Spread Page approach to Business Process Management

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Recently, we have observed a slow departure from printed texts towards electronic publications. However, electronic publications pretend to be paper-like. Whereas, such content may be presented in many ways, including three-dimensional, time-varying, layered, scaled detail, and aspect-oriented representations. This is the area of application for the Spread Page Initiative.
Spread Page Initiative refers to the development of notation and tools for knowledge representation in a modern manner not limited by using the traditional paper-oriented technique.
The article describes the Spread Page approach to the modeling of business processes.
The authors consider a possibility of using new ways of knowledge representation to ensure accurate and more precise modeling of business processes.

Keywords: Spread Page, knowledge representation, Business Process Management.

1. Introduction

The purpose of Spread Page Initiative is to develop notations, models and methods for representing of knowledge so that its transfer is as efficient as possible.

Therefore, Spread Page departs from printed texts, bearing in mind all their glaring limitations, and moves towards modern methods of knowledge representation.

The following chapters give, on one hand, an overview of different methods of knowledge representation and describe all aspects of the modeling of business processes, on the other. Subsequently, proper use of particular methods of knowledge representation was proposed for specific aspects of the modeling of business processes. Special attention is also paid to assessment of the current state of technology in terms of modern methods of business modeling.

2. Spread Page model representations

There are several Spread Page model representations. Each of them can be used to illustrate a different aspect of a model being designed.

Three-dimensional Representation

Three-dimensional (3D) models represent an object using a collection of points in 3D space, connected by various geometric entities such as triangles, lines, curved surfaces, etc. Being a collection of data (points and other information), 3D models can be created by hand, algorithmically (procedural modeling), or by scanned. Their surfaces may be further defined with texture mapping.

Today, 3D models are used in a wide variety of fields. The medical industry uses detailed models of organs; these may be created using multiple 2-D image slices from an MRI or CT scan. The movie industry uses them as characters and objects for animated and real-life motion pictures. The video game industry uses them as assets for computer and video games. The science sector uses them as highly detailed models of chemical compounds [1]. The architecture industry uses them to demonstrate proposed buildings and landscapes in lieu of traditional, physical architectural models. The engineering community uses them as designs of new devices, vehicles and structures as well as a host of other uses.

Contrary to 2D models, 3D models may include many more details describing the modeled phenomena. Therefore, it is worthwhile applying them in software engineering as an extension of previously used

notation. First attempts of the modeling of business processes using 3D visualization were made at the Institute of Applied Informatics and Formal Description Methods at Universität Karlsruhe, Germany [2].

Time-varying Representation

In many scientific disciplines, there are models with elements or relations between them that vary in time. Dynamic networks are one of many examples. They are very often described as time--varying graphs which consist not only of nodes and edges sets but also have an additional time instants set that stores changes of nodes and edges attributes in the network with time [3].

Time-varying models could be viewed as a film-strap object that allows skipping from one point in time to the next one or the previous one. It could also play an animated clip for a given period of time.

Layered Representation

Modern digital maps are in fact collections of layers. At the beginning, digital maps had the same basic functionality as paper maps. They were just pictures representing roads outlined by the terrain encompassing the surrounding area. However, as digital maps have grown with the expansion of GPS technology in the past decade, live traffic updates [4], points of interest and service locations have been added to enhance digital maps to be more "user conscious" [5]. Traditional map views are now only part of digital mapping. In many cases, users can choose between virtual maps, satellite, and hybrid views.

However, layered representation is used not only for geographical map representation. Layers are commonly used in digital image editing and processing. In medical image analysis layers are very powerful tools for collecting data from different sources, presenting them together, separating different parts of image analyzed, and supporting doctors in decision making.

Many scientific notations can be represented as layers. This approach allows us to present individual aspects of constructed model on different layers and analyze them separately or together, depending on layer visibility settings.

Multi-resolution Representation

In geography, the larger resolution of the map, the better the features that can be detailed. A map that shows the water network of a small area may show the river as a polygon layer and will show the tributaries of that river. A small resolution map covering the area would show that same river as a line feature and the tributaries would be removed (a process known as generalization). The smaller resolution of the map, the less precise detail is preserved [6].

