

# Meta-Modelling Support for a General Process Modelling Tool

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**Abstract:** *The paper at hand presents a research prototype for using a meta-modelling tool in the context of business process modelling. The prototype has been part of an e-commerce-related project and implements the mapping of business process models to workflow schemata. A meta-modelling tool has been used for implementing a modelling tool and the mapping. The analysis of the mapping is based on finding equivalent concepts in the source (MEMO-OrgML) and the target language (XPDL). Features which are not available in the source language have been added using special language elements. The paper also presents the idea of a generic mapping approach. Mappings from business process models to other process-oriented representations can be realised. The realisation of these mappings is similar to our approach. We will extend our tool with respect to support different target languages like BPEL4WS. The meta-modelling tool MetaEdit+ has been used for the prototypes.*

## 1 Motivation

Meta-modelling tools support the development of modelling tools for specific modelling languages. Those languages usually provide language features which correspond to concepts of a given domain (cf. [EsJa01]). Hence, a modeller can use known concepts for creating models describing given aspects of his application domain. One of the goals of domain specific-modelling is the generation of software applications on the basis of domain-specific models (cf. [LKT04]). Domain-specific concepts are represented by language features of a domain-specific modelling language. Additionally, a mapping of those concepts to an executable programming language is defined. We use this approach for supporting the automated generation of e-commerce applications in the context of the ECOMOD-project<sup>1</sup>. The idea behind ECOMOD is that an organisation's strategy can be used for the determination of business processes supporting this strategy. The underlying concepts<sup>2</sup> are shown in Figure 1. An organisation's core processes and strategic options are situated on a

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<sup>1</sup> More information on the ECOMOD project can be found on the ECOMOD Web Portal: [http://www.wi-inf.uni-essen.de/FGFrank/ecomod/index.php?content\\_type=&&lang=en](http://www.wi-inf.uni-essen.de/FGFrank/ecomod/index.php?content_type=&&lang=en)

<sup>2</sup> Note that the implementation of the application is not shown in the figure.

strategic level. The interface layer allows for the identification of typical business processes supporting a given strategy. These processes are provided as reference models on the operational level. The identified process models represent the processes of the targeted e-commerce application.

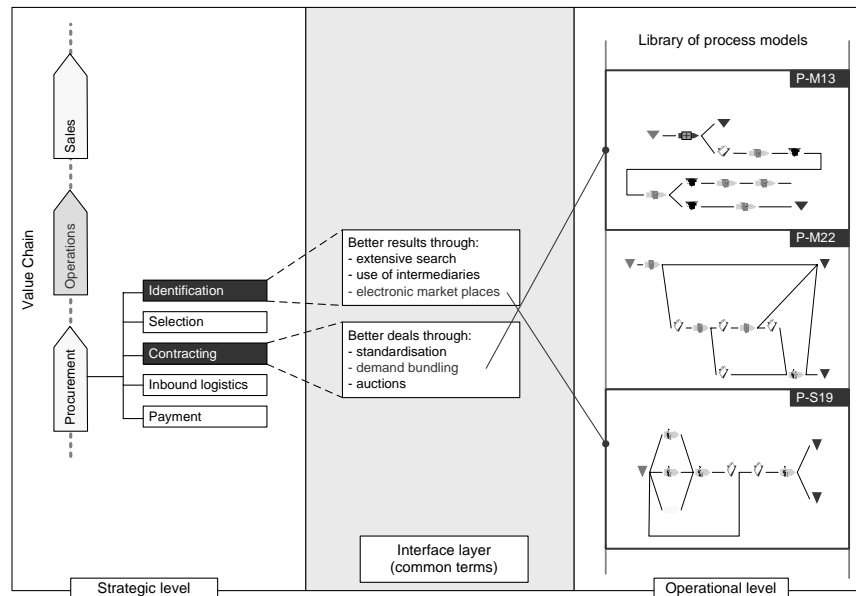


Figure 1: Integration of strategic and operational level using common terms (source: [FrLa05])

Reference process models usually describe typical processes in a domain or for a task. They usually prescind from details regarding a business process in a given enterprise. Information concerning a given organisation has to be added to the reference process models in order to transform them to concrete process models. The concrete models can be used as a starting point for the implementation of an information system. There are many ways for the transformation of a process model to a running application. The application might be implemented from scratch (using a programming environment) or might be realised using a WfMS (Workflow Management System). We chose the mapping of the business processes to a workflow language because of its similarities to process modelling languages. The workflow language has similar concepts for describing the control flow. Both, business process models and workflow schemata, share common concepts for the description of actors and software.

