Developing Quality Management Systems with DEMO

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Abstract. The International Organization for Standardization (ISO) has defined Quality Management, but it has not yet adopted standards for developing Quality Management Systems (QMSs), notably not for modeling business processes in this context. Consequently a variety of modeling techniques are in use. Most of these are not able to produce concise and comprehensive models, whereas these features are particularly important for QMSs. Moreover, these techniques appear to be based on the mechanistic paradigm, meaning that they are task oriented instead of human oriented. Various researches indicate that this leads, among other things, to alienating employees from their work. DEMO (Design and Engineering Methodology for Organizations) has both desirable features: it is human oriented and it produces concise and comprehensive models of business processes, since it is based on the systemic notion of enterprise ontology. This paper reports on the theoretical evaluation of DEMO for the purpose of developing QMSs, as well as on practical experiences in applying DEMO to it.

Keywords: Quality Management System, DEMO, mechanistic paradigm, institutional paradigm.

1 Introduction

In general, the function of a company is to deliver particular services to its environment, where a service may regard tangible or intangible products. Also in general, companies strive to fulfill this function as good as possible, i.e. delivering high quality services. Quality, however, is a multi-faceted issue; it is not easy to measure it, nor to maintain or even improve it. Nonetheless, it is a major managerial area of concern in most companies. Collectively, this managerial attention together the activities performed to monitor, assess, and improve quality, are called Quality Management. In the realm of standardization, it is addressed by the ISO 9000 family of standards, in particular by the standard ISO 9001. In [1] Quality Management is defined as follows:

- fulfilling the customer's quality requirements, and
- the applicable regulatory requirements, while aiming to

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– enhance customer satisfaction, and to
– achieve continual improvement of the organization's performance in pursuit of these objectives.

The focus in ISO's definition is on customer satisfaction. It is achieved by fulfilling the customer's quality requirements, which on its turn is enabled by business process improvement. The term 'regulatory requirements' remains rather unclear. Therefore we will not take it into account.

The implementation of ISO 9001 in a company can lead to an increase in productivity, customer satisfaction, less scrap and rework, and continuous development. Since most companies like to achieve these goals, ISO 9001 is applied in many of them [2]. Unfortunately, being compliant with this norm has become such a status symbol that quite some companies are proud to say that they have implemented the standard, whereas they have not really and fully done it [3]. It has been shown that most Total Quality Management (TQM) programs develop an "ideal organizational identity" that the enterprise presents to the outside-world, but which is often far removed from the daily reality [4].

DEMO (Design and Engineering Methodology for Organizations) is an enterprise engineering methodology. The authoritative source for DEMO is [5]. This paper reports on the theoretical evaluation of DEMO for the purpose of developing QMSs, as well as on practical experiences in applying DEMO to it. We have done that in the context of the new discipline of Enterprise Engineering. Although this discipline is certainly not fully established yet, the main characteristics are becoming clear [6]. They are summarized in the Enterprise Engineering Manifesto [7].

The remainder of the paper is structured as follows. Besides the problem statement are desired features for a QMS handbook given in Section 2. Section 3 contains an introduction to DEMO and explains how it fulfills the desired features stated in Section 2. Consequently the aspect models of the methodology that supports Enterprise Ontology are elaborated on. Section 4 explains the construction of a QMS handbook, the representations of the models are illustrated according a plain example. Finally evaluation and conclusions are to be found in Section 5.

2 Problem Statement

The objective, rational, and structured appearance that a QMS handbook usually shows and the concern for detailed activity descriptions that it addresses characterize the mechanistic and instrumental view of quality management on which the ISO 9000 standards are based. Moreover, the mechanistic viewpoint is shared by most of the studies of ISO 9000. The literature focuses primarily on describing the objective of this standard and its implications for quality management and organizations performace improvement [8,9,10,11]. In contrast to the mechanistic paradigm, the institutional paradigm attempts to describe how people interpret and construct their reality by conforming to standards and values that define "the way things are and/or the way things are to be done"