Computer graphics and animation systems use multi-resolution approach to object representation. There is no need to draw every detail of an object that appears at a very long distance from the observer. However, in case when the same object approaches the observer it is necessary to unhide its details to make it look properly at the screen.

In scientific models, sometimes there is a need for looking at the model "from the distance". That kind of view could be a draft of a detailed model. For instance, at the general view of data model there is no need to show all attributes of entities. Rectangles representing entities, their names inside, and lines representing associations between them would suffice.

Aspect-oriented Representation

Sometimes a model could have a slightly different meaning depends on whom it is addressed to. For instance, if we could imagine a model of a legal agreement, different parts of that model are important for different persons involved in an approval and signing of it. Instead of delivering the whole text to everybody, each person could receive only the pertaining parts (aspects), and in the form that he or she prefers. This is the main point of aspect-oriented representations.

3. Business Process Management

Business process models can be used in a variety of contexts, for example business process engineering, information system design and development, investment evaluation, and so on. The goals and objectives of a study will necessarily impact the uses to which a model will be put and therefore influence the requirements posed on the process representations to be employed [7]. Table 1 illustrates typical BPM goals and objectives, along with associated requirements for modeling techniques in each case [8].

Tab. 1. BPM goals and objectives. Source [8]

Modelling Goals and Objectives	**Requirements for Modelling Techniques**
Support Human Understanding and Communicating	Comprehensibility, Communicability
Support Process Improvement	Model Process Components, Reusability, Measurability, Comparability, Support Technology Selection and Incorporation, Support Process Evolution
Support Process Management	Support Reasoning, Forecasting, Measurement, Monitoring, Management, and Co-ordination
Support Process Development	Integrate with development environments, Support for Process Documentation, Reusability
Support Process Execution	Automate Process Tasks, Support Co-operative Work, Automate Performance Measurement, Check Process Integrity

Due to the complex and dynamic nature of organizations, it has been argued that carefully developed models are necessary for understanding their behavior in order to be able to design new systems or improve the operation of existing ones [9], [10], [11]. However, high complexity of business processes can make modeling and experimentation an arduous and problematic task [12].

Since BPM techniques have been developed without a reference to business processes and information systems integration, a fundamental research question would involve studying existing approaches to modeling with a view of developing applications.

Figure 1 below shows several selected BPM modeling techniques that have been reviewed and classified.