The paper at hand is structured as follows. Conceptual differences between *business process* and *workflow* are presented in section 2. Section 3 explains the mapping of business process models (MEMO-OrgML) to a workflow schema (XPDL). An overview of the potential of meta-modelling tools for the incremental development of a general process modelling tool is given in section 4.

## 2 Business Processes and Workflows

Business process modelling (BPM) and Workflow Management (WfM) emphasize a process-oriented perspective on organisations. This process-oriented view comprises activities and their relationships within and beyond an organisation's context. Relationships among business processes are usually specified using control flow (consecutive, parallel or alternative execution) and/or hierarchical decomposition. The organisational context consists of organisational units (company, department, and role) and resources (tools, machinery).

Nevertheless, a more differentiating reflection on business processes and workflows is necessary. Referring to several sources, they both represent different levels of abstraction on process-oriented organisations. According to Frank and van Laak a workflow mainly focuses on the processing of digital office documents (cf. [FrLa03]). Human activities (in terms of manual processes) as well as decision making processes are reduced to interactions with software applications. Böhm summarises the conceptual differences between business processes and workflows as the emphasis on IT in the context of workflows. Like other authors, he situates business processes on a conceptual level of the enterprise (cf. [Böhm00]). Junginger mentions the fact that any kind of resource might be allocated to a business process while workflows are mainly supported by IT-related resources (cf. [Jung01], p. 18). Stark characterises workflow by the management and support of business processes combined with IT<sup>3</sup>.

Two languages have been used in the paper at hand: MEMO-OrgML for business process modelling and XPD (XML Process Definition Language) as a workflow description language. Both have a different focus. MEMO (Multiperspective Enterprise Modelling) is a method for modelling organisations using different views (cf. [Fran99]). The OrgML (Organisation Modelling Language) is one of the languages provided by MEMO and is used to model an organisation's structure and processes (cf. [Jung04]). Hence, the OrgML focuses on the modelling of business processes from the view of a domain expert. It offers an intuitive graphical notation and business related abstractions. The XPD is a language for describing workflows schemas (cf. [Nori02]) and has been standardised by the WfMC (Workflow Management Coalition). It does not define a graphical notation and does not offer any business related concept other than workflow participants and software applications (cf. [zMüh99]). Workflow schemas can be interpreted by a piece of software – the WfMS.

Moreover, OrgML might be a starting point for the specification of a general process modelling language. This language has to offer both: intuitive domain-specific concepts and special concepts for the mapping of business process models to different process-oriented abstractions. Only XPD has been used in ECOMOD but there are other possible target languages: Business Process Execution Language for Web Services

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<sup>3</sup> “Workflow promises a new solution to an age-old problem: managing and supporting business processes. What is new about workflow is the way it harnesses the power of information technology to structured work.” [Sta97, p. 5]

(BPEL4WS; cf. [LeRo04]) or Business Process Modelling Language (BPML; [Arki02]).

### 3 Mapping of MEMO-OrgML to XPD

General aspects regarding the mapping of business process models to workflow schemata will be presented in this section<sup>4</sup>.

#### 3.1 Processes

The MEMO-OrgML provides language features for elementary and aggregated processes (cf. Figure 2). Elementary processes are classified by the types of resources required for their execution. Processes can be executed manually, automatically or semi-automated. Manual processes are exclusively performed by human resources without any IT-support. Automated processes are solely executed by information systems without any support of human resources. Semi-automated processes refer to a support by human and technological resources. An aggregated process is composed of other elementary or aggregated processes.

