UPDATED AND EXPANDED WITH EXCITING NEW CONTENT!

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BPMN 2.0 HANDBOOK
SECOND EDITION

Methods, Concepts, Case Studies and Standards
in Business Process Modeling Notation (BPMN)

Foreword by Dr. Bruce Silver

EDITED BY
LAYNA FISCHER

Published in collaboration with the
Workflow Management Coalition (WfMC)

BPMN 2.0 Handbook

Second Edition

Digital Edition

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18 Years of Thought-Process Leadership

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BPMN 2.0 Handbook 2ⁿᵈ Edition Introduction

Layna Fischer, Future Strategies Inc. USA

Authored by members of WfMC, OMG and other key participants in the development of BPMN 2.0, the **BPMN 2.0 Handbook Second Edition** assembles industry thought-leaders and international experts. Following the ground-breaking body of work in the **BPMN 2.0 Handbook First Edition** this book is greatly expanded with substantial new content and chapters updated to the latest advances in this important standard.

The authors examine a variety of aspects that start with an introduction of what's new and updated in BPMN 2.0, and look closely at interchange, best practices, analytics, conformance, optimization, choreography and more from a technical perspective.

The authors also address the business imperative for widespread adoption of the standard by examining best practice guidelines, BPMN business strategy and the human interface including real-life case studies. Other critical chapters tackle the practical aspects of making a BPMN model executable and the basic timeline analysis of a BPMN model.

FOREWORD
Bruce Silver, Principal, Bruce Silver Associates

The *BPMN 2.0 Handbook* illustrates this diversity of interest in the new standard. In addition to discussion of BPMN 2.0's technical features, we have examples of its application in business and government, its relation to SOA and process execution, and its suitability as a business-readable communication tool. We also have many suggestions for how BPMN could be extended, improved, or enhanced to meet the broader goals of business process management.

SECTION 1—Guide to BPMN 2.0 Technical Aspects

NEW CAPABILITIES FOR PROCESS MODELING IN BPMN 2.0
Stephen A. White PhD, International Business Machines, and Conrad Bock, National Institute of Standards and Technology, USA

This paper introduces new features in processes diagrams in the Business Process Model and Notation (BPMN) Version 2.0. A companion paper introduces new features in interaction diagrams for BPMN 2. BPMN provides a view of processes (how things get done) with flow charts tailored for business processes and interactions. BPMN 2 expands the capabilities of BPMN 1.x Process and Collaboration diagrams, and adds Choreography diagrams for business interaction modeling. The paper focuses on the new process modeling capabilities of BPMN 2 and assumes familiarity with earlier versions of BPMN.

NEW CAPABILITIES FOR INTERACTION MODELING IN BPMN 2.0
Conrad Bock, National Institute of Standards and Technology, USA, and Stephen A. White PhD, International Business Machines

Interaction models capture how businesses interact with customers and each other to provide products and services. Models are needed to reach agreements about what will be provided to whom and when, and to gather requirements and expertise in one place for a successful business. The trend towards combinations of products and services increases the complexity of interactions beyond the capacity of conventional business process modeling languages. Conventional process modeling typically focuses on business internals. Interaction models hide the proprietary aspects of business processes, while exposing those aspects needed for interaction. They scale to complex interactions between many parties, as in supply chains.

ANALYTICS FOR PERFORMANCE OPTIMIZATION OF BPMN 2.0 BUSINESS PROCESSES
Robert M. Shapiro, OpenText, USA and Hartmann Genrich, GMD (retired), Germany

We describe a new approach to process improvement based on the combined use of statistics and simulation to study the structural aspects of process models. Past efforts to use simulation focused on resource optimization have led to some significant successes when coupled with Workforce Management scheduling technology, but that approach has not been particularly successful in making structural improvements in the actual processes. The difficulty of preparing satisfactorily detailed schedules, combined with the structural complexities introduced in particular by the event and looping structures in BPMN, requires a fresh look at the problem.

MAKING A BPMN 2.0 MODEL EXECUTABLE
Lloyd Dugan, BPMN4SCA, USA, and Nathaniel Palmer, SRA International, Inc., USA

The very notion of an executable BPMN model can generate very different reactions. On one hand, BPMS vendors and implementers may agree, since the majority of BPMS platforms run models represented by BPMN. Yet their agreement belies the significant use of embedded business logic and proprietary extensions to make models executable. Process modelers, however, may question whether making a BPMN model executable is even worth pursuing. They might argue that the proper use of BPMN surrounds other purposes than simply creating BPMS applications. Yet this position often stems from a lack of appreciation for what makes models executable, which involves technical concepts perhaps of little interest to modeling purists. What is often missed in the "pure model" versus "executable model" argument, however, is that the same techniques that make BPMN models executable can in fact make models better.

BPMN EXTENSION FOR SOCIAL BPM
Piero Fraternali, Marco Brambilla and Carmen Vaca, Politecnico di Milano, Italy

The success of Social Networks has demonstrated the centrality of online interactions among people and the importance of communities of practice, whereby users can interact with the service providers and among themselves, for being informed, share experience, and express their opinion on the quality of a service. Several studies and analyses have demonstrated the advantages that this "socialization" of the users' online experience, for customers, citizens, or employees, will carry over to the enterprise environment. This trend is already in place in several business scenarios under the broad definition of "Social Enterprise" or "Enterprise 2.0". One specific example of this lays in the changes in the paradigm of Business Process Management, from "closed" to "open and social". This is known as *Social BPM* and encompasses the ability of integrating the advantages of social interactions with the well known value of enterprise process definition and improvement.

ADMISSION PROCESS OPTIMIZATION WITH BPMN AND OSCO (CASE STUDY)
Jack Xue, Butler University and Conseco Service LLC, USA

The Business Process Modeling Notation (BPMN) is an increasingly important standard for business process design and optimization and has enjoyed high levels of attention in academic research and business practice. In this paper, experiences are shared from a project that using BPMN to design and optimize an online admission process. This process is optimized with a framework of the Online Stochastic Combinatory Optimization (OSCO) which chooses a subset of incoming requests such that the revenue of the service provider is maximized. The admission decision is based on an estimation of requests' service times, and the rewards associated with serving these requests within their Quality of Service (QoS) bounds with respect to limited system resources. Historic distributions are utilized to help in decision-making. Experiments demonstrated the effectiveness of the admission process.

ADDRESSING SOME BPMN 2.0 MISCONCEPTIONS, FALLACIES, ERRORS, OR SIMPLY BAD PRACTICES

Denis Gagné, Trisotech, Canada

Business process modeling using BPMN requires at least two corpus of knowledge: Modeling knowledge and BPMN knowledge. BPMN knowledge, without an understating of basic modeling concepts and principles, will likely lead to less than useful business process models, while improper knowledge of BPMN rules and best practices, will not lead to any more useful process models.

This chapter addresses the question: what are models? Broadly speaking, we use the term model to refer to any structured knowledge that accurately reflects and/or helps us to make sense of our surrounding context (the term "world" rather than "context" is more often used in formal discussions). Models exist both internally as mental models and externally as artifacts. These artifacts can take many forms: written texts, spreadsheets, equations, diagrams, etc. While these different kinds of models vary greatly in their form and function, they all share certain desirable properties.

