Towards Systematic Usage of Labels and Icons in Business Process Models

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Abstract. Surprisingly little research has investigated the factors contributing to the successful practice of process modeling, in particular those contributing to the development of process models that facilitate human understanding. This research discusses the use of text and icons for labeling the graphical constructs in a process model. We discuss the use of two verb classification schemes to propose a systematic approach for describing, and graphically representing, domain semantics in labels used in process model constructs such that human understanding can be improved. We argue that the systematic use of domain labels and corresponding icons will result in process models that are easier and more readily understandable by end users. Our findings contribute to an ongoing stream of research investigating the practice of process modeling and thereby contribute to the body of knowledge about conceptual modeling quality overall.

1 Introduction

Process modeling has emerged as a primary reason to engage in conceptual modeling overall [1]. Similar to other forms of conceptual modeling, process models are first and foremost required to be intuitive and easily understandable, especially in IS project phases concerned with requirements documentation and communication [2]. But even though process modeling has been around for some thirty years, surprisingly little is known about the practice of process modeling and the factors that contribute to building a "good" process model, for example one that results in human understanding [3].

Recent research has started to examine process model understandability, for instance, the impact of process model structure, model user competency, and activity node labeling. While the impact of structural properties is clearly identified [4], it is also reported that model readers systematically overestimate their ability to draw correct conclusions from a model [3]. Furthermore, shorter activity labels have been found to be positively correlated with understanding [5]. This raises the question in how far a better representation of domain semantics in process models beyond the use of text labels only would improve understanding.

In our work we continue along this line of work towards more understandable process models. Previous research has successfully investigated, for instance, the graphical constructs and their meaning in process models, e.g.,[6], the expressiveness and validity of control flow aspects in process models, e.g., [7] or process-related aspects such as data and resources, e.g., [8, 9]. However, only little attention has been devoted to a very essential task in process modeling - the *labeling* of the graphical constructs, in particular of the constructs standing for "activities" (or "tasks", or "work to be performed") in a process model. This is surprising given that - clearly - the true meaning of any construct in a process model is only revealed when model users read - and intuitively understand - the labels assigned to a construct. Current practice indicates that the labeling of activity constructs is a rather arbitrary task in modeling initiatives and one that is sometimes done without a great deal of thought [10]. This can undermine the understandability of the resulting models in cases where the meaning of the labels is unclear, not readily understandable or simply counter-intuitive to the reader.

Research in cognitive science suggests that incorporating graphical icons in textual messages improves reader understanding [11–13]. And indeed, several modeling tools already provide mechanisms to assign an icon to an activity construct such that its meaning can be grasped faster and more intuitively. Yet, none of the tools that we are aware of deals with icons in a systematic way. Accordingly, the objective of this paper is to discuss a systematic approach for using icons and meaningful labels to annotate graphical 'activity' constructs in process models so as to warrant improved model understandability.[1]

The remainder of the paper is structured as follows. In Section 2 we discuss work in cognitive science that forms the theoretical basis for our elaborations. In Section 3 we review existing approaches implemented in process modeling tools and the way they support the assignment of icons to activities. In Section 4 we discuss the role of verb classifications in a systematic approach to using icons.

2 Theoretical Background

The Dual Coding Theory [13] suggests that individuals have two separate channels (visual and auditory) they use when processing information. The two channels complement each other such that receiving simultaneous information through each channel improves understanding compared to receiving information through one channel only. In other words, individuals understand informational material better when it is provided through both auditory (i.e., words) and visual (i.e., images) channels.[2]

[1] It should be noted that a focus on activity constructs denotes a limitation of the scope of our work. We recognize the need to extrapolate our research to other aspects of process models, such as the data, resource and control flow perspective. We deemed the focus on activity constructs a suitable starting point for our endeavor due to the centrality of the activity perspective in process modeling.

[2] Note that most people read by speaking out the words of the text in their mind, which even suppresses visual activation [14].