[12,13]. The latter seems to be interesting because the mechanistic view of organizations has been strongly contested by critical theory [14,15,16,17]. There are reasons to believe that the growing rationalization and formalization of human activities constitutes one of the dominant traits of modern society. The mechanistic view leads to the development of excessive bureaucratic organizations that are unwieldy and inflexible. Though the latter is considered to be precise and efficient, they are also characterized by impersonal and alienating employee control mechanisms [18,19,20,21,22,23]. Boiral's study shows that ISO 9000 is not a monolithic system that can be imposed in a mechanistic way. Rather, this standard is a socially constructed management system that people adopt, reinterpret, or reject depending on the situation. Boiral concludes furthermore that the importance given to the employees's participation and a common consensual view on the organization are key factors for a succesful implementation [3]. Practical experience of the authors confirms Boiral's conclusion. It turns out that commitment of the employees appears to be indispensable to a successful certification process. Commitment of the employees is also necessary guarding the quality management process [11,19]. Furthermore, Boiral [3] concludes that the focus in ISO 9000 process descriptions is on the production acts themselves and not on the interaction between employees. Focusing too much on the production acts (the mechanistic view) carries the risk of alienating employees from their work, which is of course an unwanted situation.

The predominance of the mechanistic paradigm in many organizations' statements and in studies of the ISO 9001 standard is subject of an ongoing dispute [3]. Therefore it might be interesting to apply a methodology to QMS that embodies the institutional paradigm. As said before, rationalizing and formalizing is necessary to achieve at precise and efficient process descriptions. Making processes transparant and involving employees in the design and implementation of the QMS will result in an increased commitment. It leads to less bureaucracy and it contributes to a successful implementation of the standard. Employee commitment during the design and implementation phase seems to a be very important factor. It determines whether a QMS implementation will be successful and whether the QMS is fully supported by the employees after the implementation, such that quality is guaranteed and improvement takes place. To receive the commitment of employees, the threshold to read the process descriptions in the QMS should be low. In order to lower this threshold the handbook must be concise. It must contain clear process descriptions, while irrelevant processes should be excluded. From the discussion above we arrive at the next problem statement:

> The introduction of Quality Management in an organization, in particular the design and implementation of a QMS, often evokes considerable resistance among the employees. There appear to be two main causes for this. One is that the selected approach is based on the mechanistic paradigm. The other cause is that the produced process models lack conciseness and comprehensiveness. It is hypothesized that applying an approach that is based on the institutional paradigm, as well as on the systemic notion of Enterprise Ontology, would take away these causes.

In order to achieve the expected benefits of applying the institutional paradigm, the following features are desirable for a QMS:

1. Conciseness of the handbook;
2. Describe the main line only;
3. No irrelevant processes;
4. No ambiguity in process description;
5. Not sensitive to minor process changes.

DEMO is currently the only methodology that incorperates the notion of Enterprise Ontology. To test the hypothesis, as stated above, the DEMO methodology will be assessed for the purpose of developing QMSs, both theoretically and practically.

3 DEMO

Enterprise Ontology is defined as the implementation independent understanding of the operation of organizations, where organizations are systems in the category of social systems. Being a social system means that the elements are social individuals. One might expect that applying the notion of enterprise ontology contributes to the benefits of applying the institutional paradigm to QMS as explained in Section 2. Since an ontological model abstracts from all implementation and realization issues, the resulting model will not be sensitive to minor process changes (feature 5). As already mentioned, Enterprise Ontology focusses on the interaction between and the responsibilities of social individuals. This facilitates the making unambiguously clear to employees what the authority and responsibility of each of them is. Practice experience has taught that this contributes to cooperation improvement. DEMO [5] incorporates the notion of Enterprise Ontology completely. It claims that the ontological model of an enterprise satisfies the C4E quality criteria [5]. It is:

Coherent: It constitutes a whole.
Consistent: It does not contain any logical contradictions.
Comprehensive: It includes all relevant elements.
Concise: It is kept as brief as possible.
Essential: It is independent of realization and implementation.