REFACTORING BPMN MODELS: FROM 'BAD SMELLS' TO BEST PRACTICES AND PATTERNS

Darius Silingas and Edita Mileviciene, No Magic, Lithuania

BPMN is already acknowledged as a *de facto* standard for business process modeling. However, it still takes a long journey to raise the maturity of business process modeling practice. The language elements and notation are described in BPMN specification, illustrative BPMN examples are given in a supplementary document. The language and basic style guidelines are already covered in BPMN books. Despite of it, in practice most business process modelers do a lot of mistakes that make their BPMN models over complex, difficult to understand and maintain. According to the old saying, "it is stupid to not learn from your own mistakes, it is wise to learn from mistakes by others". Therefore, it is important to understand the common mistakes and their indicators that can be detected automatically or manually in BPMN model.

SIMULATION FOR BUSINESS PROCESS MANAGEMENT

John Januszczak, Director, MAXIMUS, USA

This paper provides an overview of business process simulation, the types of information required to define a business process scenario for the purpose of simulation, and a proposed standard for defining simulation scenarios that is compatible with the Business Process Modeling Notation (BPMN and XML Process Definition Language (XPDL). The article also describes how a RESTful web services API can be developed to support the standard. By providing a standard interchange format and/or a standard API, various artifacts currently available in the event logs of BPM systems could be used to generate baseline simulation scenarios useful in operational decision making and addressing near term processing issues, as well as long term process design.

COLLABORATIVE ACTIVITIES INSIDE POOLS

Michele Chinosi, European Commission Joint Research Centre, Italy

Choreographies and Conversations, introduced with BPMN 2.0, will make modelers able to describe interactions among different Participants as well as messages exchange. Often enough different Participants have to accomplish the same task. This can be now easily and clearly represented using BPMN 2.0. BPMN 2.0 does not specify the usage of Lanes neither their meaning. However, Lanes are sometimes used to specify internal roles or departments.

In this context it could happen that modelers want to represent an Activity performed by different roles or offices together (e.g., attending the same meeting, collaborative writing of a document). Such situation has been modeled so far by using merging Gateways placed before the activities, but this patch does not solve a related problem. BPMN forces to draw elements within Lanes boundaries. This means that, at least conceptually, one Activity is lead by the subject which the containing Lane is linked to, which is not necessarily true. Some experiments revealed how much the means to model such inner collaboration is a desirable feature.

BESPOKE ENTERPRISE ARCHITECTURE: TAILORING BPMN 2.0 USING CONFORMANCE CLASSES
Dennis E. Wisnosky, Office of the Deputy Chief Management Officer, Department of Defense, and Michael zur Muehlen Ph.D., Center for Business Process Innovation, Stevens Institute of Technology, USA

Government agencies have to fulfill their mission while being fiscally responsible and maintaining customer focus. Understanding the agencies' end-to-end processes and mission threads is essential to ensure that both performance and compliance objectives are met. Increasingly, Enterprise Architectures are used to document end-to-end business operations and to prove compliance to rules and regulations. Enterprise Architecture covers the creation of analytical or prescriptive models of organizations to understand, manage, or change the enterprise. The models that describe different architecture facets are typically organized according to the views they describe, such as process, data, rules and organization models, among others. For organizations that engage in multiple architecture projects, a systematic organization of these views is essential; only if the views and their representations are consistent across different projects can an organization efficiently identify organizational and technical interfaces, streamline cross-functional operations, and assert compliance to rules and regulations.

A number of obstacles to consistent architecture efforts exist to date: Divergent viewpoints, different frameworks, multiple modeling methods, and inconsistent interpretations of individual methods. This paper reports on the development of a methodology for the creation of architecture models that is centered around BPMN and is based on the notion of a common vocabulary.

SECTION 2—Guide to the Business Imperative for BPMN

BPMN AND BUSINESS STRATEGY: ONE SIZE DOES NOT FIT ALL
Lionel Loiseau, BNP Paribas Personal Finance Process & Performance Analyst and Michael Ferrari, Analyst, France

In BPM, we would like to conciliate the management-oriented abstraction necessary to fully grasp the essence of a process with the exhaustiveness and realism that are essential to an automated solution. But one size does not fit all!

This led us to develop a classification of the various business process modeling plans and a gradual approach aimed at defining how to move smoothly from one plan to another.

Our classification takes into account the required levels of abstraction, the legacy notations, and the important number of existing process models as well as the contribution of the BPMN notation. While traditional BPMN approaches present three levels of process modeling, respectively descriptive, analytic and exhaustive, our classification connects BPMN to strategy, indicators, business rules and risks, and breaks down further the separation between general process models and organized process models.

In this chapter, we intend to detail and justify our approach and our classification, as well as explain how they are used in our company. We also intend to shed a new light on the role of the BPM analyst, an emerging position blending several skills, notations, and collaborative tools.

BPMN FOR BUSINESS PROFESSIONALS: MAKING BPMN 2.0 FIT FOR FULL BUSINESS USE
Tobias Rausch, Harald Kuehn, BOC AG, Marion Murzek, BOC GmbH, Austria and Thomas Brennan, BOC Ltd, Ireland

Addressing users throughout the business is one of the key goals of BPMN 2.0. At the same time "BPMN is constrained to support only the concepts of modeling that are applicable to business processes. This means that other types of modeling done by organizations for business purpose is out of scope for BPMN." While this is understandable when defining a standard, it is essential for organizations to have support for BPM scenarios such as work instructions, organizational analysis, process costing, ICS/ERM etc.

This paper shows how BPMN 2.0 could be extended with business relevant concepts to support business-analysis (e.g. creating risk reports by assigning risks/controls to tasks). This will be demonstrated by looking at different real-life scenarios and how BPMN process-

es are linked with organizational data, resources, information, risks and controls and thereby allowing rich business analysis, reporting and simulation. There has been much discussion about BPMN's first letter and this paper illustrates how users are offered both a standard for describing process models and support of their key business application scenarios.

BEST PRACTICE GUIDELINES FOR BPMN 2.0
Jakob Freund and Matthias Schrepfer, camunda services GmbH, Germany

In practice modeling projects often tend to be quite large. Adopting BPMN 2.0 eases the creation of process models for business and technical projects. However, the creation of models in large modeling projects is still not a trivial task. The introduction of modeling guidelines guides and supports modeling projects. This article introduces an approach to establish such modeling guidelines for individual modeling projects using BPMN 2.0 as modeling notation. The article discusses the concept of modeling guidelines and shows why their application can help to apply BPMN 2.0 in practice. A framework for the creation of guidelines is described in detail. Real-world examples illustrate the use of modeling guidelines and constitute the effectiveness of best practice guidelines.

HUMAN-READABLE BPMN DIAGRAMS
Thomas Allweyer, Professor, University of Applied Sciences Kaiserslautern, Germany

The Object Management Group has published a useful non-normative document for BPMN modelers: "BPMN 2.0 by Example". While the specification of the BPMN standard describes the BPMN diagrams, elements, and their meanings, the examples document provides suggestions of how to use BPMN for modeling real processes. The reader can get valuable insights and hints for his own modeling practice. This paper discusses one of the models, the E-Mail Voting Example. The E-Mail Voting Example describes how a distributed working group discusses issues and votes on them by e-mail. This process was used during the development of BPMN. The authors claim that "This process is small, but fairly complex […], and it will help illustrate that BPMN can handle simple and unusual business processes and still be easily understandable for readers of the Diagram".