Based on this observation, the Cognitive Theory of Multimedia Learning (CTML) [11, 12] suggests that learning material intended to be received, understood and retained by its recipients should be presented using *both* words and pictures. This sounds conducive to the task of process modeling, where both visual (graphical constructs) and auditory (labels and text annotations) material are available to add information about a business domain in a process model. Due to the overall limited number of graphical constructs used in a process model (there are typically few if not only one graphical construct for representing "tasks" or "work"), however, most of the critical domain information is typically contained in the textual labels of the constructs - in other words, in auditory channels. Based on CTML it can thus be expected that model understanding can be increased if additional graphical images (such as icons) are incorporated in the labeling of process model constructs (Mayer [12] labeled this principle 'Multimedia Principal').

3 Labels & Icons in Business Process Modeling Tools

The labeling of constructs such as activities is often more art than science. In practice, a number of guidelines exist that typically suggest a verb-object convention (e.g., "approve order", "verify invoice") for labeling activities, e.g. [15–17]. Naturally, one may think that the more information contained in the labels, the clearer the meaning is to the reader. Recent research, however, uncovered that shorter activity labels improve model understanding [5]. This observation, in combination with the prevalent verb-object convention, would suggest that the verb that signifies the action would be a suitable counterpart to directly match an icon within an activity construct.

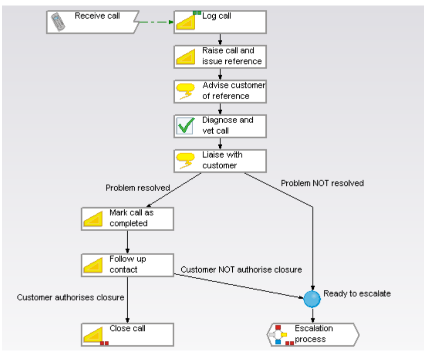


Fig. 1. Use of icons in Protos

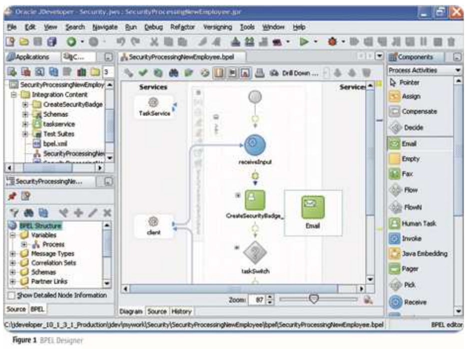


Fig. 2. Use of icons in OracleBPEL

And indeed, some modeling tools already allow for the embedding of additional graphics. Protos (`http://www.pallas-athena.com`), for instance, allows for selecting specific types of activities (e.g., Basic, Logistics, Authorize, Communication and Check) and represents these by means of different images. For instance, when one sets the activity to be a Communication activity, the image becomes a talk balloon. An example is shown in Fig. 1. Similarly, ARIS in its Version 7.02 (`http://www.ids-scheer.com`) allows users to right-click on activities in BPMN diagrams to select one of several pre-defined graphical markers to distinguish atomic tasks from transactions, sub-processes or ad-hoc processes. However, these graphical markers distinguish the granularity and type of the activity construct but do not visualize its domain meaning. Intalio's BPMS Version 5 (`http://bpms.intalio.com`) graphically distinguishes manual from automated tasks while - as shown in Fig. 2 - Oracle's BPEL Process Manager (`http://www.oracle.com`) offers graphical icons to distinguish, for instance, "invoke" from "receive" activities.

In summation, these tools, while providing some graphical differentiation, fail to use icons to meaningfully distinguish activity constructs based on their domain and contextual meaning. However, a differentiation scheme - and graphical representation - of different types of relevant domain semantics of process model constructs would arguably be of most benefit to process model readers.