At first sight, it seems that the C4E quality requirements are a good match to the desired features 1 to 5. Process description should be kept as concise as possible (feature 1) while it includes all relevant elements (comprehensive)(feature 2). Furthermore the processes should not contain logical contradictions (consistent) and constite a whole (coherent)(feature 3 and 4). Besides these properties, it is very desirable that the document need not be changed for every minor change in the enterprise.Thus, process descriptions should be implementation and realization independent (essential)(feature 5). It can be concluded that Enterprise Ontology is a good fit to the institutional paradigm. As mentioned in Section 2 DEMO is currently the only methodology that incorperates the notion of Enterprise Ontology. Figure 1 shows DEMO's ontological aspect models [5]. The aspect

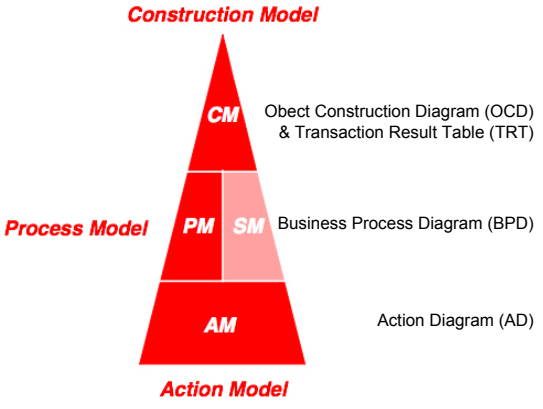

Fig. 1. The ontological DEMO aspect models and the used representations

models can be represented either in diagrams or tables or a combination of the two. Research on representations has turned out that the representations given on the right side of Figure 1 appear practically most appropriate to describe the processes in the QMS handbook [24]. The red parts show the Construction Model (CM), Process Model (PM) and the Action Model (AM). These are the most important models for making QMS handbooks. The pink colored part shows the State Model (SM), which is not used in handbooks. The Organization Construction Diagram (OCD) and Transaction Result Table (TRT) represent the CM. The Business Process Diagram (BPD) represents the PM and the Action Diagram (AD) represents the AM. Each representation will be elaborated by means of a small case in the coming subsections. This case is purely meant to illustrate because the complete model would overshoot the mark of this paper. A fully worked out case can be found in [24].

4 QMS Handbook

4.1 Layout

Determination of the optimal layout is a main topic in the research of Geskus [24]. Figure 2 shows the page layout of the QMS. The first 6 pages contains general information of the regarding enterprise. This is mandatory according the ISO 9001 standard. The last pages in the handbook elaborates the legend of the used symbols besides that a cross reference is included. The focus in this paper is on the process descriptions and therefore are those pages not taken into account in Figure 2. The variable page number 'n' corresponds with the number of processes that are to be described (n starts with 0 and adds up with multiples of 2).

Figure 2 shows that page 7 and 8 are filled with the Actor Description Table (ADT). This table enumerates the identified actor roles with their responsibilities

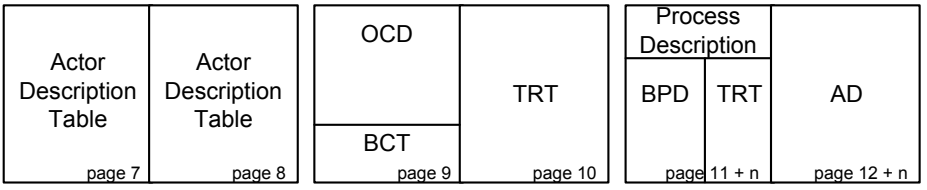

Fig. 2. Layout of the QMS handbook

and authorities. Furthermore, it shows by which function(s) the actor role is fulfilled. The ADT will be elaborated further in subsection 4.2. Page 9 contains the CM represented in the OCD and Bank Contents Table (BCT). The BCT shows information of the external banks. The Transaction Result Table (TRT) is given on page 10, it specifies the results of the identified transactions. The representations of the CM are further elaborated on in subsection 4.3. Each process description takes at least 2 pages where on the left side the textual process description is given. Herein are the aim, required instruments and KPI's of the process defined. Below, the BPD, and the transaction results of the process are given. The elaborated BPD of the case is to be found in 4.4. The AD of the process is given on the right side. The AD is to be found in 4.5. In theory the AD contains all information that is given in BPD so one could say that the BPD is redundant and be omitted. The reason why this is not the case will become clear in subsection 4.4.

4.2 Actor Description Table

In Table 1 the actors of the OCD are listed. Only the internal actors are included. In row BA-01, the order deliverer is marked in the column Managing Partner (MP). This is to be explained as follows: the position MP fulfills the role of order deliverer and is assigned to the responsibilities as listed in the last column. In general a position fulfills at least one actor role and an actor role is fulfilled by at least one position.