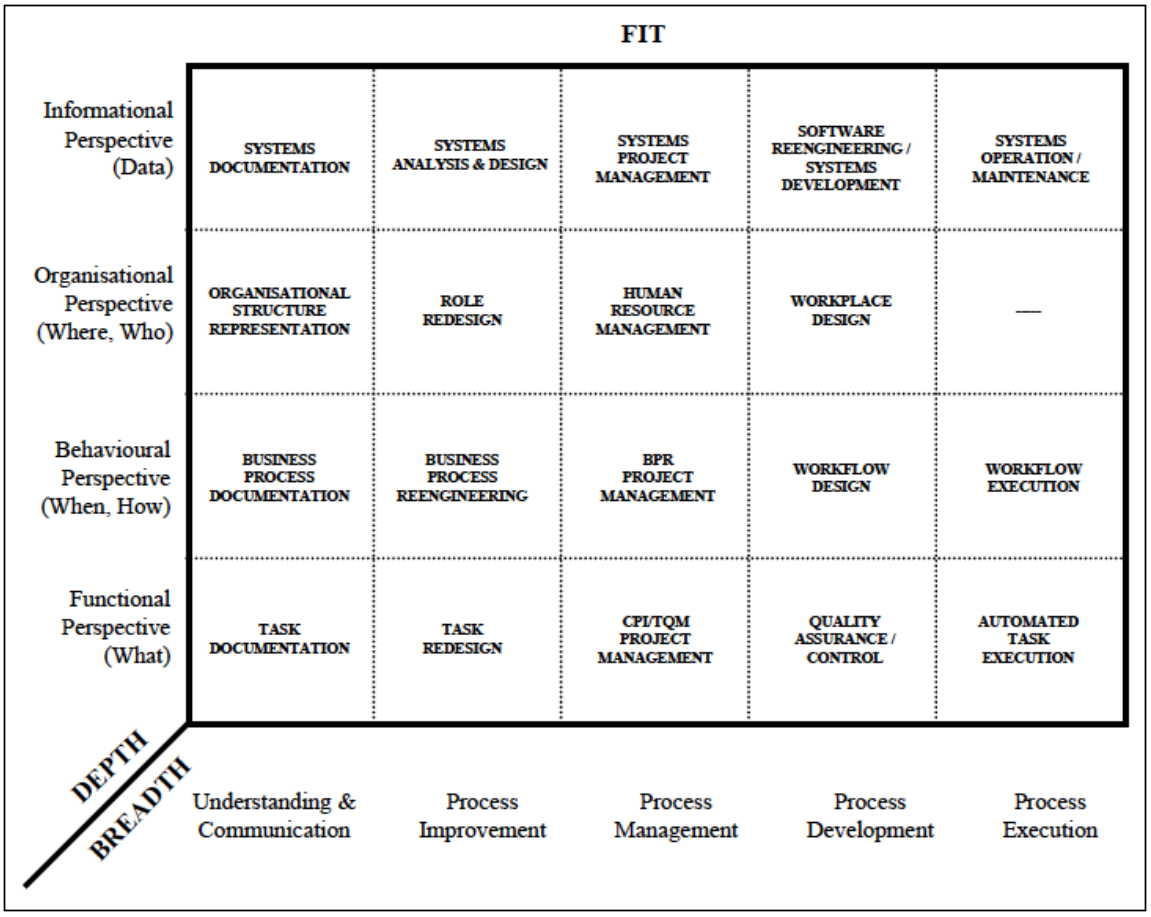

Fig. 1. BPM modeling techniques

All modeling techniques have to be capable of providing various information elements to its users. Business process models include information of what activities are executed in the process, who is performing these activities, when and where are these activities executed, how are they performed, and what data they manipulate.

To provide this information, a modeling technique should be capable of representing one or more of the following "process perspectives" [8]:

Functional perspective – represents what process activities are performed.

- behavioral perspective – represents when activities are performed including basic sequences as well as feedback loops, iterations, decision-making conditions, entry and exit criteria;
- organizational perspective – represents who performs activities and where as well as the physical communication mechanisms used for storing and transferring entities;
- informational perspective – represents data produced or manipulated by a process and relationships between the data.

To model business processes, there are many techniques that have been tried and tested throughout the years. Some may have few drawbacks and some have proven successful. Most important of them are:

- Flow Chart Technique;
- Data flow diagrams – Yourdon's technique;
- Role-Activity Diagrams (RAD);
- Role-Interaction Diagrams (RID);
- Gantt Charts;
- Integrated Definition for Function Modeling (IDEF);
- Colored Petri-nets (CPN);
- Object Oriented Methods (OO);
- Workflow Technique;
- Business Process Modeling Notation (BPMN);
- UML Activity Diagram.

The modeling of business processes is much more than just setting the course of actions, sequencing actions and determining performers. To function properly, the business process needs to operate on data.

The emergence of certain data in an organization initiates a given business process. For example, placed orders initiate the production and supply process, whereas vacation leave requests initiate the vacation request handling process, etc.

While executing the process, the input data are supplemented with other information available in a company. The data are, to a large extent, derived from various registers kept by the company. In case of the production and supply process, the data include information on the product range, time and cost parameters of the production processes, essential subgroups and raw materials, warehouse inventory, and availability of personnel. In case of the vacation request handling process, the data include information on employees, their used leaves, potential replacement, required approvals.

While handling the process, additional data are produced. As a result of the subsequent tasks of the process, the records are being supplemented or modified. When the process is completed, the modified, coherent and verified entries showing the current status occur in the registers of the company.

Apart from the data, the processes also handle documents. From the perspective of a given process, the documents are data with a strict form. Similarly to the data, the emergence (delivery to the company) of new documents may initiate a given business process. The data within the documents usually require additional treatment so that they might be separated, verified and used by the process.

The new documents being delivered may supplement the data in the already launched processes. It is a relatively advanced aspect of modeling of business processes, as not all notations provide for such a possibility. Separate processes are often used for the modeling of such phenomena.