4 The Suitability of Verb Classifications

In this section we argue that the classification of verbs according to their *domain semantics* appears to be a systematic way of assigning icons to activities. Accordingly, a generic verb class should be represented by a generic icon that captures its semantics. Some research has been conducted on this topic in disciplines including conceptual modeling and linguistics. More precisely, our line of work follows the example given by Storey [10] in the data modeling domain. She developed an ontology for the semantic classification of relationship-type constructs in data models based on dictionaries, business taxonomies and previous research.

Domain semantics define the real-world meaning, or essence thereof, of the terms used in any conceptual model, that is, of words and phrases used to label constructs [10]. The tricky part is that some of these semantics are well-known and unambiguous while others may vary with context, i.e., they can be subject to multiple interpretations. Accordingly, it would appear only logical to develop a verb classification scheme based on the process management context, in which process models are used.

Accordingly, we investigate two verb classification schemes in terms of their suitability to support icon assignment in process models: the MIT Process Handbook [17] and the Verb Classes proposed by Levin [18]. Both verb classification schemes are well-known libraries for sharing and managing knowledge about business processes and organizations. In order to evaluate the suitability of these verb classification schemes, we apply both in the classification of the verbs used in the activity labels of the SAP Reference Model [19]. The SAP reference model contains over 3,000 process models capturing various information about the SAP

R/3 functionality to support the business processes in an organization and denotes a frequently used tool in the implementation of SAP systems [20]. With the SAP solution being the market leading tool in the Enterprise Systems market we feel that the examination of SAP process models gives us a good understanding of the use of process models in real-life business contexts. We extracted 19,839 activity labels from these models for our analysis. 4,553 of these labels are unique and they refer to 309 different verbs. Table 1 lists the 30 most frequently used verbs of the SAP Reference Model. Clearly, some verbs are semantically overlapping like *determine* and *check*. The following sections discusses how verb classifications are suited to resolve these overlaps.

Table 1. The 30 most frequently used verbs in the SAP Reference Model

Verb	Occurrences	Verb	Occurrences	Verb	Occurrences
process	2003	post	330	update	203
enter	1922	release	328	analyze	191
determine	1755	maintain	316	settle	186
check	971	calculate	271	allocate	180
create	665	assign	261	transmit	171
plan	614	define	258	copy	164
transfer	510	edit	258	print	162
select	349	perform	228	generate	141
confirm	345	specify	226	change	136
carry out	337	evaluate	203	display	131

4.1 Using the MIT Process Handbook

The MIT Process Handbook Project started in 1991 with the aim to establish an online library for sharing knowledge about business processes [17]. The business processes in the library are organized hierarchically to facilitate an easy navigation. The hierarchy builds on an inheritance relationship between verbs that refer to the represented business activity. A list of eight generic verbs including *create, modify, preserve, destroy, combine, separate, decide,* and *manage* have been identified using the lexical database WordNet [21], an online library containing over 21,000 verb word forms divided into 15 semantic files. We used WordNet to build a list of all synonyms of these verbs, and using them we linked the verbs of the SAP Reference Model to the verb class. Since some verbs have common synonyms, verbs are potentially related to more than one class.

Figure 3 shows the classification results. The eight generic verbs of the MIT Process Handbook cover 21,046 verb occurrences[3] while 11,029 could not be automatically classified using the synonyms of WordNet. Yet, the eight generic verbs of the MIT Process Handbook occur at least 1,358 and up to 4,691 times

[3] Note that verbs can be assigned to more than one class.

in our data sample. Hence, we can conclude that the eight generic verbs quite evenly capture the spectrum of activities.

In performing the classification, we encountered two types of problems. First, there are several terms that are too technical to be covered by the synonyms of WordNet, examples of such terms include *to dun* (15 occurrences) and *to accrue* (16 occurrences). Second, there are some verbs that are not covered at all although they are arguably synonyms of one or many of the generic verbs provided. A prominent example is the verb *to process*, which infact is the most frequently used term in the SAP set of models (2003 occurrences). Even though it shares a number of characteristics with, for instance, *to modify*, this relationship is not documented in WordNet.