Table 1. The Actor Description Table

Nr.	Name	MP	Consultant	Office manager	Responsibilities & Authorities
B-A01	order deliverer	X			•Guarantees that INQA keeps its promises to the customer and guarantees the order quality. •Clear communication between order producer and customer about the order results and the execution of the order. •Is aware of all possible signals indicating a customer's dissatisfaction.
B-A02	order producer	X	X		•Execution of the order. •Share knowledge, expertise and tangible products to reach an optimal result. •Execution of the order according to plan of action.

Practical reflection. Practical experience has revealed that the ADT, particularly on the work floor, brings a significant contribution to the support of the QMS by employees. This first table in the handbook make the employees recognize their operation and the corresponding responsibilities and authorities. This fits directly to the recommendations of Boiral [3]; recognition of the employee in models leads to an increase in support of the QMS among the employees. This support is crucial for a successfulimplementation.

4.3 Representation of the CM

As one can see, the OCD in Figure 3 clearly outlines the scope of the QMS. The Service delivery company has responsibility for all processes within this outline titled: "Service delivery company". These outlines are called boundaries in the DEMO. At the edge of this outline the interactions with the gray colored external actors are shown. E.g: the customer (CA01) requests the delivery of an order from the internal order deliverer B-A01, making it clear that the responsibility of the order delivery lies with the service delivery company.

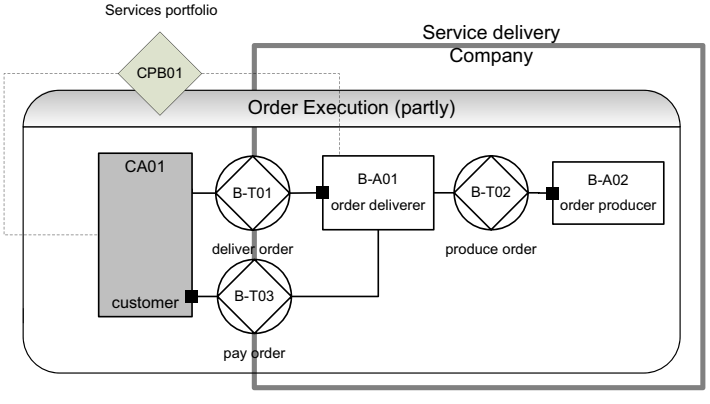

Fig. 3. The Organization Construction Diagram

Transaction Result Table. The transaction results as formulated in [5] are hard to explain to non-DEMO experts when the SM is not given, as is the case in the QMS handbook. Therefore a different notation is chosen to formulate the transaction results. The transaction results are formulated according to the Semantics of Business Vocabulary and Business Rules (SBVR) [25] to distinguish between types and instances. Both notations of the transaction result of B-T01 are given in Table 2. At first sight, one could say that there are not many differences, but it is important to distinguish clearly between type and instance. In DEMO-2 notation it is clear that O is a variable and Order is the type that can be instantiated, e.g.: *Order is delivered* is the type and the instance can be *Order INQ368 is delivered*. In SVBR notation the type always starts with a capital, which does

Table 2. Transaction Results formulated according DEMO-2 and SBVR

Nr.	Transaction name	Nr.	Transaction result(DEMO-2)	Transaction result(SBVR)
B-T01	deliver order	B-R01	Order O is delivered.	Order is delivered.

not look strange to a non-DEMO expert. To avoid unnecessary discussion with non-DEMO experts we have chosen to use the SBVR notation in the handbook. In Table 3 the transaction results of the three transactions are given.

Table 3. Transaction Result Table

Nr.	Transaction name	Nr.	Transaction result
B-T01	deliver order	B-R01	Order is delivered.
B-T02	produce order	B-R02	Order is produced.
B-T03	pay order	B-R03	Order is paid.

Bank Contents Table. Table 4 specifies the contents of the external banks. The dotted lines from an actor role to an external bank are information links. An information link is to be explained as follows: an actor needs external information from the bank in order to do its work. For example, in Figure 3, both the order deliverer and customer are linked to the services portfolio bank: both need to know what kind of services INQA provides.