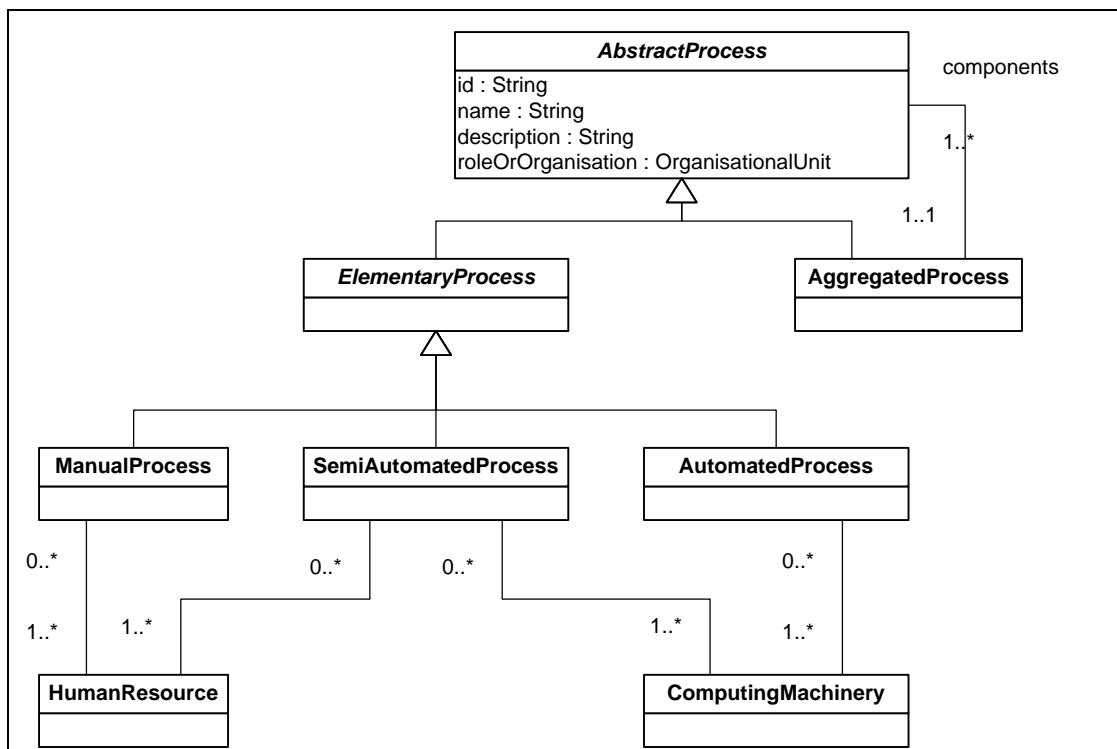


Figure 2: Meta-model of process types (excerpt)

<sup>4</sup> The mapping of business process models to workflow schemata is described in [Jung04].

Just like general processes, aggregated processes can be specified by assigning an organisational unit and annotating a unique number and a descriptive name (qualifier). It is important to note that an aggregated process is mainly specified by its sub-processes. Also, its sub-processes are assigned to an organisational unit and specified according to necessary resources. Furthermore, an essential part for the specification of an aggregated process is the control flow between its sub processes. Hence, every aggregated process has to be specified by a process model containing its sub processes and their control flow.

The workflow specification language XPDL is not specified using a (graphical) meta-model but by XML Schema<sup>5</sup>. There are diagrams describing only vague information of meta-types in the language specification<sup>6</sup>. Different XPDL process types are shown in Figure 3. A generic activity is an indivisible unit of work executed under the control of a WfMS. Such an activity can be executed automatically or by a human participant and usually works on workflow-relevant data. In contrast to this, block and route activities do not refer to workflow-relevant data. A block activity invokes the execution of a set of sub-activities. A route activity is an activity with no behaviour. It only serves as a dummy activity for cascading control flow conditions<sup>7</sup>. The mapping of MEMO-OrgML processes to workflow activities is outlined in the following paragraphs<sup>8</sup>.

*Aggregated processes* in MEMO-OrgML have no inherent implementation but consist of other processes. In the same way, a block-activity in XPDL uses no resources of its own and contains a set of other activities. This set is called *Activity Set* in the WfMC's terminology. Every aggregated process will be mapped to a block-activity and all contained processes are collected into an activity set. The mapping of elementary processes is not straight forward: There is no counter part to automated, semi-automated and manual processes in XPDL. *Automated and semi-automated processes* are mapped to generic activities. The differentiation between full and partial automation can be realised through attribute values of XPDL generic activities. An activity is performed by a *Workflow Participant*. A participant might be a resource, a human being or an organisational unit (among others). Participants use software tools for performing tasks. An activity derived from an automated process has no *Workflow Participant*<sup>9</sup> but is performed by a software tool. A semi-automated process requires both: a *Workflow Participant* and an application. Furthermore, workflow activities can

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<sup>5</sup> XPDL is an XML-based language. The syntax of this language is described using XML Schema. XML Schema is a language for defining document types (cf. [W3C01] and [SKS05], pp. 405-408).

<sup>6</sup> The language specification (i.e. the XML Schema) can be found in [Nori02].

