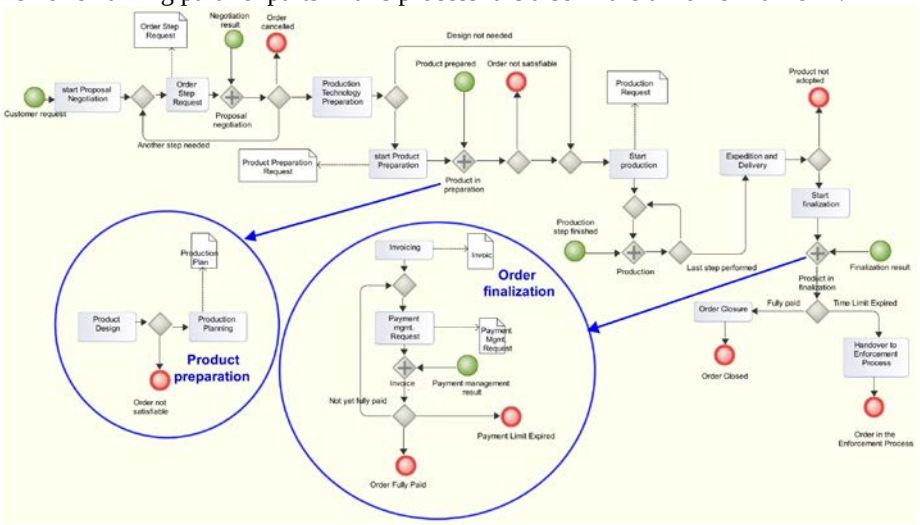

Fig. 4. Example - Process in the 2nd and 3rd Normal Forms

In the fourth normal form (Figure 5) the process has been exempt of two parts representing standalone standard services: *Production Technology* and *Expedi-*

tion&Delivery. All remaining parts of the process are then fully specific to the starting event *Customer request*.

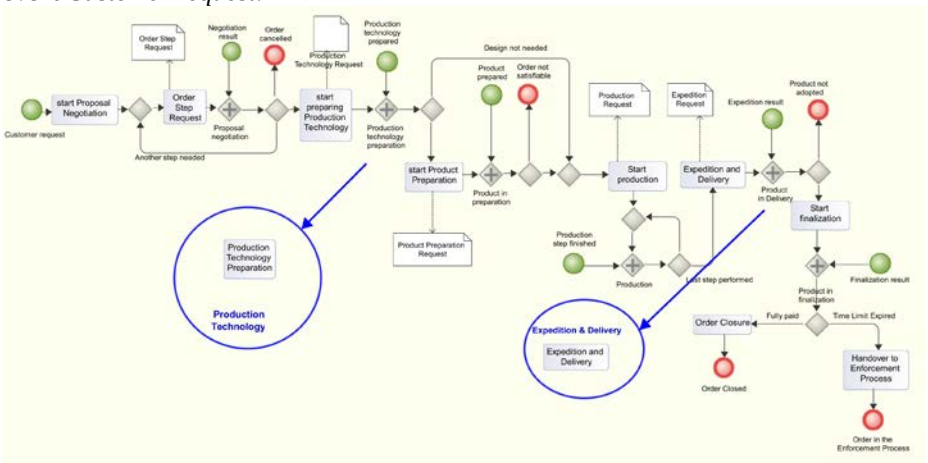

Fig. 5. Example - Process in the 4th Normal Form

Figure 6 shows the resulting map of processes in the Eriksson/Penker notation [4] after the full normalization of the original one key process. Besides the newly created support processes discussed in the previous comments to the particular normal forms of the process there are also several other new processes created by the normalization of new support processes: *Product Design* and *Production Planning* removed from the *Production Preparation* support process, and former three parallel parts of the *Production Step Management* process. The process *Payment Management* originally created from the key process on the way to its first normal form has been completely removed in the second normal form together with the process *Order Finalization* and is no more connected directly with the key process.