Another element of the modeling of business processes are business rules. In short, they are formal principles, according to which the parameters are set for the business process. The parameters have impact on the course of the process, since any decision-making elements are based thereupon.

The business process model would not be complete without its participants, i.e. the persons (or sometimes automated systems) who perform tasks in the predefined process.

The assignment of employees to certain tasks is another issue. It seldom means a simple assignment of a person to a certain task. In practice, a number of issues must be considered, i.e. selection of a performer from a group of other equivalent performers, appointment of replacement for absent performers for the time when a given task should

be executed, selection of performers based on values of the parameters in a given process instance and definition of advanced principles for selecting performers pursuant to their powers of attorney and authorization for representation.

All these aspects of the modeling of business processes may not be contained in individual 2D diagrams, as, in practice, each of them is modeled through different notation. Such an approach makes it impossible for the modeler to provide direct links between the modeled elements of the process. The application of the Spread Page approach may prove to be a good method for filling the gaps in the models and ensure that the properly developed business process models are more complete and eligible for their recipients.

4. Modeling business processes with Spread Page

There are several attempts to model business processes using 3D notations. Stefanie Betz, Daniel Eichhorn, Susan Hickl, Stefan Klink, Agnes Koschmider, Yu Li, Andreas Oberweis, and Ralf Trunko described their approach to such a modeling. They claim that 3D models provide higher plasticity and eliminate some deficits of conventional 2D process modeling such as the limitation of the amount of information to be integrated into a process model in an understandable way. The usage of an additional visual modeling dimension may support users in compactly representing and animating business process models. For this purpose, they propose an approach for 3D representation of business process models based on Petri nets [2].