<sup>7</sup> XPDL only allows for the specification of one kind of control flow for all outgoing transitions of an activity. If there are more than one outgoing transitions, either all of the following activities or exactly one of them might be executed. More complex routings are realised using *route activities*. These activities can be used to describe complex combinations of exclusive and parallel control flows.

<sup>8</sup> The mappings of some attributes which are equal in both kinds of models (unique identifier, name or description) are omitted.

<sup>9</sup> In fact, we assign the organisational unit which is responsible for the execution of the automated process to the workflow activity. Nevertheless, the activity is executed without any user interaction.

be started and stopped manually or automatically. Every automated process is mapped to an activity, which is started and stopped automatically. Semi-automated processes are started and stopped manually by the human resource performing the activity. Therefore, *start* and *stop mode* of such an activity is set to *manual*.

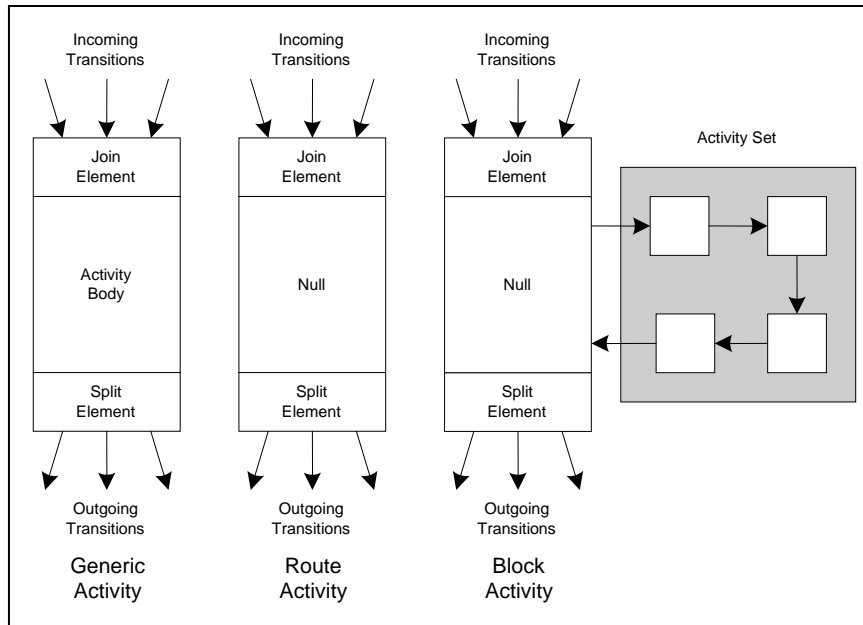


Figure 3: Different kinds of activities in XPD (source: [Nori02], p.30)

*Manual processes* are executed only by human resources without any IT-support. Hence, those processes seem to be irrelevant for a workflow schema. However, the result of a manual process might be relevant for the control flow of following workflow activities. This is illustrated by an example. Checking the quality of incoming goods in a warehouse need not be supported by an information system (manual process). But depending on the good's quality, either a production process might be started or the delivery be refused. Hence, manual processes in an OrgML-model are mapped to a generic activity, too. This activity is started and stopped manually by the human actor executing the task.

### 3.2 Resources

The MEMO-OrgML is complemented by a resource modelling language (MEMO-ResML<sup>10</sup>). This language offers several language features for the modelling of resources in the context of business process modelling. The MEMO-ResML specifies three types of language features: resources, resource relationships and the allocation of

<sup>10</sup> The Resource Modelling Language (ResML) is presented in [Jung03a] and [Jung03b].

resources to business processes. Some of the resource types<sup>11</sup> defined in MEMO-ResML are shown in Figure 4. Elementary resource types can be classified as human, physical or intangible resource types. The meta-type HumanResource is not further specialised. PhysicalResource has five subtypes representing different kinds of physical resources. IntangibleResource can be divided into IntellectualProperty and BeneficialInterest. Concrete types of BeneficialInterest are software, information and patents. A beneficial interest represents the right to use an intellectual property. Software licenses are an example for a beneficial interest referring to software. In the same way, one can receive the beneficial interest for using a patent or for the usage and/or reproduction of information.