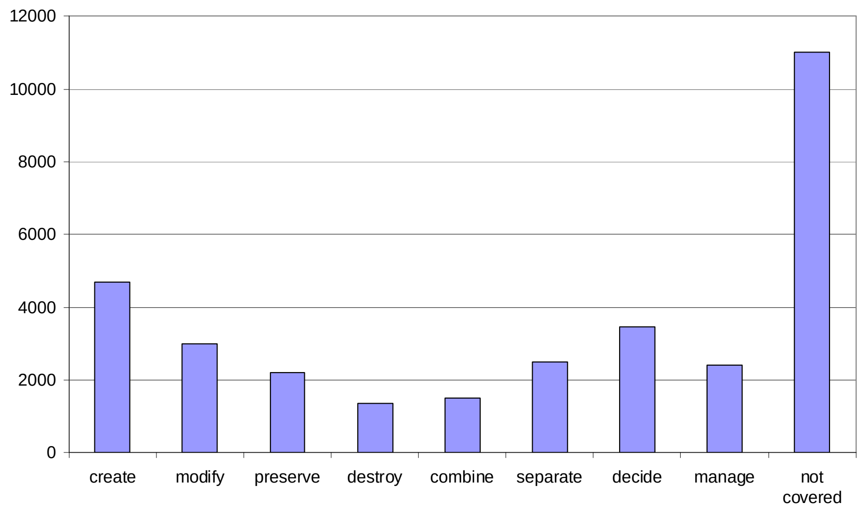


Fig. 3. Generic verbs of the MIT Process Handbook and Occurrences in the SAP Reference Model

4.2 Using Levin's Verb Classes

The systematic work on verb classes by Levin is an important contribution to understanding the use of languages. It defines 49 semantic classes of verbs and categorizes more than 3,000 English verbs [18]. In contrast to the MIT Process Handbook that builds upon WordNet, Levin's verb classes are derived from linguistic analysis. Each verb class is divided into sub-classes that list some prominent example verbs. We used a respective online version of this classification hierarchy[4] for our analysis. Again, multiple assignments between a verb and a class were possible.

[4] See http://www-personal.umich.edu/~jlawler/levin.html

Figure 4 shows the classification results using Levin's classes. Altogether 17,868 occurrences could be categorized in one or more classes, 6,232 were not covered. The most frequently occurring verb class relates to verbs with predicative complement. These are basically speech acts [22] like *to accept*, *to acknowledge*, or *to select*. This could be seen as an indivation for a focus of business process on inter-personal communication and decision-making scenarios.

We faced classification problems similar to our usage of the MIT Process Handbook: some verbs were too specific, others not covered. Interestingly, again the verb *to process* was not included in any class.

4.3 Identifying Suitable Classes

We extracted 19,839 activity construct labels from the SAP reference models, from which some terms were classified in multiple verb classes. We can assess the coverage of the two classification schemes as $1 - \frac{notcovered}{19{,}839}$. Accordingly, the coverage of the MIT Handbook is $1 - \frac{11{,}029}{19{,}839} = 0.44$ while the Levin classes cover $1 - \frac{6{,}232}{19{,}839} = 0.68$. This would indicate a preference for Levin's work. However, it should be noted that the two classification schemes considered operate on different levels of conceptual abstraction.

Based on our initial analysis we assume that in particular those verb classes with more than 100 noted occurrences can be viewed suitable candidates for considering an individual icon assignment. Table 2 shows the 25 resulting generic verbs we consider based on this assumption. Given the overlap between the two considered schemes (e.g. there are several Levin classes that are subcategories of the MIT generic verb *to modify*), Table 2 only lists the more specific terms (e.g. *verbs of creation and transformation* instead of *to modify*). Note that we skipped the Levin term *change state* since this is the generic definition of what an activity of a process does.