BUSINESS PROCESS INTEGRATION IN A DEFENSE PRODUCT-FOCUSED COMPANY (CASE STUDY)
Kerry M. Finn, Enterprise SOA Lead and J. Bryan Lail, Chief Architect, Raytheon Company, USA

A common language for integrating processes across silos is a significant enabler in ways both obvious and subtle. Once the business organizations that touch a product or execution life cycle can agree on the first priorities where tighter integration is very clearly going to yield measurable benefits, then the common process language immediately leads to communicating one shared model across leadership and stakeholders. From there, modern methods and tools lead to validated processes, key performance indicators that can be tracked during execution, behavior and cultural changes, and executable processes that automate and parallelize legacy practices. This paper describes how BPMN 2.0 can promote a balance of business agility and enterprise efficiency. The approach takes two tiers to execute for a product-focused company, which the authors call horizontal and vertical integration. The methods and common language around BPMN apply to internal business operations for any sizeable company; however, the approach for applying the methods to the actual products of a defense company is different. The dual benefits come from focusing on the information management for those products in either the battle-space or the business space; this paper will study both areas and deliver a common theme for BPI.

BPMN USED BY BUSINESS PROFESSIONALS: AN IN-DEPTH REFLECTION ON BPM WITH BPMN BY THE SWISS FOITT
BOC: Christian Lichka, Diana Boudinova;
FOITT: Jochen Sommer, Frank Wittwer

Standardisation is one of the major advantages of using a common BPM notation. The need for a common notation is recognised by the eCH – a widely-known e-government focused

association requiring the use of the Business Process Management Notation (BPMN) in the public administration sector in Switzerland. However, due to the complexity of BPMN, an in-depth ex-ante reflection of its application focus is crucial. This article describes the experiences and challenges of a BPMN 2.0-based introduction of Business Process Management at the Swiss Federal Office of Information Technology, Systems and Telecommunication (FOITT) in Bern. The FOITT business-oriented case required a narrowing down of the notational complexity by reducing the used set of objects and attributes and thus making business process models business-usable and –understandable while allowing for further application scenarios. The article describes the modelling results obtained with the BPMN IT-solution in use at FOITT – ADONIS by BOC Group[BOC, 2011] - and gives further insights into planned application scenarios such as release workflow management, quality and audit management and internal control system (ICS /risk management). The challenges of a successful introduction of BPM in terms of organisational set-up, guidelines and best practices, training, etc. are further discussed.

Multi-faceted Business Process Modeling

Marco Brambilla, Politecnico di Milano, and Stefano Butti, Web Models Srl, Italy

Turning a business process model into the specification, design and implementation of a software solution for process enactment is a non trivial task: the specified processes can be a mix on new functionality to be developed and interactions with pre-existing systems and the user's activities must be supported through effective and usable interfaces, possibly compliant with the visual identity and interaction style of other corporate applications. Furthermore, the business requirements embodied in the process models, as well as the technical context in which the underlying applications are deployed, are subject to evolution. This may cause severe alignment problems when trying to keep the business process and the application in sync. We claim that business process models *per se* are not enough for representing the complexity of real world software applications that implements them; therefore other design dimensions must be taken into account in the analysis, design, and implementation of applications.

SECTION 3—Reference and Appendices

Reference Guide—XPDL 2.2: Incorporating BPMN 2.0 Process Modeling Extensions

Robert M. Shapiro, WfMC Chair XPDL Technical Committee, USA

XPDL2.2 is intended as a preliminary release which supports the graphical extensions to process modeling contained in BPMN2.0. In fact, the BPMN specification addresses four different areas of modeling, referred to as Process Modeling, Process Execution, BPEL Process Execution, and Choreography Modeling. In this reference guide, we focus only on Process Modeling. Within that we define several sub-classes to support process interchange between tools. This is discussed in a later section of this paper. Here we discuss significant additions in XPDL 2.2.

BPMN 2.0 Handbook Companion Website

Additional Material

A Companion website is available at www.bpmnhandbook.org which contains, in addition to the Digital Edition of the BPMN 2.0 Handbook, substantial material on BPMN 2.0 helpful to readers. This includes free BPMN and XPDL Verification/Validation files, webinars, videos, product specs, tools, free/trial modelers etc. Several Handbook authors have contributed additional files and explanatory diagrams to the CD. This additional material gives readers exposure to a larger resource on BPMN 2.0 and XPDL than a book alone can offer.

Foreword

Finalization of the BPMN 2.0 standard in OMG marks a major milestone in the evolution of business process modeling. We now have a tool-independent graphical process definition language that is widely adopted by both business and IT for purposes ranging from basic process documentation to detailed performance analysis, requirements specification, and executable design. While the notation on the diagram surface seems little changed from BPMN 1.2, under the covers there is much that is new: a formal UML metamodel, more precisely defined operational semantics, and an XML Schema and conformance classes supporting model interchange. As such it represents "something new" for a broad spectrum of process modelers, from business process analysts and architects to BPM academics to process automation engine designers.

The *BPMN 2.0 Handbook* illustrates this diversity of interest in the new standard. In addition to discussion of BPMN 2.0's technical features, we have examples of its application in business and government, its relation to SOA and process execution, and its suitability as a business-readable communication tool. We also have many suggestions for how BPMN could be extended, improved, or enhanced to meet the broader goals of business process management.

One thing you won't read much about in the Handbook is the arduous path and hard work it took to complete the BPMN 2.0 specification. I was a "fringe" member of the BPMN 2.0 team from the fall of 2008 until publication of the beta spec and launch of the Finalization Task Force (FTF) in the summer of 2009. As such I got to see for myself how this sausage was made, and as you might suspect, it was not a pretty sight. I tried to represent the interests of the majority of existing BPMN users, typically business process analysts and architects modeling non-executable processes, and I often felt overwhelmed by the focus on process execution. But however frustrating the process seemed at times, it was ultimately "fair" and achieved a remarkable result. For that we owe a debt of gratitude to the managers of the BPMN 2.0 spec development effort in OMG. We owe an equally large debt to two Handbook authors, Robert Shapiro and Denis Gagné, who succeeded where I could not in two critical parts of the spec—process modeling conformance classes and a proper XML schema for diagram graphics information—developing and driving them from near-oblivion at the start of FTF to inclusion in the final standard. When model interchange among BPMN tools eventually becomes commonplace, we will all have Robert and Denis to thank.

What most people fail to realize is that a specification as wide-ranging as BPMN 2.0 is of necessity a "political" document as much as a technical one. It is a negotiated settlement of competing interests and aims. In this case, OMG initially tried to take its abstract, language-independent Business Process Definition Metamodel and simply rebrand it BPMN 2.0, even though its graphical notation, almost an afterthought, had only passing resemblance to BPMN 1.2 and its terminology no similarity at all. While that may have served the purposes of OMG's broader Model Driven Architecture effort, it was a bit too abstract for BPM tool vendors looking to bridge the gap between business-oriented process modeling and executable process design. Led by IBM, Oracle, and SAP, a competing BPMN 2.0 proposal was put forward. In the end the two efforts were merged, although the IBM-Oracle-SAP ideas, which took the existing BPMN notation and armed each shape with execution-oriented semantics, mostly carried the day.