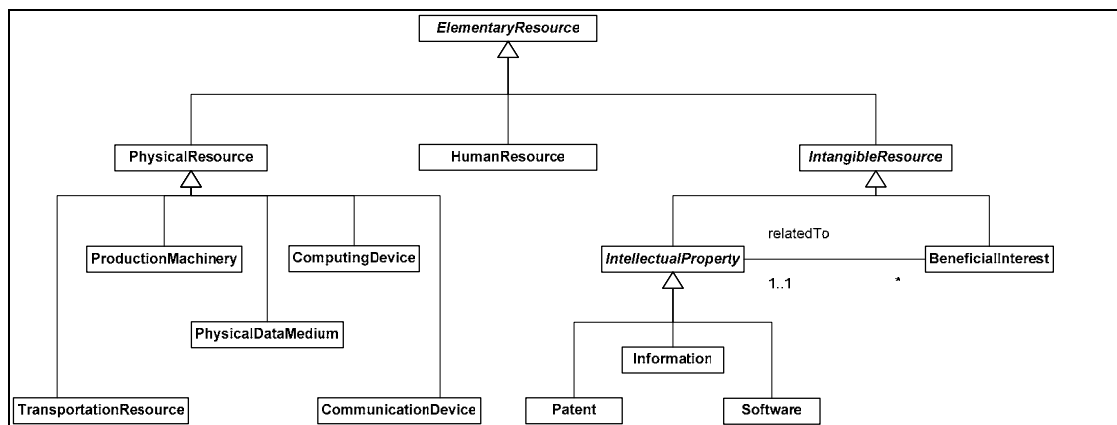


Figure 4: Meta-model of resource types in MEMO-ResML

Only a fraction of these resources is needed in the context of workflow management. Human resources can be mapped to workflow participants who are assigned to generic activities. Software and information resources correspond to workflow applications and data. Workflow applications are external software applications which are used by a WfMS. Examples for such applications are word processors or financial information systems. Workflow data is the data processed within a workflow activity and transmitted to subsequent activities. Other resource types of the ResML have no counterpart in XPD.

### 3.3 Workflow-relevant Attributes

There are some properties required for an XPD-based document which are not part of a business process model:

- Every XPD element may have *extended attributes*. Those attributes are not part of a general business process modelling language like MEMO-OrgML.
- Workflow participants are classified using types given by the XPD. Those types (RESOURCE, RESOURCE\_SET, ROLE, ORGANIZATIONAL\_UNIT,

<sup>11</sup> All attributes and most relationships are omitted in the figure.

HUMAN and SYSTEM) can hardly be derived automatically from a given business process model. This classification has to be done manually.

- Workflow data is referred to by a unique name and has a type which is defined by the XPDL. The type system of MEMO-OrgML is incompatible with the type system of the XPDL. Hence, workflow data can not be derived from a process model.
- The binding of workflow data to formal parameters of external software tools is defined in the XPDL. Parameter passing is usually not defined in general purpose business process modelling languages.

The properties listed above have been added to MEMO-OrgML by providing additional language features and diagram types. We did not want to mix concepts for modelling business processes on a conceptual level with workflow-relevant abstractions (separations of concerns). Hence, existing model elements have not been modified (e.g. adding *extended attributes* to the process meta-types).

#### 4 Towards a Generic Mapping Approach

A tool for modelling business processes has been implemented in the context of the ECOMOD project. This tool also supports the generation of workflow schemata conforming to the XPDL. A meta-modelling tool – MetaEdit+ Version 4 by Metacase<sup>12</sup> – has been chosen for the implementation. The MetaEdit+ *patch* can be downloaded from the ECOMOD Web Portal<sup>13</sup>. The MEMO-OrgML is represented by *process diagrams* and *process decomposition diagrams*. A process decomposition diagram only contains an aggregated process and its components. A process diagram specifies the control flow between business processes. An additional diagram type for describing workflow-relevant aspects of a process – *workflow-specification-diagram* – has been introduced. This diagram allows for the specification of all information which is required for a workflow schema but is not present in the business process model. The mapping of business processes (complemented with workflow-relevant aspects) is realised using the scripting language of MetaEdit+. This language can be used for iterating over model elements and generating a textual representation<sup>14</sup>.

The basic conceptualisation of the workflow modelling tool can be summarised as follows: Model types of MEMO-OrgML have been implemented using a meta-modelling tool (e.g. *process diagrams* and *process decomposition diagrams*). Additional diagram types for aspects which are not covered by the process modelling language but are required by the workflow specification have been introduced (*workflow-specification-diagrams*). The concepts of the previously defined diagram

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<sup>12</sup> A demo version of MetaEdit+ can be downloaded from <http://www.metacase.com>

<sup>13</sup> <http://www.wi-inf.uni-essen.de/FGFrank/ecomod/info/downloads/MEPatch.zip>

<sup>14</sup> An XPDL workflow specification is an XML-document conforming to the XPDL Schema definition.

types are mapped to the target language (in this case XPDL) using the scripting language of the meta-modelling tool. This mapping includes all business process modelling concepts which are relevant for workflows. Furthermore, information of additional diagram types will be included in the mapping process. Other information represented in the business process models will be omitted.