Table 4. Bank Contents Table

Bank nr.	Bank name	Bank content	Actor nr.	Actor name
B-CPB01	Services portfolio	Services	B-CA02	capacity/knowledge deliverer
		General conditions	B-A01	order deliverer

Practical Reflection. The CM is the most abstract aspect model of DEMO that gives an overview of all identified transactions and actor roles. This is the first model that is shown in the handbook. The CM has proven to be very useful, especially in discussions with managers. This can be explained as follows: the CM is capable, because of its concise and comprehensiveness, to show the essence of an entire enterprise on one page. This powerful instrument function as a strong fundament in discussions with managers about responsibilities and authorities, futhermore it obliges that the discussion is kept on the correct abstraction level. The CM replaces the EFQM Excellence model [26] is a predefined management system that is used to structure an ISO 9001 handbook. It may be clear that the CM is much more useful compared to the EFQM Excellence model because it reflects the true Enterprise.

4.4 Representation of the Process Model

The PM is represented by the BPD. The BPD enables to reveal dependency and causal relations between transactions in a concise way. DEMO experts are able

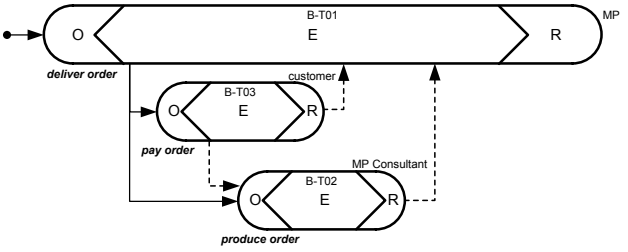

Fig. 4. The Business Process Diagram

to see (Figure 4) in one glance that both B-T02 and B-T03 are component transactions of B-T01. In other words: transactions B-T02 and B-T03 are required to end-up in the accepted state before B-T01 can be finish the execution step. Besides it shows that the order payment must be promised before the transaction: produce order can be requested.

Practical Reflection. Although the BPD is a very powerful representation that enables to show the structure of transactions, practical experience has taught that the BPD has initially a deterrence effect to non-DEMO experts. The main cause for this is that the diagram and the used symbols itself are not self-explanatory, therefore it is chosen to combine the BPD and AD next to each other as shown in subsection 4.1. Interviews with employees have revealed that the BPD is skipped at the first moment and the focus is on the AD. After reading the AD by employees, the relation between the AD and BPD becomes clear and the addition of the BPD becomes evident.

4.5 Representation of the Action Model

The AM is represented by the AD. The AD deviates from the developed pseudo algorithmic representation of Dietz. The main reason for this is that practical experience in making DEMO models has taught that the pseudo algorithmic representation [5] of the AM is hard to interpret by employees without a (computer) science related background. As an alternative the AD has been developed. Figure 5 shows a single AD element.

C-A0x Fulfiller of role CA0x	**Request** B-T0x **deliver order**	Data carrier:
B-A0x	**Promise** B-T0x **deliver order** **IF <condition>** **ELSE**	
Fulfiller of role B-A0x	Infological Action #1 performed when B-T0x is promised Infological Action #2 performed when B-T0x is promised Datalogical Action #1 performed when B-T0x is promised	Data carrier that is needed to perform infological action #1

Fig. 5. The Action Diagram element

As one can see in Figure 5, the element is build up in 3 columns. The cells in the first column are filled with the actor role. Its fulfiller that correspond with the performed transaction step in the second column. The fulfiller of the actor role is given mainly to lower the understanding threshold that was explained in Section 2. The cells in the second column do always contain a transaction step (e.g. request, promise, etc.) and, if applicable, a condition that needs to be satisfied. Furthermore infological and datalogical actions can be defined. The third column contains the needed data carrier for the condition or to perform the infological or datalogical action. Figure 6 shows the elaborated AD of the service delivery company's order execution process (partly) which is built from AD elements as depicted in Figure 5. As one can see, the actions and conditions inside the AD elements are written in natural language.