So, in the end, BPMN 2.0 had to accommodate and harmonize the needs and interests of three constituencies: one group thinking about executable BPMN, another thinking about a way to link BPMN to other OMG standards under the MDA banner, and a small but insistent minority pleading with the team not to forget about the vast majority of existing BPMN users, who cared little about either of those things. That might explain the seemingly odd choice of what to put in and what to leave out of the standard. There is no doubt some "pork" in there, included to win the support of some particular interest group, while something like simulation—a mainstay of most process modeling tools today and a topic covered in the Handbook—was left out entirely. But BPMN 2.0 never aspired to cover all the modeling needs of BPM. If it had tried to include the wishlists of some authors in the Handbook, I doubt we would have gotten any spec at all through the committee. BPMN 2.0 exists because it doesn't try to do too much. Like all negotiations, it achieved as much as it possibly could get agreement on.

An unfortunate consequence of the focus on execution semantics in the spec is a bit of a backlash against BPMN 2.0 from business-oriented practitioners. We sometimes hear that BPMN is too complicated for business users, and that it mainly serves the needs of BPMS vendors. That's too bad, because in my experience most BPMN users today are not trying to automate anything, but simply document and analyze their existing processes. The BPMN spec could have addressed that issue, but did not consider that its mission. For example, there are no rules, best practices, and diagram examples intended to promote "good" BPMN —clear, business-readable, and well-structured—anywhere in the spec. For that reason I am particularly interested in the Handbook articles by Allweyer, Silingas and Miliviciene, Kuehn et al., and Freund et al., all of which touch on the topic of making BPMN more consumable by business.

The good news is that we don't have to change BPMN 2.0 in order to create "good" process models. The spec provides room to create good models just as easily as bad ones, and offers plenty of "value-add" opportunity for both tool vendors and service providers to promote (and even enforce) best modeling practices for business and technical users within the confines of the spec as it is. As BPMN 2.0 tools are only beginning to enter the marketplace, this Handbook is not the last word on BPMN 2.0, but the start of a long and lively discussion.

Bruce Silver, Principal, Bruce Silver Associates

January 2012

Section 1

Guide to BPMN 2.0 Technical Aspects

New Capabilities for Process Modeling in BPMN 2.0

Stephen A. White PhD, International Business Machines, and Conrad Bock, National Institute of Standards and Technology, USA

1   INTRODUCTION

This paper introduces new features in processes diagrams in the Business Process Model and Notation (BPMN) Version 2.0 [1]. A companion paper introduces new features in interaction diagrams for BPMN 2 [2].

BPMN provides a view of processes (how things get done) with flow charts tailored for business processes and interactions. BPMN 2 expands the capabilities of BPMN 1.x Process and Collaboration diagrams, and adds Choreography diagrams for business interaction modeling. The paper focuses on the new process modeling capabilities of BPMN 2 and assumes familiarity with earlier versions of BPMN.

The primary purposes of BPMN 2 are threefold:
- First, to provide a notation that is readily understandable by all business users, from business analysts creating initial drafts of the processes, to those performing processes or implementing technology to automate them, and finally, to business people who will manage and monitor those processes.
- Second, to support the notation with an internal model that has formal execution semantics enabling process model execution, as well as declarative semantics to relate processes and interactions.
- Third, to provide a standard interchange format for transfer of process and interaction models, and detailed visual information, between modeling tools.

These features of BPMN 2 create a standardized bridge between the business process design and process implementation.

1.1   *The Origins of BPMN*

The BPMN 1.0 specification was developed by the Business Process Management Institute (BPMI), now merged with the Object Management Group (OMG), and released to the public in May, 2004. BPMN was adopted as an OMG standard in February, 2006. Work on BPMN continued within the OMG and BPMN 1.1 was completed in June, 2007, BPMN 1.2 was completed in June, 2008, and BPMN 2.0 was completed in June, 2010 and then released as a formal specification in January, 2011. The term "BPMN 1.x" is used in this paper to represent the 1.0, 1.1 and 1.2 versions of BPMN.

1.2   *New BPMN Modeling Capabilities*

The basic look-and-feel of BPMN has not significantly changed in BPMN 2, especially for process modeling. The updates to process modeling are described in the following sections.

In addition to process and interaction enhancements, BPMN 2 defines four new Conformance Levels to support different modeling requirements:

- Process: includes Collaboration, but not Choreography and Execution.
- Process Execution: for execution engines.
- Business Process Execution Language (BPEL) Execution: for BPEL execution engines [3].
- Choreography: for Choreography tools. Process and Execution are not required.

Furthermore, the Process Conformance level is divided into three sub-levels:

- Descriptive: a small element set for high-level modeling.
- Analytic: a larger element set for more detailed modeling and analysis of process behavior, also consistent with the Department of Defense Architecture Framework [4].
- Common executable; an element set tailored for models that can be executed.

2   PROCESS MODELS

The most common use of BPMN is for modeling business processes, sometimes in the context of collaborations (i.e., with Pools and Message Flows). BPMN 2 diagrams are basically the same as they were in BPMN 1.x, but BPMN 2 adds significant support for more advanced process modeling patterns. The major areas updated include: Activities, Events, Gateways, and Data.

2.1   *Updated Activities*

BPMN 2 Activities are updated in the following ways:

- Markers for Task types
- A new Business Rule Task
- Changes in Multi-Instance markers
- New Global Tasks
- New Call Activities
- New Event Sub-Processes

The sections below will describe these changes.

Markers for Tasks

BPMN 1.x was developed with various types of Tasks (atomic Activities). These provide a set of predefined Tasks, such as sending or receiving a message. The full set of Task types were: User Task, Service Task, Receive Task, Send Task, Manual Task, and Script Task, as well as an undefined (or None) Task. In BPMN 2, a Business Rule Task is added (see next section).

In BPMN 1.x the Task types were a part of the BPMN model--the properties of each Task type were tailored to fit their functions--but there was no visualization to distinguish the Task types. In BPMN 2, markers are added to distinguish the Task types (see Figure 1). These markers are placed in the upper left corner of the Task shape, except for the None Task (also called an Abstract Task).

Figure 1: Task types and their markers

Note that the Receive Task has two variations. A standard Receive Task has a marker in the shape of an envelope. A Receive Task that is used to start (initiate) a Process has a marker that looks like the Message Start Event.

Business Rule Task

BPMN 1.x provided Gateways where sets of conditions are evaluated and then the flow of the Process is determined by the results of these evaluations. The Gateways and sets of possible paths are informally called "decisions." For example, a Gateway could be used to evaluate whether or not an application has been approved. However, the sets of conditions that might be used to determine the answer might be very complex. It is not always practical to create a complex condition in a BPMN Gateway, especially when the conditions might change regularly.

Thus, a new Task type is added in BPMN 2—the Business Rule Task (see Figure 2). This Task represents an Activity in the Process where a decision engine evaluates Process data and returns the results. The external engine is used to maintain the complex conditions used for the evaluations. Process data can be updated based on the results, and simple Gateway conditions can then be used to direct the flow of the Process.
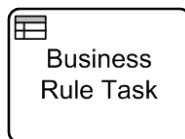

Figure 2: A Business Rule Task

Note that there is some discussion in the business rules community about terminology for this type of Task. In many cases, a business rule is only one possible mechanism (e.g., an algorithm could be used) for returning data to the Business Process Management System (BPMS). In fact, business rule engines are more commonly called decision engines. Thus, some tools may refer to this Task as a "Decision Task."

