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Detail REA Production Planning Model Using Value Chain

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Abstract

REA (resource-event-agent) is an ontology based on the value oriented perspective of resources, utilized in business process modeling. The value chain model is a network of business processes that are bound by the inflows and outflows of resources, the result of which provides an overview of the business processes of a particular enterprise and validates the consistency of the whole model. The fact that resources can only flow among business processes considerably restricts activities such as planning, controlling and monitoring. The paper designs advancement how to adopt the REA value chain model in order to effectively comprise the flows of entities between two neighboring REA process models at both operational and policy levels.

Keywords: business process modeling; REA ontology; value chain; controlling and controlled process; metamodeling

1. Introduction

A production planning model captures the planning and production processes of an enterprise. These processes are immediately consequential processes, which means that the output of the planning process is consumed in the production process. Process modeling methods have been elaborated upon by many authors using different frameworks and ontologies. In particular, we should take note of IDEF0 [2] and the profound analysis of process models performed by [3]. However, traditional process models do not depict property rights, resource controls and value flows. The e3-value ontology, similarly to that of the REA ontology deals with the value flows of resources. However, deeper insight in e3-value modeling in e.g. [5] shows that this method only covers exchange and trade processes while leaving out production and conversion processes. The state-of-art e3-value model focuses only on the operational level (i.e. what has happened) and not on management policies (i.e. what could or should happen).

The enterprise ontology, as developed by [4], precisely defines basic concepts such as the actions and processes that represent the actual core of business operations. However, this ontology leaves out the economic fundamentals of business activities, namely value flows and property rights.

The REA ontology is a powerful tool for business process modeling as it provides a set of benefits that enable the user to create a robust domain specific model whose integrity can be checked even during the development phase.
with a precise definition of concepts and relationships between them. The main benefit of the REA ontology is that it includes the economic fundamentals of business activities.

The REA ontology is presented as a two level model where the base level specifications known as the *operational level*, is sufficient for all business operations that run in the current and the meta level specifications known as the *policy level*, which defines the constraints and guidelines under which an enterprise operates.

The two important semantic abstractions that are utilized between the policy and operational levels of the REA models are *typification* and *grouping*, as introduced and described by Geerts and McCarthy [1]. The main use of these semantic abstractions is in the definition of constraints and guidelines. The basic structure of the REA conversion process containing essential entities and relationships between the operational and policy levels is illustrated in Fig. 1.

![Fig. 1 Basic structure of the REA conversion process](image)

Apart from these semantic abstractions, planning process utilizes *fulfillment* relationships between a *Commitment* entity at the policy level and an *Event* entity at the operational level to express the extent of “commitment” to be fulfilled. Possible implementations of this relationship are elaborated in Hunka et al. [7]. The main aim of the paper is to show and rationalize a different solution for the REA value chains.

2. Value Chain

A Value Chain concept, developed and introduced by Michael Porter [6] can be arranged as a series of input-output business processes with resource flows between them, this is described more closely in [8, 9]. A fundamental notion in value chain analysis is that a product gains value as it passes through a stream production within the chain (enterprise). If a resource flow is created by REA resources and business processes comply with REA exchange or conversion processes, we can speak about an REA value chain. The REA value chain was introduced by Geerts and McCarthy [10] as a network of business processes whose purpose is to directly or indirectly contribute to the creation of the desired features of the final product or service, and to exchange it with other economic agents for a resource that has a greater value for the enterprise. While the REA business processes are bound together by a duality relationship, the REA value chain model is woven together by resource inflow and outflow relationships.

Through a detail examination of the value chain structure, we can identify several principal features that are applied for this notation. The most important of this features is that only resource entity values can flow (inflow, outflow) between different REA process models. This fact implicates that a policy level of the REA model is not included in this stockflow. However, an REA model consists not only of the operational level but also contains a policy level. A simple value chain of the REA conversion and exchange process models is illustrated in Fig. 2. The difference between both levels of the REA model can be shortly described as follows: At the operational level, the
model records the day-to-day events of the domain. At the policy level, the model records the general rules that govern this structure. In addition, instances at the policy level govern the configuration of the instances at the operational level.

More extensively, value chains that cover planning, monitoring and controlling lead to active involvement at the policy level in the value chain concept. By active involvement, we mean that preceding process model creates an entity that will be utilized at the policy level of the subsequent process model. This requirement is entirely natural and would considerably increase the usage of REA ontology in the areas of real applications. Resources at the operational level represent only physical items in this way, which comprises a bottleneck within the current REA ontology that is only focused on resource flow at operational level of the process.

In order to model a given domain, e.g. production planning, it is also necessary to introduce some notions and relationships that enable influence and control of entities at the policy level. Here a challenge is posed, regarding how to generate entities such as a schedule or contract at the policy level. Citing Fowler [11]: “Instances on the policy level govern the configuration of the instances at the operational level”. From the perspective of the developer this means that instances at the policy level must be created first while instances at the operational level are generated consequently.

3. Planning Process Model

The main objective of this process is to create a schedule entity that will be utilized in the neighboring process. A schedule is a crucial entity for the conversion processes that specifies what should occur in the future. In short, a schedule in the REA model is a collection of increment and decrement commitments. Therefore a schedule entity cannot be modeled as a resource entity. It is due to these reasons that proposed solution will be described.