5 On the Use of Icons

Our previous discussion revealed that indeed we are able to reduce the set of activity labels used in process models to a restricted set of semantically different task or activity terms. In fact, with the 25 extracted verb classes together we achieve a coverage of 0.95 per cent of the activity verbs used in the SAP reference process models, which confirms the results from our analysis

We argue that a suitable strategy for making process models more understandable would be to develop iconic representations for the different identified verb classes. This would allow model users to intuitively identify - by mere visual inspection - the most common classes of activities contained in any process. For instance, a model reader could instantly identify in any given how often (s)he is required to communicate with other stakeholders and how often a process object needs to be modified etc. Detailed information about the exact type of activity (e.g., what form of communication, what type of process object) can then be obtained from the label of the construct.

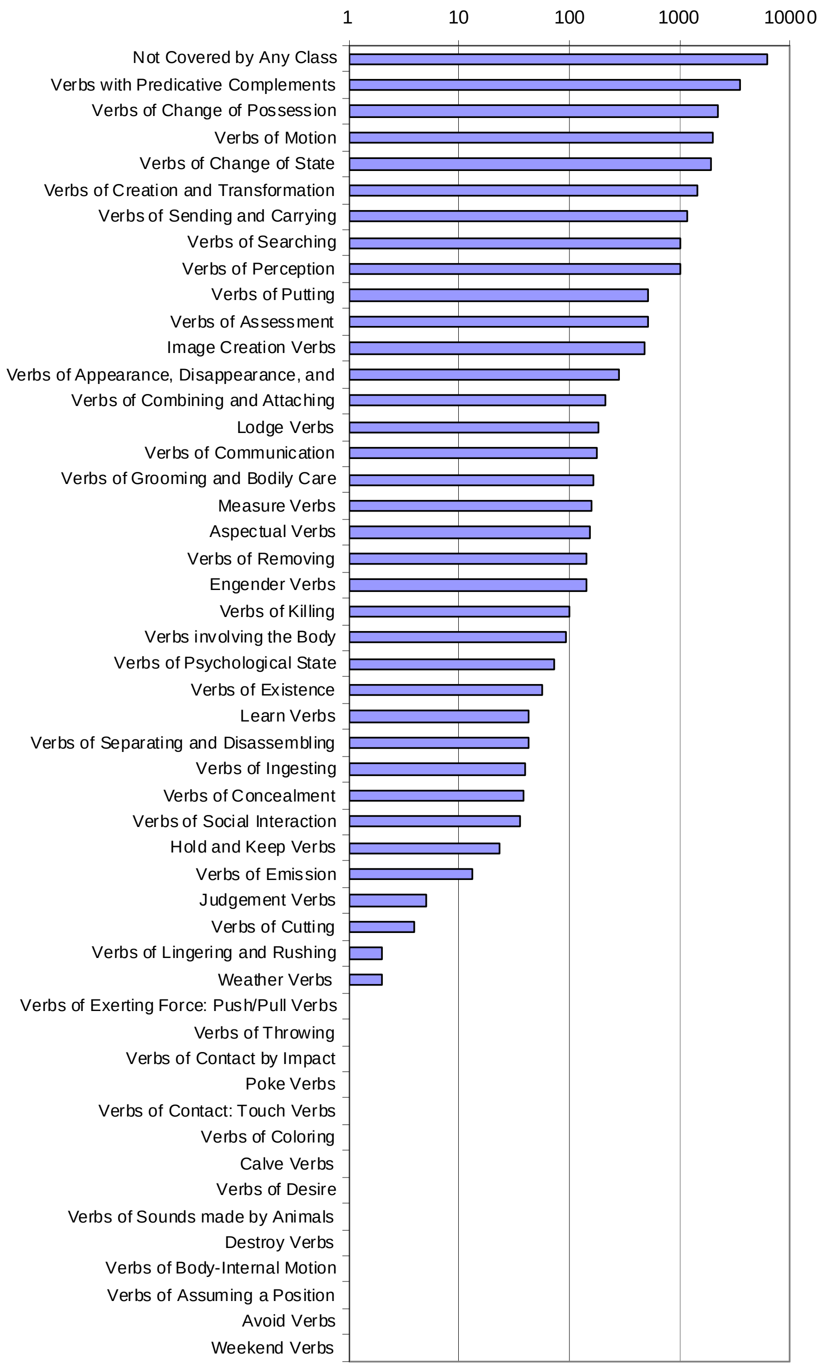


Fig. 4. Verb Classes by Levin and Occurrences in the SAP Reference Model

We further argue that the use of iconic representations is conducive to improving process model understanding even more so because graphical icons essentially have become part of our daily lives (think of the hourglass in Windows, the telephone symbol in Skype or the use of emoticons in text messages). Accordingly, our endeavor was also to investigate the development of suitable iconic representations for the identified verb classes. Unfortunately, icon development has more of an art than science [23]. Yet, some guidelines based on research in graphical user interface design, e.g. [24, 25] exist to support our undertaking:

1. *Semantics-oriented*: Icon selection should emphasize the easiness of interpretation by the users (icons should be natural to users), resemblance (to the things or tasks it refers to) and differentiation (all icons should be easily differentiated from each other and should not be subject to mis-interpretation).