Practical Reflection. The AD is the most exhaustive diagram of DEMO. It contains all information that is also contained in the CM and PM; but in a

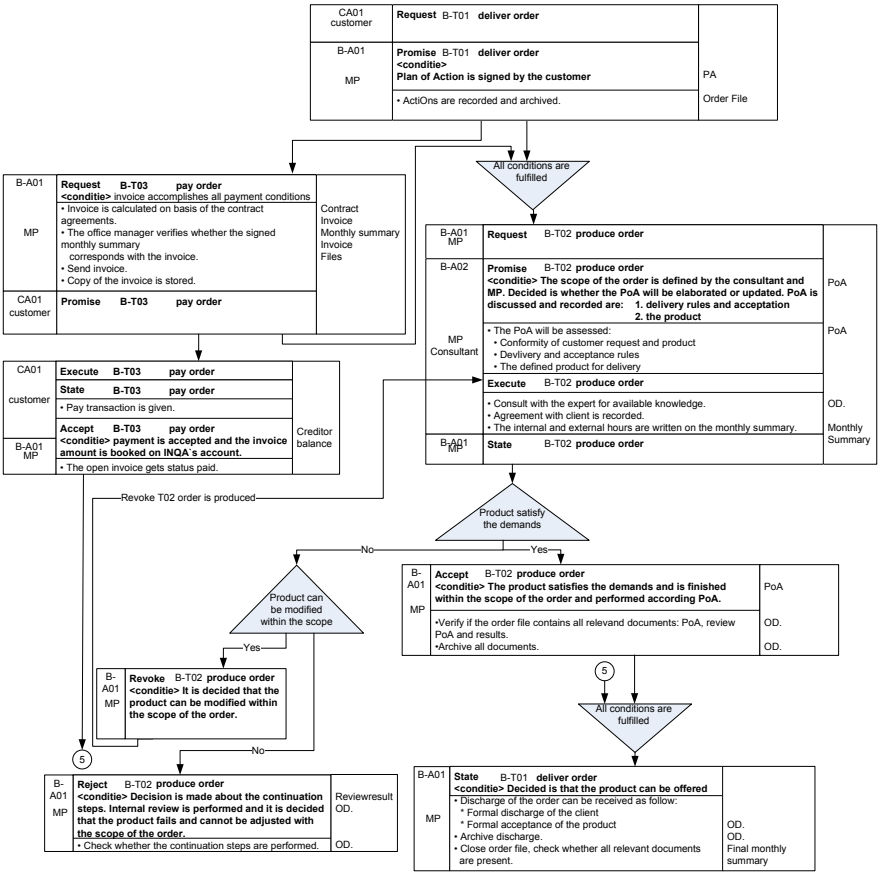

Fig. 6. The Action Diagram

different, and not so easily accessible, way. Practical experience has revealed that the AD is very easy to interpret. This is not very surprising because the AD has a lot of similarities with traditional flowcharts. A disadvantage of the AD might loose its clear overview when the number of relationships between the transaction steps increases. The challenge to optimize the composition in order to realize a clear overview can in result in a tough and time consuming job for the modeler.

5 Evaluation and Conclusions

The new shape of the QMS handbook, as proposed in Section 4, has been tested in two SME companies, namely INQA Quality Consultants and KIPP en Zonen. In both cases the handbook was produced for the purpose of getting the ISO certification. INQA is a service delivery company that conducts ISO certifcations in other companies, Kipp en Zonen produces state-of-the-art high quality electronical devices. In both cases the experiment has been extensively discussed an evaluated. One of the results is that the use of the ADT offers a significant contribution to the support by the employees of the developed QMS. Another one is that the CM has proven to be a powerful instrument in discussions with managers. In particular, the CM has been discussed as a potential substitute for the EFQM Excellence model [26] that was used mostly before. Managers consider the CM to be a substantial improvement compared to the EFQM Excellence model because it represents for them the 'real' enterprise. Lastly, as elaborated in Section 4.4 and 4.5, combining the BPD and the AD leads to an increase in understanding the structure of processes by employees. In addition, the employees get a more clear picture of their responsibilities. We have discussed the results of our approach with the managment of INQA. This has lead to the decision by the management to adopt the new approach in future certification projects. Although the practical evaluation is only based on two cases, the results so far are very interesting and promising. It endorses Boiral's conclusions [3] that the application of a methodology that supports the institutional paradigm results in an increase of commitment by the employees. This has been observed convincingly. Regarding the desirable features of a QMS handbook, as presented in the introduction, the next conclusions can be drawn. First, the produced handbooks are absolutely concise. The reduction in size is estimated at about 80 percent. Next, since this reduction stems mainly from focussing on the ontological model of the enterprise, the other features are achieved as a more or less logical consequence of this. Whether the process descriptions are indeed insensitive to minor changes needs to be experienced yet. However, the evaluations of over 100 other projects in which DEMO has been applied [27] indicate that this will certainly be the case.

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