Multi-Instance Markers

BPMN 2 adds notation to distinguish between the two types of Multi-Instance Activities: sequential and parallel. The parallel Multi-Instance Activity maintains the BPMN 1.x notation of three vertical lines (see the Activity on the left in Figure 3). The sequential Multi-Instance Activity now uses three horizontal lines (see the Activity on the right in Figure 3).
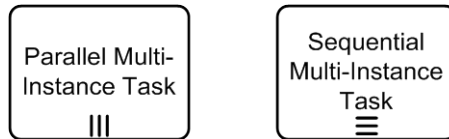
*Figure 3: Parallel and sequential multi-instance Task markers*

Global Tasks

Global Tasks are new elements in BPMN 2 that enable modelers to create libraries of reusable atomic Tasks that can be called into a Process through a Call Activity (see the next section). If the behavior of a Global Task is changed, then the change will affect all the Processes that call that call that Global Task.

Global Tasks are not graphical elements themselves, but are reused through Call Activities. Of the types of Process (embedded) Tasks (see Figure 1, above), only Business Rule, Manual, Script, and User types can be Global Tasks (see Figure 4, below).

Call Activities

BPMN 1.x provided the capability of reusing one Process, as-is, in the flow of another. BPMN 2 modifies and expands this capability. The Sub-Process types *reusable* and *reference* in BPMN 1.x are replaced with a Call Activity in BPMN 2. The remaining BPMN 1.x Sub-Process type *embedded* becomes the BPMN 2 Sub-Process element.

The Call Activity is an Activity that reuses either a previously defined Global Task (see previous section) or a Process. Call Activities are distinguished from other "local" Activities by their thick border (see Figure 4). When a Call Activity reuses a Global Task, the marker for that type of Task will be visible in the upper left corner. When a Call Activity reuses a Process, the plus sign marker of a Sub-Process will be visible in the bottom center.
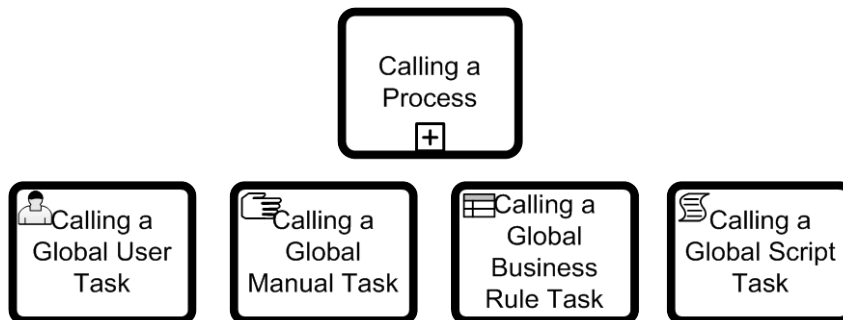

Figure 4: Call Activities

BPMN 2 introduces a notational convention that thin boundaries represent elements local to the diagram (e.g., the Tasks shown Figure 1, above) and that thick boundaries represent elements that reuse global elements (e.g., the Call Activities shown in Figure 4, above).

Event Sub-Processes

Event Sub-Processes are a new element in BPMN 2 that combine the characteristics of Sub-Processes and boundary Events. They are Sub-Processes in that they are a compound Activity—an Activity that has lower-level Activities as part of its definition. They behave similarly to boundary Events, except

they are placed *inside* a Process or Sub-Process, rather than on a boundary. Thus, they can be thought of as *optional* Sub-Processes--they are only performed if they are triggered by an Event.

The Event Sub-Process is graphically distinguished from a normal Sub-Process by its dotted line border and the specific Start Event type that may trigger it shown in the upper left corner of the shape (see Figure 5).
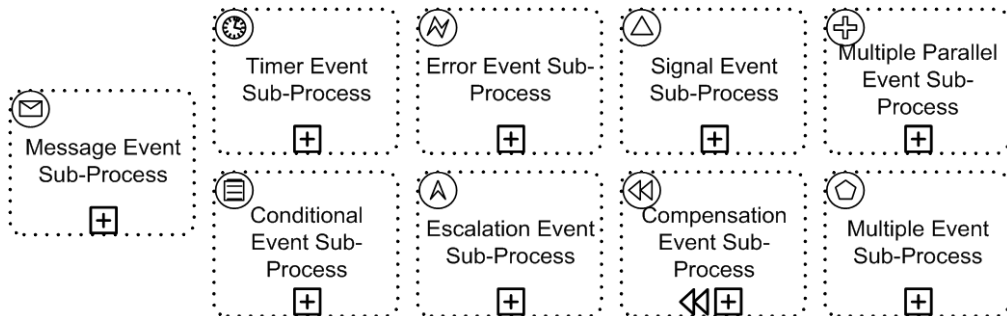
Figure 5: Event Sub-Process types and their markers

If the Event Sub-Process is expanded, then the marker is not shown (because the Start Event is visible), but the dotted border remains (see Figure 6, which displays a Process snippet that includes an expanded Event Sub-Process).
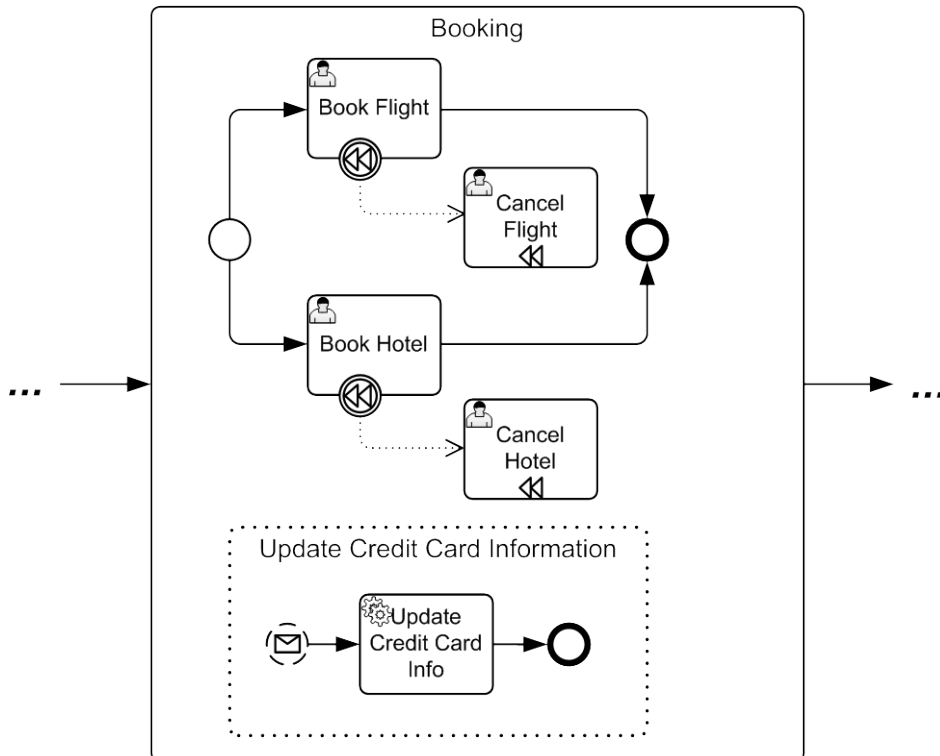

Figure 6: An expanded Event Sub-Process

To create its behavior, an Event Sub-Process is allowed only one Start Event and that Start Event must have a trigger (i.e., it cannot be a None Start Event). The type of Events that are valid for the Start Event of an Event Sub-Process are: Conditional, Error, Escalation, Message, Multiple, Parallel Multiple, Signal, and Timer.