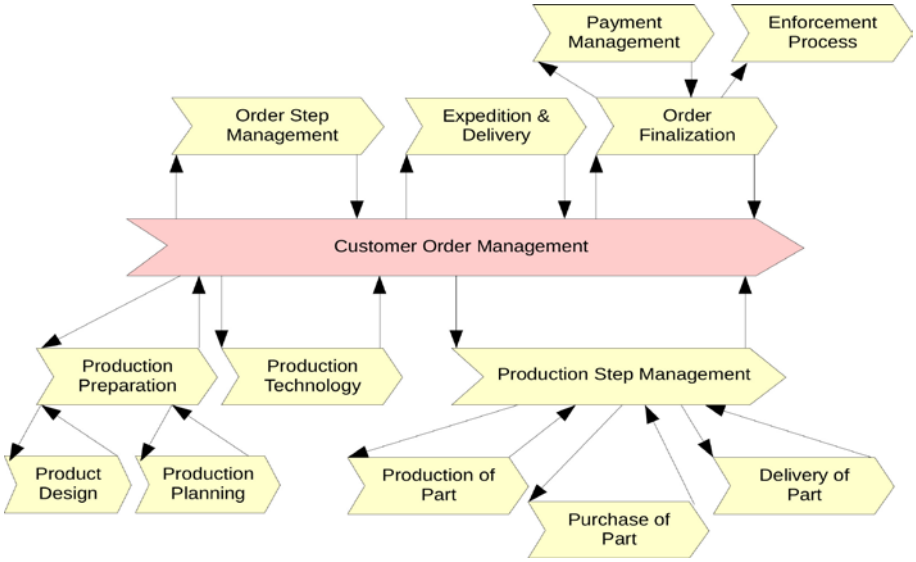

Fig. 6. Example – Process Map

Process map shows the structure of mutually collaborating processes following the common goal – the final product of the key process *Customer Order Management*. The structure perfectly reflects the main characteristics of the process driven organization:

- All processes are organized in the network structure which means that they are generally independent, their relationships reflect just their collaboration: mutually supporting each other with the services. There is no general hierarchy of processes.
- Common meaning of all processes in the map is given by the key process which is a final consumer of the supporting services thus its final product defines the meaning of the presence of all processes in the map.
- Such structure of generally independent processes which however follow the common goal can be called *purpose-centric collaboration network structure*.
- The process in the center of the structure (key process) represents the direct contact with the *Customer*, a representative of the common purpose of the whole structure. As the main idea of a process-driven management is to make the organization as much flexible a possible towards the customer needs, the central (key) process is naturally the most dynamic and specific (purpose-oriented) process in the structure.
- Consequently, other (support) processes the bigger is their distance from the center of the structure, the more they are universal, generally oriented and naturally static. For example see at Figure 6 the 'first order' support processes *Product Preparation*, *Production Step Management* and *Order Finalization* which are obviously closer to the specific customer aspects than more general 'second order' support processes like *Product Design*, *Purchase of Part* or *Enforcement Process*.

4 Discussion

The essential meaning of the Process Normalization can be characterized as a summarization of the needed decisions and their mutual dependencies led by the intention to distinguish as much as possible between the individuality of the normalized process and the natural generality of the processes which support it. Such principal differentiation is a certain way to achieve the needed *equilibrium of the maximal flexibility on one hand and maximal stability of the enterprise performance at the other hand*; every needed process which does not directly fulfill the primary function of the organization should be stabilized as much as possible up to its complete outsourcing. This way the process outsourcing can be regarded as a border of the maximal possible stabilization of the process. Often discussed automation of processes then should be regarded as a special case of the outsourcing where the 'service supplier' is a machine. The significant outcome of this short reflection is the fact that the complete automation of the enterprise including also the automation of key processes which is often regarded as a finite goal of the Business Process Re-engineering is a clear nonsense as it is in contradiction with the main idea of the process driven management ([5]). Once the process is outsourced it cannot be more regarded as a process in terms of the organization's performance. From the organization's point of view such original process then exists just as a single service delivered by the external supplier which means that the organization is no more responsible for its performance as it now has the role of customer.

The crucial condition for the proper use of Process Normalization is the ability to think about the process a structural way which means to be able to see the process in terms of the hierarchical structure of sequences, selections and iterations as it is defined in [7] and generalized in [8]. The Structure Diagram introduced by Jackson in [7] is the best tool for the description of the process such way. Figure 7 shows the description of the *Customer Order Management* process by the Structure Diagram. Nevertheless, a structural viewing of a business process for the purpose of the Process Normalization technique requires expressing also possible parallel actions in the process. For this purpose we enrich the original concept of three basic structure types (sequence, selection and iteration) from [7] by the fourth type 'simultaneity' which represents the parallel running of actions synchronized at the beginning and at the end. In the Jackson's Structure Diagram we label the elements of this additional structure with the plus sign ('+') in the upper right corner (see Figure 7). The structural view of an algorithm prevents parallelism in general as it is a determinant of the border between a single algorithm and the system of cooperating algorithms (see [8] for instance). In spite of it the parallelism can be accepted as a fourth basic type of structure if it is controlled: a simultaneity can be used only if beginnings as well as ends of all parallel actions are synchronized in a single point of time which allows regarding the whole structure as a single element from the point of view of the upper level of the structure. Such encapsulation of parallel actions in a single structure element prevents

the possible corruption of the nature of an algorithm[1]. Another complement to the Jackson's Structure Diagram is the predefined action 'End' which means the termination of the process before its regular end. Use of the 'End' expresses the situation when the process has to be terminated for some specific objective purpose in the particular point of its structure, an exception from the regular process flow. Therefore, the End operation can be used only as a part of a selection structure under the condition which represents the specific objective reason for the termination of the process. Regularly, such situation should be expressed in the Structure Diagram as an upper-level selection in order to keep the principle that the structure has just one end. From the point of view of the time flow such description however expresses the decision before the action which allows this decision. The Jackson's method generally solves this problem with the special technique called 'backtracking' [7] which allows the needed exceptional jump from the structure in the implemented program together with keeping the clearly static 'conceptual' description of the program structure. Nevertheless, for the purpose of the Process Normalization we need to describe the process in structural way but as a process, respecting primarily the time flow which is the main reason for this complement to the original Structure Diagram.