2. *User-oriented*: Icon selection should be based on user preferences and extensive user testing.
3. *Composition principle*: Icon composition rules should be natural and easy to understand and learn. The Multiple-level icon composition principle, for instance, suggests rules for composing high-level icons from low-level icons based on similar concepts used in data/system modeling and the English grammar [26]. The grouping principle, on the other hand, provides some rules to design icons in groups based on the type and instance concepts found in data/system modeling and icon-based natural languages [27].
4. *Interpretation rules*: Icon composition rules should be transferable to different models and audiences.

We have referred to these principles in a first attempt to provide icons for the most frequently used generic verb classes. Table 2 shows the results. We should note though that our attempt to provide suitable iconic representations is in its early, formative stages. We are aware that the selected iconic representations may not actually be valid and suitable. This, however, is a question of empirical nature and thus requires further research in the form empirical testing. This is a noted future research direction.

As an example, we consider the *Period-End Closing: Material Ledger* process from the SAP module *Revenue and Cost Controlling*. In this process, four tasks are specified, which are described with the verbs *to determine*, *to allocate*, *to update* and *to analyze*. As per the classification scheme we used, these verbs are instantiations of the four generic verb classes *to search*, *to lodge*, *to modify* and *to measure*. Accordingly, Figure 5 shows the process model annotated with icons for these generic verb classes to illustrate our approach. Again, please note the initial stage of this design effort, we do not consider our design to be complete or sufficient at this stage.

6 Conclusions

In this paper we discussed an essential yet under-researched aspect of process modeling practice, that of labeling the graphical elements in a process model.