Furthermore, an Event Sub-Process is separated from the main flow of its Process level. That is, it is not allowed any incoming or outgoing Sequence Flows. Because of this, as the Process flows from its normal Start Event to End Event during runtime, the Event Sub-Process will not be (automatically) initiated. The Event Sub-Process can only be initiated if its Start Event is triggered, which may or may not happen. The Process can complete normally without the Event Sub-Process being performed.

Like boundary Events, an Event Sub-Process can be set to either interrupt its parent Process or not (see below for more details on boundary Events). Event Sub-Processes set to interrupt will stop all the activities of its parent Process when its triggering event occurs. Event Sub-Processes that do not interrupt will run in parallel with the main Process flow and can be triggered multiple times during the lifetime of the main Process. Although the main flow of the Process may have stopped, the Process as a whole will not officially complete until all the active Event Sub-Processes have been completed.

Interrupting and non-interrupting Event Sub-Processes are visually distinguished by the border of the marker for collapsed Event Sub-Processes or the border of the Start Event for expanded Event Sub-Processes. Non-interrupting Event Sub-Process markers have a dashed border (see the Event Sub-Process on the right side of Figure 7).
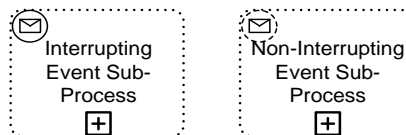
*Figure 7: Interrupting and non-interrupting Event Sub-Processes*

As with boundary Events, not all kinds of Event Sub-Processes can be non-interrupting. The Event Sub-Processes that do not have non-interrupting options are Compensation and Error. The remaining Event Sub-Processes do have non-interrupting options.

2.2 Updated Events

A major enhancement to the behavior of Events in BPMN 2 is boundary Events can be triggered without interrupting the Activity. BPMN 2 also introduces two new types of Events: Escalation and Multiple Parallel.

Non-Interrupting Events

One of the unique characteristics of BPMN 1.x was the innovation of placing Events on the boundaries of Activities (boundary Events) to show that those Activities might be interrupted during their performance (see the Process snippet in Figure 8).
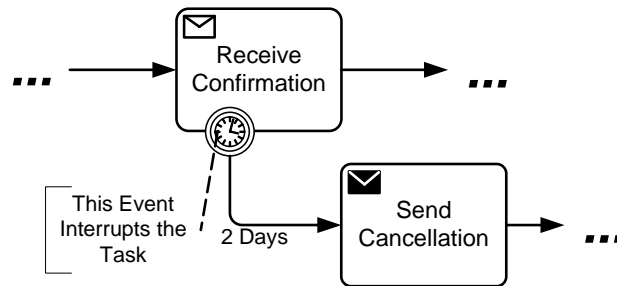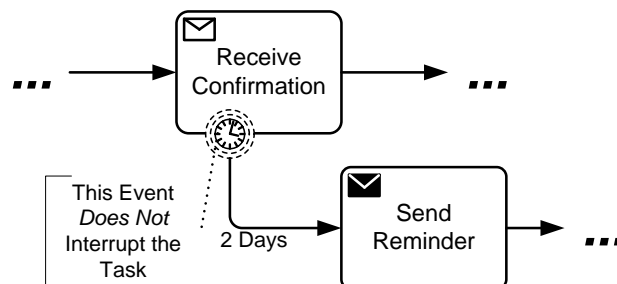
Figure 8: Use of interrupting boundary Events

However, some business process patterns require the boundary Event to be triggered without interrupting the original Activity. Thus, the Activity would continue being performed while a parallel path is triggered. With BPMN 1.x there are alternative ways of modeling this behavior, but they are complex and require many additional modeling elements.

In BPMN 2, the capabilities of boundary Events are upgraded to enable triggering without interrupting the source Activity. When this happens, the Activity continues to be performed and a parallel flow will be created for the boundary Event's outgoing Sequence Flow. How the parallel flow ends or merges into the main flow is determined by the structure of the Process.

An interrupting boundary Event maintains the BPMN 1.x double lined border (see Figure 8, above). A non-interrupting boundary Event has dashed lines for its border (see the Process snippet in Figure 9).


Figure 9: Use of non-interrupting boundary Events

Some boundary Events do not have a non-interrupting option. These Events are the Cancel, Compensation, and Error Events. The boundary Events that do have a non-interrupting option are Conditional, Escalation, Message, Multiple, Multiple Parallel, Signal, and Timer.

Escalation Events

Escalation Events are added in BPMN 2. In concept, they are similar to Errors, but are generally less critical. They usually represent a situation requiring human intervention. Escalation Events can be used for Start Events (for Event Sub-Processes), catch and throw Intermediate Events in the main Process flow, boundary Events, and End Events (see Figure 10).

| Event Sub-Process (Interrupting) | Event Sub-Process (Non-Interrupting) | Boundary Event (Interrupting) | Boundary Event (Non-Interrupting) | Throw Intermediate Event | End Event |
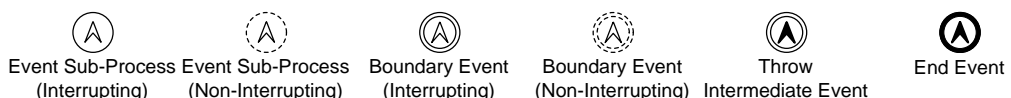
Figure 10: Escalation Events

When used as a boundary Event or a Start Event in an Event Sub-Process, they are not required to interrupt when attached to Activity boundaries--they can be set to interrupt or not. Thus, they differ from Error Events, which are required to interrupt the Activity or Process.

Multiple Parallel Events

Multiple Events, which existed in BPMN 1.x, can respond to more than one Event type for a single Event on the diagram. For example, there might be multiple ways to start a Process. Instead of creating a separate Start Event for each of these ways (which is also possible), the modeler might want to have less clutter and combine them into a single Start Event on the diagram. Thus, the Multiple Event is a collection of more than one Event type. This Event can be triggered by any one of the Event types it contains, including multiple definitions of the same type (for example, multiple unique Messages).

Multiple Events behave exclusively. That is, if any one of the defined Event types for the Event is triggered, the Process flow will continue from that Event. In the case of Start Events, each time one of the Events is triggered a new Process instance is created.

In BPMN 2, Multiple Events are expanded to support parallel dependency between the types of Events defined for a single Multiple Event. In this case, *all* of the Event types defined for the Event must be triggered before the Process flow can continue. This variation of the Multiple Event is called the Multiple Parallel Event.