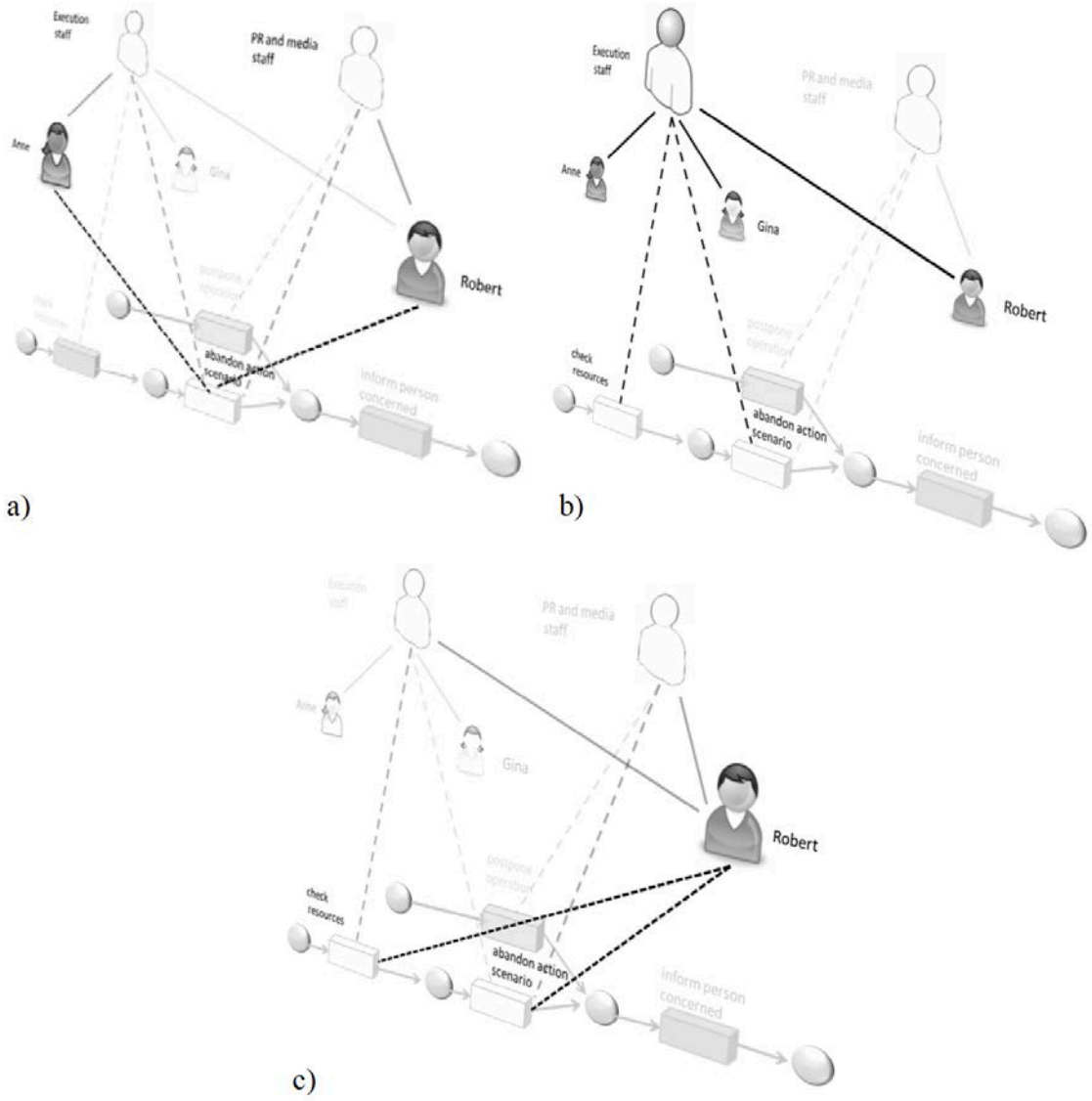

Fig. 2. Using the third dimension for a view on a) roles, b) resources, and c) activities
Source [2]

There are also publications dealing with the aspect-oriented modeling of business processes. Concerns such as compliance, auditing, business activity monitoring or accounting need to be addressed in early stages of modeling and not only at the implementation or execution phase. Mostly, such concerns are modeled as part of the normal flow in business process models. However, the crosscutting nature of such concerns leads to scattered and tangled models. When we try to model business processes that require support for some of these concerns they quickly become complex and cumbersome to understand and manage. The lack of appropriate means to modularize crosscutting concerns in process modeling languages seriously affects understandability, maintainability and reusability [13].

There also exists the specification of the AO4BPMN extension to the BPMN notation. It is an aspect-oriented extension of BPMN that facilitates the modularization of crosscutting concerns in BPMN models such as separation of duties, billing or monitoring.

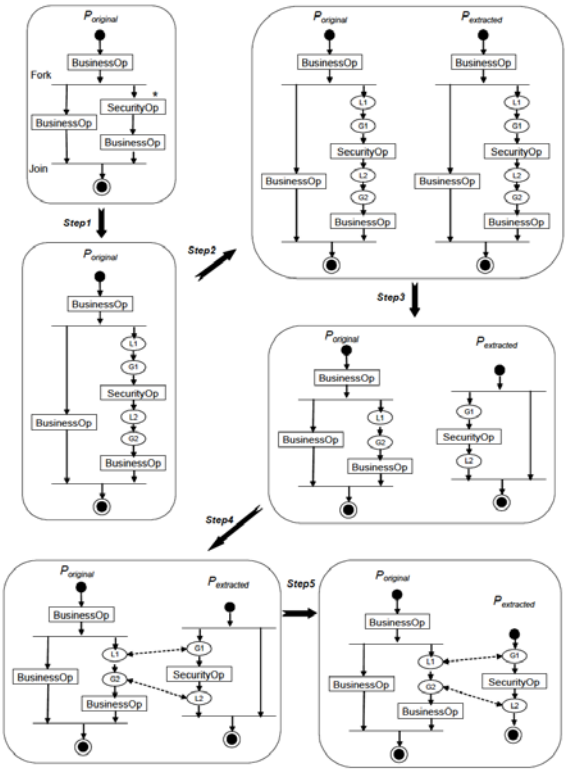

Fig. 3. A simple scenario for aspectual process extraction

The main purpose of aspectual process extraction is to separate target business aspects from original business process model, and keep the extracted aspectual process as a meaningful self-contained process. The extracted process is supposed to represent a specific aspect of the original business process model. In Figure 3, a simple scenario is used to provide an intuitive understanding of the overall aspectual process extraction procedure. In the sample scenario, it is expected that the aspect of security operations (annotated with the asterisk mark) will be separated from the original business process model to help business consultants get a cleaner understanding of the core business [13].