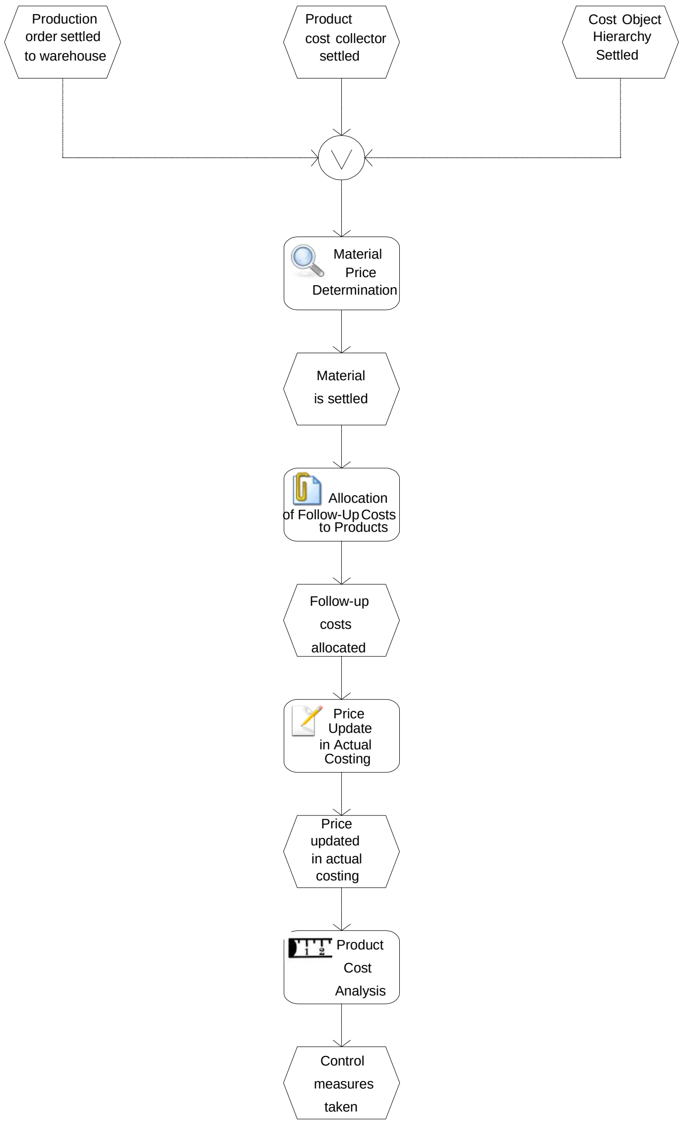
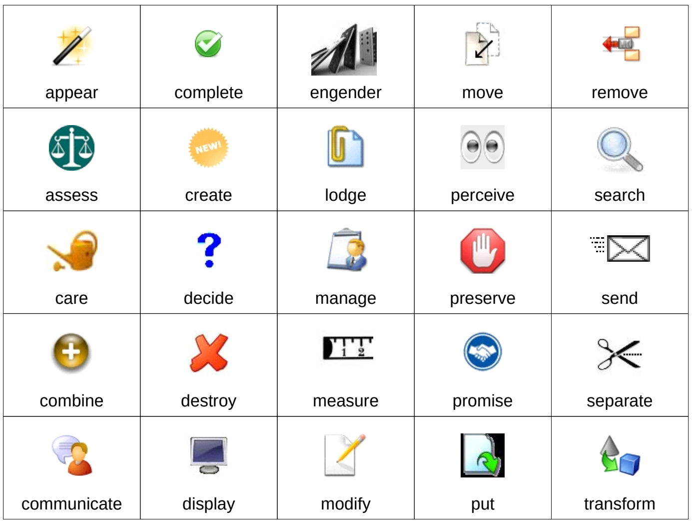


Fig. 5. Example process model with icons

Table 2. A set of 25 generic verbs for describing activities of business process models, including iconic representations



This way we complement the existing streams of research investigating other dimensions of process modeling (e.g., the data, resource, or control-flow perspectives). Our line of research is based on the assumption that process model understanding can be improved if a more systematic way of labeling constructs can be found. Based on Dual Coding Theory and CTML we argued that understanding can be improved if labels in process models can be complemented by iconic graphical representations. We provided a systematic approach towards the use of labels by identifying from a sample of over 3,000 process models the twenty-five most frequently used verb classes using two existing verb classification schemes. Based on the results we provided a first set of iconic representations to match the identified verb classes.

Clearly, our research is still at the early, explorative stages. Hence, our forthcoming research is as follows: We will examine empirically the suitability of verb classification schemes for classifying activity tasks in process models. Similar to the experiment described in [10], we will have students classify activity tasks in a number of process models as per the verb classification schemes to establish the viability of these schemes. After identifying the most common verb classes used in process modeling, we will further develop the set of iconic representations for these verb classes. In another stream of research we will then investigate empirically whether the inclusion of words (labels) and images (icons) in process models does *in fact* warrant improved model understandability. CTML suggests three outcomes of understanding - retention, recall and transfer - that can be used as measures in a related empirical study. In conducting such a study we can refer to the works of Gemino and Wand [28] and Recker and Dreiling [29] that both used exactly these measures for examining understanding generated through data [28] and process modeling [29], respectively.

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