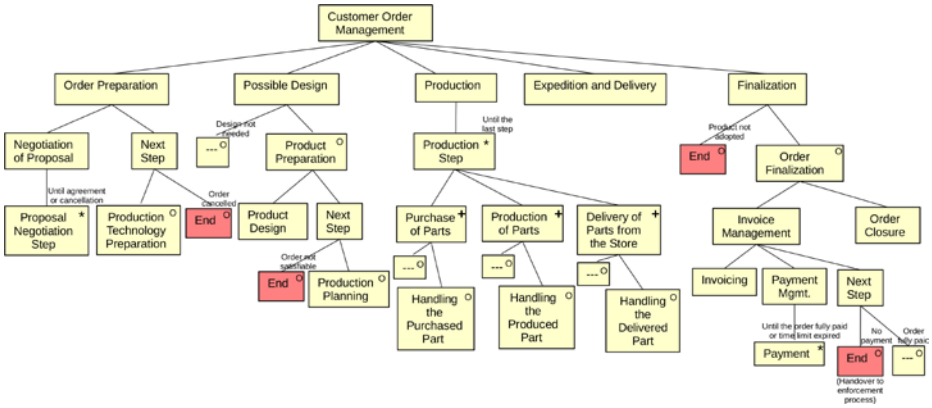

Fig. 7. Structural view of the process

Process Normalization is also closely connected with the object-oriented view of a business system which represents the “causal” view of the Real World. Each removed part of the normalized process should be identified with some business system object. This object points to the general meaning of the new support process created from the removed sub-process. General meaning of this object can be subsequently used for the generalization of this new process in order to achieve its needed stability. For exam-

[1] For example, Tse in [12] considers even five basic structure types: 'sequence, selection, parallelism, iteration and procedure call' and mentions also the rule that 'every selection or parallelism must have a single input state and a single output state' [12]. It can be seen that the Tse's 'procedure call' represents in fact any sub-structure invoked by the 'call' operation, and that the same is implicitly ensured in Jackson's diagram with its hierarchical nature. The simultaneity thus remains the only natural structure type not covered by the original Jackson's diagram.

ple processes like Expedition&Delivery, Payment Management, Production Planning, etc. from the Process Map at Figure 6 are typical representatives of standard processes absolutely independent of any specific key process which can use their services.

The title of this paper is a paraphrase of the title of the crucial work in the field of conceptual modeling [6]. In this article Peter Chen expressed the need for perceiving the data base of the organization as a model of a relevant part of the Real World in terms of objects (entities), their mutual associations (relationships) and classifications (types) which is nowadays known in informatics as a 'Principle of Modeling'. This principle should not be limited just to the field of data (i.e. Real World objects, Real World ontology) but regarded as a universal principle valid even in the field of operations (i.e. business processes, Real World behavior). Just this universality of the Principle of Modeling is an original reason for such title of this paper and it also uncovers the essential relationship between these two parts of the Real World: objects and processes, alias ontology of the Real World and behavior in the Real World. Looking at this relationship from the philosophy point of view one can see also general consequences of the causality and the intentionality in the Real World.

5 Conclusions

The purpose and practical meaning of the Process Normalization are similar to the technique for "normalization of data structures" ([2], [9]). Like in the case of the Data Normalization technique the main value of the Process Normalization does not lie in the procedure and its particular steps in terms of the strict instruction for making the decisions in the defined order. Once the user of this technique understands its essential meaning he/she usually looses the ability to use it as a directive procedure because he/she anticipates what should be the result of the next steps which influences his/her way of thinking and disallows him/her to keep the prescribed procedure. Instead of being the prescription of mechanical making the decisions in defined order it rather serves as a 'training program' for understanding the essential meaning and purpose of the proper division of process steps into the natural process chains related to existing business objects.

In the near future we suppose possible development of succeeding process normal forms and also the analysis of relationships among the principles expressed in the Process Normalization and some relevant aspects of the conceptual analysis, for example the problem of generalization structures in the conceptual model and its manifestation in the structure of supporting processes. Such reflections may also take the form of new succeeding normal forms.

All these visions of possible future development emphasize the essential meaning of the process normalization It is not only the training procedure for understanding the essence of proper division of activities to processes but also the *framework for the generation of stimuli for the further research in the field of business process modeling* and its relationships to other fields like the conceptual modeling, for instance.

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