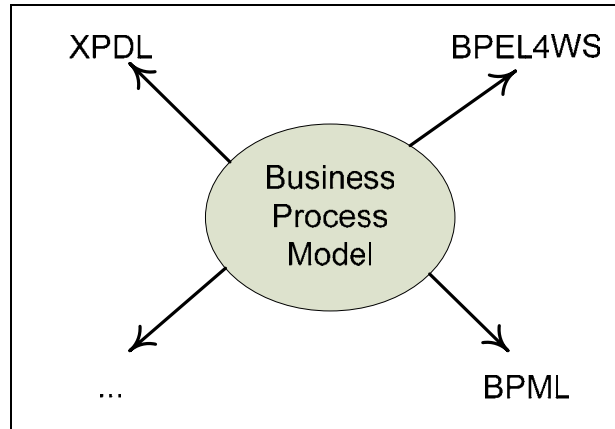


Figure 5: Mapping of business process models to other process-oriented languages

The same basic idea can be applied to the mapping to other target languages. XPDL-based specifications are derived from business process models using additional information. In the same way, business process models can be complemented with information regarding other process-oriented abstractions (see Figure 5). A modelling tool implements a business process modelling language. Other process-oriented output might be generated basing on the concepts of the business process modelling language. Additional abstractions are provided by additional diagram types.

Meta-model-based mappings usually require meta-models of the source and the target language as well as a specification of the mapping itself<sup>15</sup>. Additionally, the meta-models of both languages should be created using the same meta-modelling language. Unfortunately, different people use different meta-modelling languages. Consequently, there are only a few modelling language specified using the same meta-modelling language. For example, the MEMO-OrgML is specified by a MOF<sup>16</sup>-like meta-model and XPDL is defined by XML Schema. Hence, one of the language specifications should have been converted to a specification the meta-modelling language of the other. The XML Schema definition of XPDL might be translated to a MOF-like representation or the MEMO-OrgML's meta-model to XML Schema. We decided not to translate the entire meta-models, because only a fraction of both meta-models has been involved in the ECOMOD project. Hence, we implemented the MOF-like meta-model of the OrgML using MetaEdit+. The meta-model of XPDL is not explicitly

<sup>15</sup> Two examples concerning entity-relationship models and relational schemas are documented in [Gogo05] and [TaZa03].

<sup>16</sup> The abbreviation MOF stands for Meta-Object-Facility and is the meta-modelling language used by the Object Management Group (cf. [OMG03] and [Bezi02]).

represented in MetaEdit+. We only described it implicitly through the specification of the mapping of OrgML to XPDL. In the same way, we are able to describe mappings to other process-oriented languages. The focus will be on conceptual differences between process modelling languages – independent of the meta-modelling language. Consequently, we will not try to describe all target languages by a meta-model. Our research prototype implements the mapping of the OrgML to other languages using the features of MetaEdit+.

## 5 Conclusion and Future Work

The paper at hand presents a research prototype for using a meta-modelling tool in the context of business process modelling. The prototype is part of an e-commerce related project and realises the mapping of business process models to workflow schemata. The meta-modelling tool MetaEdit+ has been used for implementing a modelling tool and the mapping. Business processes are modelled with the MEMO-OrgML and mapped to XPDL. The analysis of the mapping is based on finding equivalent concepts in the source (MEMO-OrgML) and the target language (XPDL). Features which are not available in the source language have been added using special language elements.

The concepts defined in the ECOMOD-project are currently evaluated by the project participants (cf. [FrLa05]). This evaluation also includes the mapping tool presented in the paper at hand as well as a prototypical WfMS. We use the Shark workflow management engine, which is intended to be a framework for the development of a concrete WfMS (cf. [Jung04]). Additionally, services (i.e. Java programs) for performing e-commerce related functions are implemented. Further results of the ECOMOD-project – including the evaluation of the applicability of our approach – will be published on the ECOMOD web portal.

The paper also presents the idea of a generic mapping approach. Mappings from business process models to other process-oriented representations can be realised. The realisation of these mappings is similar to our approach. We will extend our tool with respect to the support different target language like BPEL4WS. A meta-modelling tool is used for the first prototypes.

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