At the operational level of the planning process (see left-hand section of Fig. 3), the labor planner and computer are input resources that are consumed or used to create the output resource, a schedule knowledge that is used at the operational level of the following process model. The Bill of Material entity (BoM) represents both a listing of all the assemblies, subassemblies, parts and raw materials that are needed to produce one unit of a finished product and also define the way in which a finished product will be manufactured. Thus the BoM entity creates a core input entity for the planning process. Assemblies, subassemblies, parts and raw materials are set in the form of “category items” and the way in which a finished product will be manufactured represents a target description. A [1] target description can take at the least two different forms: standards and budgets. Standards often refer to engineering information while budgets provide quantified performance measures mostly related to a specific time period. Therefore the BoM entity is located at the policy level of the model. The BoM is related to a decrement event by a use knowledge relationship to be utilized in planning process. At the policy level, the output of the process is a resource type production schedule. The BoM and production schedule resource types are related by a policy-level association that expresses the restrictions imposed on the production schedule resource type. The production schedule resource type and schedule knowledge resource are related by a typification relationship.
4. Production Process Model

This process model which immediately follows the planning process model is illustrated in the right-hand section of Fig. 3 and is managed by a schedule entity. Via a clause relationship, this schedule entity is joined to decrement/increment commitment entities which holds these increment and decrement lists of commitments in place see Fig. 1. A schedule entity represents rules, restrictions and commitments by which the future production is performed.

Commitment entities are related by a fulfillment relationship to decrement/increment event entities. The output of this process is a product type at the policy level and a product at the operational level. In order to distinguish between standard neighboring REA models where relationships exist only at the operational level and to overcome this semantic gap, we introduce two new notions of REA models and a new relationship between them. As was mentioned earlier, a resource entity is mainly characterized by its value and is bound to event entity(ies). On the other hand, a resource type entity bears rather the knowledge, rules and restrictions that can be applied to a resource entity.

The drawing in Fig. 3 illustrates the proposed solution. As can be seen from this figure, there is not only a resource flow at the operational level but also, a resource type flow at the policy level between neighboring processes. To distinguish this change, we introduced new notions for neighboring processes that meet the above mentioned conditions.

Let us call an REA model that produces a resource type at its policy level and a resource at its operational level a controlling REA model. An REA model that consumes (inflows) resource type and resource entities from the controlling REA model is called a controlled REA model. The notion of controlling and controlled process models has been previously introduced in [12]. A resource type entity of the controlling process is reflected in a Schedule
entity of the controlled process at the policy level of the REA model. A resource of the controlling process outflows into a resource of the controlled process at the operational level of the REA model, expressing the amount of resource to be consumed or used to produce a schedule entity.

The notion of controlling and controlled processes exists to distinguish among the standard relationship between REA models and newly introduced models joined at the policy level of the processes. A reflection relationship is a newly introduced association between entities at the policy level. It expresses that a resource type from the controlling process is reflected in an entity type (schedule) of the controlled process. This means that the necessary data attributes are transferred into an entity with a different structure. This relationship enables the joining of a resource type in the controlling REA model with a schedule entity in the controlled REA model.

5. Proposed Solution Discussion

The planning and production process models create a part of a value chain. The main purpose of the planning process is schedule creation and its outflow into the production process model. According to REA ontology, a schedule is an entity at the policy level of the REA model. A schedule knowledge resource entity, which is the standard and singular output of REA process models, is an entity with a firm structure and relations within the scope of the operational level of REA models. Any contemplation regarding the utilization of a resource entity and its “transformation” into an entity at the policy level are not possible due to the structure and relations of the resource entity. Moreover, the crucial entity for planning process is the BoM, the entity that with its structure and functions is part of the policy level.

With its character and relations entity at the policy level of the REA model, the resource type entity, typifies the corresponding resource at the operational level. The schedule creation policy is used for the association between the BoM and resource type. This association firmly determines utilization of the BoM in a resource type. In addition, a resource entity is created at the operational level of the planning process. This entity contains “physical items” concerning the amount of planner labor and computer time that was consumed or used for the schedule (resource type) creation. It also bears the schedule knowledge information needed at the operational level.

The resource type then uses the reflection association to be transferred into a schedule entity. The resource type contains all the necessary items required for the schedule entity but due to different structure and semantic meaning, a transfer is necessary.

The larger, real applications e.g. the production planning model brings questions concerning planning documents and other “knowledge resources” into the foreground. This information should be worked out in the form of a resource type and resource entities of the subsequent processes. Their role is very important within that context and can be appreciated in vast applications including planning, monitoring and controlling processes.

6. Conclusion

The REA framework possesses large potential for modeling business applications. The paper describes the way in which these possibilities may be utilized in order to achieve more precise business models. The whole application can be modeled beneficially in the form of value chains which brings unique overall view to the entire business application structure and that enables further detailed modeling of individual business processes. Newly introduced and delineated notions of controlling and controlled processes by a reflection relationship subsequently facilitate the modeling of business process applications focused on planning, modeling and controlling. The proposed changes to the REA framework extend its utilization in practice.

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References