The Multiple Parallel Event marker is distinguished from the Multiple Event and looks like the Parallel Gateway marker (a plus sign—see Figure 11). The plus sign is unfilled to indicate that it is used in "catch" situations.

| Process | Event Sub-Process (Interrupting) | Event Sub-Process (Non-Interrupting) | Boundary Event (Interrupting) | Boundary Event (Non-Interrupting) |

Figure 11: Multiple Parallel Event types

Multiple Parallel Events can be used for Start Events, catch Intermediate Events in the main Process flow, and boundary Intermediate Events. They are not used for throw Intermediate Events or End Events, since throw Multiple Events (with the existing marker) already throw all of the defined Event types in parallel.

2.3   *Updated Gateways*

BPMN 2 updates the notation and capabilities of Event Gateways. BPMN 1.x behavior allowed Event Gateways to be set to initiate a Process or not. But there was no visual distinction between the two settings. In BPMN 2 provides a notational difference between the Event Gateways that initiate a Process and those that do not. The Event Gateway that does not initiate a Process maintains the original internal marker that looks like a Multiple Intermediate Event (see left Gateway in Figure 12). The Event Gateway that does initiate a Process now has an internal marker that looks like a Multiple Start Event (see middle Gateway in Figure 12). This notational distinction accurately reflects the behavior of the two Event Gateway variations.

Figure 12: Event Gateway variations

Both the initiating and non-initiating versions of the Event Gateway direct the Process flow exclusively. This means that for the Events that are part of the Gateway's configuration, only one of them can be triggered each time the Gateway is used at runtime. However, to fill the requirements of some business process patterns, a new variation of the Event Gateway is added in BPMN 2—the Multiple Parallel Event Gateway.

The Multiple Parallel Event Gateway is used only for initiating a Process. It requires that *all* of the Events that are part of the Gateway configuration must be triggered before the Process can be initiated. The internal marker for this variation looks like the new Multiple Parallel Start Event (see right Gateway in Figure 12, above).

2.4 *Updated Data Elements*

In BPMN 1.x data was considered an Artifact and not a main part of the Process flow. While the flow of data is still separated from Sequence Flows, data is upgraded to a first class element in BPMN 2.

Many technical and graphical changes are made to how data can be modeled. The technical changes are mainly of interest to the tool implementers and advanced modelers, but there are new graphical data elements, including: Data Association, Data Input, Data Output, and Data Store (see the annotated Process snippet in Figure 13). Details about the new graphical elements are provided in the sections below.
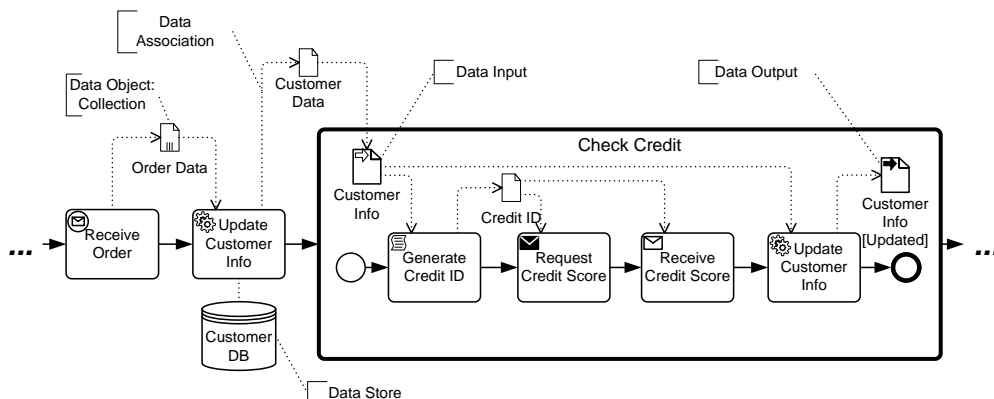

Figure 13: A Process with changes to BPMN data elements highlighted

Data Associations

In BPMN 1.x a connector between a Data Object and an Activity was an Association (a dotted line). BPMN 2 transforms these lines into new elements called Data Associations. Normal Associations are still used for connecting Artifacts to elements, such as a Text Annotation to an Activity, but Data Associations are used exclusively between data elements and Activities or Events. They also include mechanisms for the transformation of data as it moves in or out of an Activity.

Both Associations and Data Associations use the same dotted line—thus, BPMN 1.x and BPMN 2 diagrams will look the same in this regard (see the Process snippet in Figure 14).
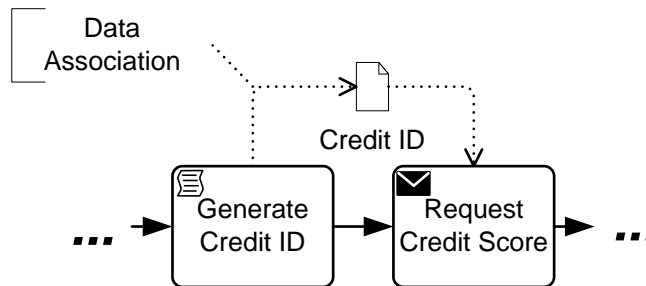
Figure 14: A Data Association used in a Process

Data Inputs and Outputs

Data Inputs and Data Outputs were a part of BPMN 1.x for Activities and Processes. These elements were hidden attributes of the model. In BPMN 2 the Data Inputs and Data Outputs for Processes can be visualized (there is no place to visualize the Data Inputs or Outputs of Tasks and Sub-Processes don't have inputs and outputs). Data Inputs and Data Outputs share the same basic shape as a Data Object, but there are markers in the upper left corner of the shape to distinguish them. A Data Input has an unfilled arrow marker (see the object on the left side of Figure 15). A Data Output has an filled arrow marker (see the object on the right side of Figure 15).

Data Input   Data Output

Figure 15: A Data Input and Data Output

Data Stores

Data Stores are a new element for BPMN 2. They represent basic organizational data stores, repositories, or databases. They appear in a diagram with the traditional database cylinder shape (see Figure 16). As in Figure 13, above, they can show how data stored in repositories interacts with the Activities of a Process.

Figure 16: A Data Store

Collections

It is often the case that data elements come grouped together using the same basic structure. For example a set of orders for the same product may be sent at the same time. This is known as a collection, and BPMN 2 adds an attribute to data elements to enable modelers to define them. If a Data Object, Data Input, or Data Output is defined as a collection, then the shape

will include the same marker that is used for Multi-Instance Activities (see Figure 17).

Data Object
(Collection)

Figure 17: A Data Object that is a Collection

3 FUTURE DIRECTIONS

The improvements included BPMN 2 have advanced the capabilities for capturing business process requirements into comprehensive process models that are suitable for executing these models by a business process management system (BPMS). BPMN 2 also advanced the modeling capabilities for capturing interaction models (i.e., Collaborations, Conversations, and Choreographies, which models that capture the communications between Process participants). A companion paper describes these models in detail.

However, BPMN does not cover every possible process situation that occurs for businesses and organizations. We will take a brief look at two potential areas of future development for BPMN: Case Management and Service Flow modeling.

3.1 *Case Management (Descriptive Processes)*

Case management is a bridge between two significant business capabilities: Content Management and Process Management. There are some requirements for defining a Case and its lifecycle that are unique to Case Management, but much of the Case Management is handle by these two domains. Since this is a paper about BPMN, we will focus on the Process component of Case Management.