There are prototype tools built on top of CME (Concern manipulation Environment, the Eclipse Technology Project) and WSU (WBI Service utility) that can provide aspect extraction and assembling features in business process models.

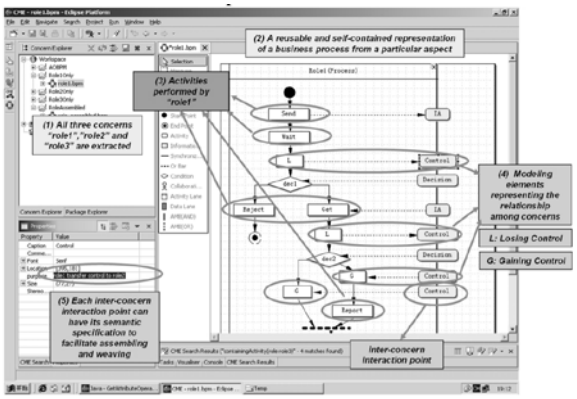

Fig. 4. Aspect extraction

To integrate aspectual process together, we can assemble them like the following figure and create the linkages between pairs of control tokens. Linkages can be automatically created with semantic matching or manually built. This diagram presents another perspective of the original business process model by role--based refactoring. Here, we only select role as a typical view, people can choose any other concerns for each specific case, such as location, time, financial dimension, and security-related aspects.

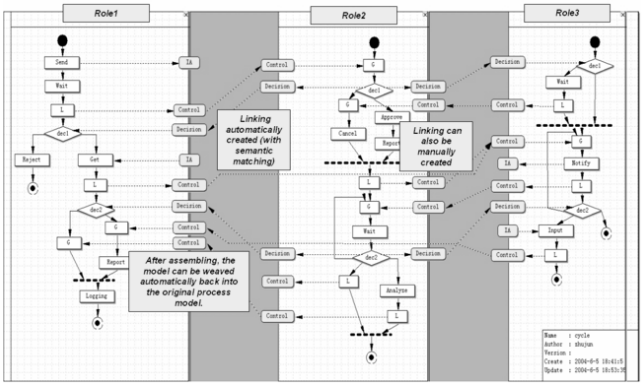

Fig. 5. Aspect assembling

There are three levels of abstraction in process modeling: Process Meta-Level, Process Model and Development Runs (Figure 6).

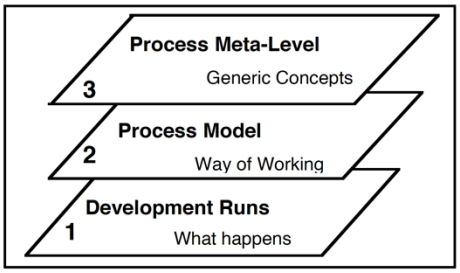

Fig. 6. Abstraction levels in process modeling

This is not the only way to represent processes in layers. Different layers should correspond to different aspects of business process models. For example, one layer could show activity durations when the other could show the activity costs.

According to the Dowson's [14], [15] classification of existing process models into:

- activity-oriented models;
- product-oriented models;
- decision-oriented models.

Activity-oriented models come from an analogy with problem solving, i.e. finding and executing a plan of actions leading to the solution. They are sequential in nature and provide a frame for manual management of projects developed in a linear fashion. Such a linear view of the design process is inadequate for methodologies that support backtracking, reuse of previous designs and have to support parallel engineering activities. The first widely used model, the Waterfall model [16], falls into this category, along with the Spiral model [17] and the Fountain model [18], which try to eliminate the well recognized lack of flexibility of the Waterfall model. Limitations and drawbacks of activity-centered development approaches come from their representation of development processes like programs which do not integrate at all the interactive aspects of information system development.

The product-oriented process models represent the development process through the evolution of the product. They promote a view of development processes which is still centered around the concept of development activity but present the advantage to link development activities to their output: the product. The ViewPoints model [19] belongs to this category as well as the development process model proposed in the European Software Factory (ESF) project [20].