The types of Processes that are often associated with Case Management situations are very free-form, unstructured Processes, since they require outcomes that are varied and customized for the case. These types of processes are sometimes called Descriptive Processes, as opposed to the highly structured Prescriptive Processes normally handled by a BPMS. Of course, Prescriptive Processes are often used for Case Management, it is Descriptive Processes that are most often associated with Case Management.

The OMG is currently developing a Case Management modeling standard. Part of this work will be to define the characteristics of Descriptive Processes and so future updates of BPMN should build in natural notational and semantic

Some of the characteristics of Descriptive Processes include (for example):

- A basic unpredictability as to the sequence of Activities that might be performed for each case.
- New Activities often have to be created after the Process has already started
- Events can occur at unpredictable times, kicking of a sequence of Activities or a full Process.
- Some of these Events involve specific user actions, changes to documents, or reaching of a milestone for the case.

When BPMN 1.0 was first developed, there was an understanding that Descriptive Processes were an important part of the process landscape. However, the initial focus of BPMN was to create a business process modeling language for business people that could also be executed by the available BPMSs.

So, as an acknowledgement that there were other types of business processes, the Ad Hoc Process was included in BPMN as a placeholder that provides many of the capabilities required for modeling Descriptive Processes. It is expected as BPMN evolves, the Ad Hoc Process will evolve to handle all Case Management Process requirements.

3.2 Service Flow (Activity Details)

There are some BPM tools that provide modelers of executable BPMN models with additional modeling capabilities for modeling the execution details of Tasks. These details include the sequence of service operations or user interface screens (sometimes called screen flow). We can call them Service Flow models.

BPMN does not currently define this type of model, but it could be considered a specialized Process outside the current BPMN process hierarchy. Thus, we can consider it as defining the details of an "atomic" Task, but not as being a Sub-Process.

The characteristics of service flow models include (for example):

- No Lanes. They exist fully within the lane of their parent Task.
- Only one Start Event. This Start Event does not have a trigger. Control is always passed from the parent Task.
- There are no parallel paths.
- They can nest lower level Service Flow models
- Sequence Flow model User Interface Activities always have a User action (e.g., click "Ok" or "Cancel") as an normal exit.

We expect that a future version of BPMN will define the notation and details semantics of Service Flow models and their relationship to Business Processes.

4 CONCLUSION

The new features for processes in BPMN 2 significantly broaden the range of applications of the language. Process Tasks and Events are more refined, including the use of business rules, and Event Sub-Processes enabling triggers of separate portions of a Process. Events themselves are more expressive, supporting Activity boundary Events without interruption if needed, and Multiple Events that combine events either exclusively or in conjunction with each other. Data becomes a first-class part of Process modeling in BPMN 2. Inputs and outputs are visually specified for Processes and Activities. Collections of Data Objects and Data Stores are also supported.

We expect that BPMN will continue to evolve and be able to provide business process modelers with more tools to capture a wider set of process requirements.

5   ACKNOWLEDGEMENTS

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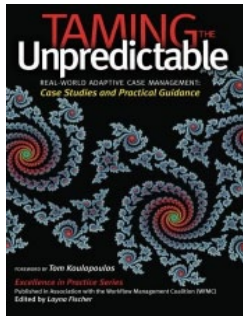
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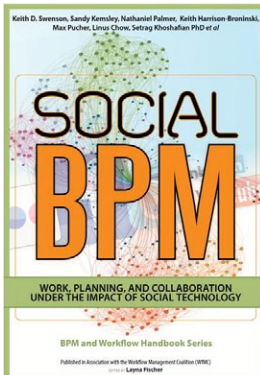
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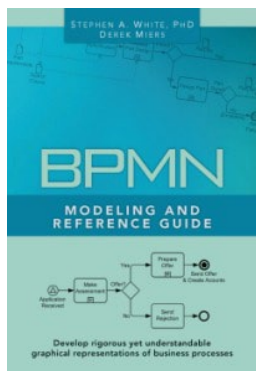
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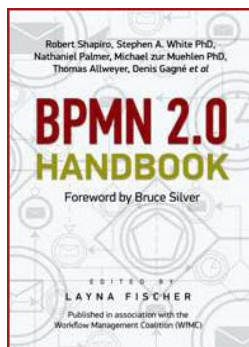
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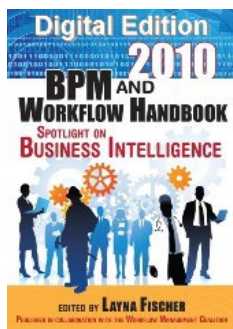
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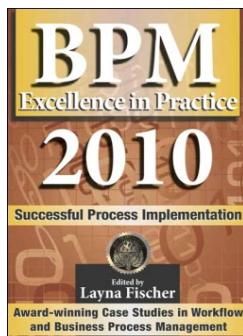
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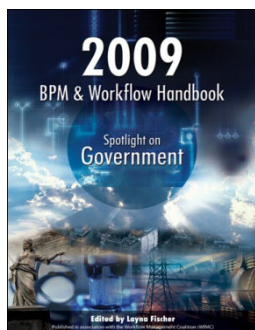
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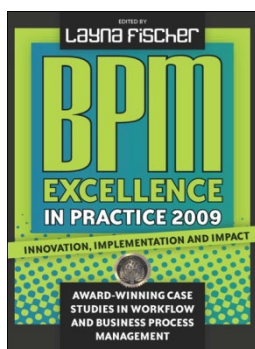
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The authors examine a variety of aspects that start with an introduction of what's new and updated in BPMN 2.0, and look closely at interchange, best practices, analytics, conformance, optimization, choreography and more from a technical perspective.

The authors also address the business imperative for widespread adoption of the standard by examining best practice guidelines, BPMN business strategy and the human interface including real-life case studies. Other critical chapters tackle the practical aspects of making a BPMN model executable and the basic timeline analysis of a BPMN model.

> This book is for *business* people who want to understand the how and why of BPMN 2.0 in simple non-jargon terms and the strategy and motivation for its adoption within the corporation.
>
> It is also for the *technical* practitioner seeking current insights into the BPMN 2.0 standard and how to take advantage of its powerful capabilities.

Guide to BPMN 2.0 Technical Aspects

- Admission Process Optimization with BPMN and OSCO
- Analytics for Performance Optimization of BPMN2.0 Business Processes
- Bespoke Enterprise Architecture: Tailoring BPMN 2.0 using Conformance Classes
- BPMN 2.0 Interchange
- BPMN Extension for Social BPM
- Collaborative Activities Inside Pools
- Making a BPMN 2.0 Model Executable
- New Capabilities for Interaction Modeling in BPMN 2
- New Capabilities for Process Modeling in BPMN 2
- Refactoring BPMN Models
- Simulation for Business Process Management

UPDATED AND EXPANDED WITH EXCITING NEW CONTENT!

Guide to the Business Imperative for BPMN

- Best Practice Guidelines for BPMN 2.0
- BPMN and Business Strategy: One Size Does Not Fit All
- BPMN Used by Business Professionals: An In-depth Reflection on BPM with BPMN by the Swiss FOITT
- Business Process Integration in a Defense Product-focused Company
- Human-Readable BPMN Diagrams
- Making BPMN 2.0 Fit for Full Business Use
- Multi-faceted Business Process Modeling

Appendix includes BPMN Supporters list, XPDL 2.2 Guide, BPMN Glossary, index and more.

MANAGEMENT, COMPUTER SCIENCE

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