A more recent class of process models follows a decision-oriented paradigm. The successive transformations of the product are looked upon as consequences of decisions [21], [22], [23]. Such models are semantically more powerful than the previous ones because they explain not only how the process proceeds but also why transformations happen. They provide a more complete knowledge about the process which is particularly useful for reuse of developed products, or of design decisions, and for backtracking purposes when a modification in requirements has to be considered either during the design process itself or during the maintenance of the information system.

Business process modeling with Spread Page principles gives some tangible benefits. Thanks to the techniques described in previous chapters the model can be more readable and detailed. The table below describes how different Spread Page representations can be used in order to model business processes.

Tab. 2. The use of Spread Page representations in business process modeling. Source: own elaboration

Spread Page model repre-sentations / **Document flow modeling aspects**	Three-dimensional	Time-varying	Layered	Scaled Detail	Aspect-oriented
Business process diagram				X	X
Business process data		X	X		X
Process Documents					X
Business Rules				X	
Roles	X				X

For business process diagramming the multi-resolution representation can be used. It helps to present on a single diagram both the general view on the process and its detailed view. That approach helps to understand processes and gives the ability to switch into details without losing the context of the process part being analyzed.

Aspect oriented representation is also helpful with business process diagramming. Thanks to that kind of multidimensional

diagrams a process designer can focus on a given aspect of the model, having its other aspects hidden as far as they are not important on that stage of analysis.

For process data modeling time-varying and layered representations are useful to show historical changes of data model. In addition, the aspect oriented representation together with the layered representation can be used to determine accessibility levels for different parts of process data. That approach is also the only way to establish individual data optionality for each task in the business process model.

A document content must not be the same for different groups of readers. Each of them could be interested in different part of the document and could look at it from different angles. That's why the aspect-oriented representation is the best to adapt.

The multi-resolution representation can be used for business rule modeling. It helps to present on a single diagram both the general and detailed views on the business rules. The multi-resolution representation is also useful because of hierarchical arrangement of business rule models. Thanks to that, operations like drill-down and roll-up are possible to perform.

Any worker can play many different roles in business processes executed in the enterprise. In one process one could be the person that enters process data, in the other – the person that approves tasks. That's why the aspect--oriented representation is the best to adapt.

Roles are independent from the organizational structure. However, workers are the part of the common of the organizational structure and roles in processes. This produces rather complicated dependency grid. Thanks to the three-dimensional representation all these dependencies could be shown on a single diagram.

5. Conclusions

The article outlines the use of particular methods of knowledge representation in accordance with the Spread Page Initiative assumptions for the modeling of business processes.

Additionally, the article describes particular aspects of the process modeling and their material characteristics. Attention was also paid to the inter-linkage between subsequent aspects of the business process model.

Standard methods for modeling of business processes make it impossible to fill the gaps that appear between various aspects of the formulated model. The application of the methods of knowledge representation as described by Spread Page is of a great importance.

The article shows how the methods of knowledge representation for particular aspects of the modeling of business processes may be used. It includes a review of the current state of knowledge, science and techniques within the scope of the modern modeling of business processes.

The conducted research confirms, first of all, that there is a need for more advanced process modeling and, second, that the introduction of the modeling methods in compliance with the Spread Page assumptions may improve the modeling methods and ensure that the obtained models are more coherent and precise.

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Zastosowanie *Spread Page* w modelowaniu procesów biznesowych

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W ostatnim czasie obserwuje się powolne odchodzenie od tekstów drukowanych na papierze na rzecz treści publikowanych elektronicznie. Takie treści mogą być prezentowane w różnoraki sposób z uwzględnieniem reprezentacji trójwymiarowej, uwarunkowanej czasowo, aspektowej, warstwowej oraz zależnej od skali.
Inicjatywa *Spread Page* zajmuje się opracowywaniem notacji i narzędzi reprezentacji wiedzy w sposób nowoczesny, nieograniczany przez technologię tradycyjnego wydruku.
Niniejszy artykuł opisuje podejście *Spread Page* do modelowania procesów biznesowych.
Autorzy rozważają możliwości zastosowania nowych sposobów reprezentowania wiedzy w taki sposób, aby zapewnić dokładniejsze i bardziej precyzyjne modelowanie procesów oraz danych, które są przez te procesy przetwarzane.

Słowa kluczowe: Spread Page, reprezentacja wiedzy, zarządzanie procesami biznesowymi.