From Language Acquisition to Subject-Oriented Modeling

2

2.1 To Go

Everybody is able to talk in natural language, well, more or less: Why would we like to describe processes in natural language? Since we already know how to do it, without the need to learn some strange language, such as that of IT people, which nobody can really relate to. Is S-BPM now the next hype? Another lingo? How does subject orientation help? And how is it related to natural language?

A business process is a highly complex bundle of communication in an organization. Humans have learned to communicate using language. Given that fact, it makes sense to describe processes entirely through natural language. Complete sentences are composed of subject, predicate, and object. At least, to my knowledge, all languages have this structure, and I have asked people of highly different origins. There might be differences in arranging the terms within a sentence, but with respect to their category they remain the same across different languages. Looking into existing BPM approaches, most of them are incomplete—they may lack the subject, the predicate, the object or some combination of these. In particular, subjects, if they are included at all, may be expressed indirectly or implicitly, e.g., using passive voice. Traditionally, processes are described by lists of predicates—we call them functions. Take, e.g., object-oriented methods: Besides predicates there are objects on which developers carry out operations. We tend to avoid expressing explicitly WHO is doing what. However, once we recognize that nothing happens without being triggered by someone, we have to move the subjects to the focus.

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In this chapter, we first reflect the origin and development of human thinking, acting, and natural language. Then, we introduce subject-oriented business process modeling by describing its main features and constructs intended to support organizational development steps. The focus of S-BPM modeling is on subjects as these are the active actors or systems in organizational development processes. Such a focus allows expressing knowledge in terms of natural language sentence semantics, as we do in natural language: a sentence consists of a subject, a predicate, and an object. Subject-oriented business process models can be directly derived from such natural language representations. Language is a complex communication system, using arbitrarily chosen symbols that can be combined in countless ways to achieve a single goal: conveying information.

In the following, we offer an overview of basic elements of natural language and show the transition of natural language representations to subject-oriented models. We start with significant findings on language acquisition and then discuss the developmental relationships between speech and action. We focus on language features and language development as detailed by Zwisler (1999).

For this reason, we deal first with the natural language semantics of sentences, which subsequently enable us to step directly into subject-oriented modeling of business processes without further effort. We then discuss the relationship of formal languages to natural language in order to clarify some differences. This discussion should help avoiding problems, primarily with respect to modeling, and subsequently with respect to implementing S-BPM models.

2.2 Acquiring Language and Dealing with Its Structure

Not only does the acquisition of language appear to be intrinsically motivated, but also its use, and thus, how to deal with distinct language structures. People intend to convey information and deliver meaningful messages when using language. Children are in particular interested in using voice communication: they find out very early how to influence their environment by acting. While improving their actions, they try to imitate the language of their parents. They learn that opening and closing the mouth twice when saying “ma” results in “mama” which not only delights their environment but also allows them to influence the behavior of their parents. Children experiment and play with language, and they quickly recognize that it is indeed useful to speak the same language as their parents. This insight has been conceptually explained as follows: “The foundation of language is based on a common understanding on the combination of sounds into meaningful units, and the combination of words into sentences. Phonemes are the sounds that make up the language. Morphemes are the smallest meaningful units” (Zwisler 1999).

Language therefore is governed by certain rules and hence structures the communication and interaction between people. While the syntactic dimension determines the relationship between linguistic symbols, the semantic dimension determines the relationship of symbols to nonlinguistic realities. Finally, the pragmatic dimension determines the relationship of symbols to speakers and listeners.

Language itself can therefore be regarded as a formal system. Within this system, distinct syntactic and semantic elements can be put into mutual context by way of rules. The most important basic semantic unit is a sentence. Language description and explanation are thus reduced to the description and explanation of sentences; the use of language is excluded. However, according to Chomsky, when using language, speakers and listeners generate some cognitive effort (while perception is learned prior to the production of language) (Chomsky 1986):

- They can judge sentences on their grammatical correctness.
- They recognize semantically equivalent sentences.
- They check ambiguities and can resolve them through paraphrasing content.
- They are able to repeatedly form new sentences and understand their meaning—they show linguistic creativity.

From the first three observations, Chomsky concluded that the perceivable forms of sentences are based on construction plans constituting actual meaning. He distinguishes between a surface structure and a deep structure of sentences. The deep structure determines which grammatical categories a sentence contains, which grammatical relations exist between the categories, and which lexical units can be used for the grammatical categories. The deep structure is allocated according to a semantic interpretation, which determines its semantic structure. By means of transformation rules, the deep structure is transferred into surface structure. Finally, sentences are pronounced correctly using the phonological component (Chomsky 1986).

Adolescents develop an individual language specific to their peer group or social environment. This language is generally characterized by simple sentences, revealing the sufficiency of natural language sentence semantics for effective communication.

Later, we show that the mapping of natural language sentences to an S-BPM model is comprehensive. Consequently, subject-oriented models enable effective communication, conveying complete information.

> Language as a formal system contains the grammar as a fundamental means for the formation of expressions, sentences, and stories.

2.3 Talking and Acting: Functional Alignment of Sentences

People do not produce sentences per se; they use them intentionally and purposefully. Linguistic competence, in terms of being able to understand meaning, includes the ability to know what to say in a certain social context, the skill to formulate content according to expectations of listeners, and the ability to recognize when it is perhaps better to conceal something. People learn the socio-normative rules of communication, i.e., communicative competence, through communication, not because they master a set of grammatical rules. People acquire the structure of

sentences through the use of language, which in turn empowers them to explore its further usage. Hence, function and structure are mutually intertwined.

Language in its functional orientation enables speech. Talking represents a kind of action, with the speech act being constituent of the mutual relationship of the communication partners. The speech act can succeed or fail, just as any other activity. Bühler, with emphasis on the action character of language, interpreted language as a tool "to tell somebody something about things" (Bühler 1937). Thus, three constituent components of language can be distinguished:

- The subjective component: "oneself" (expression)
- The intersubjective component: "the other" (appeal)
- The objective component "of things" (presentation)

This distinction emphasizes the importance of separating presentation from content. It is reflected by the respective categories of symbols:

- Symbols by virtue of their relationship to objects and situations (objective component).
- Symptoms by virtue of their dependence on the speaker's intention, therefore, from the sender (subjective component).
- Signals by virtue of their appeal to the listener whose behavior they control (intersubjective component).

Therefore, a speech act always concurrently serves as a means for presentation, expression, and appeal. Usually, in a speech act, one of these functions moves to the foreground. Similarly, model building in BPM is aligned to a specific function.

2.4 Language Proficiency: The Transmission of Meaning

Being capable to use a certain (modeling) language means for a person to be able to master the grammatical rule set on the one hand. On the other hand, it means being able to make other people understand, to talk about items and issues, and—where appropriate—to reach an agreement. The first functional aspect is also known as "linguistic competence," while the second one is termed "communicative competence" due to its orientation toward action. In the context of modeling a business process, the functional aspect refers to the appropriateness of representation, from scratch to a complete and therefore coherent representation. The action aspect refers to adequately representing a situation by using a modeling language.

Language proficiency goes beyond the knowledge and application of the grammar of a language to convey meaning. People can only interpret information correctly when knowing its overall context. The conveyed meaning of a sequence of words can only be determined when knowing who the receiver is and what the concrete situation the sender and the receiver are part of involves. These dependencies of intended meaning determine, among other things, the cultural evolution:

- Semanticity: the utterance of a word is not necessarily linked to the presence of the signified object.
- Productivity: utterances that have never been expressed are possible.

- Substitutability: communication can occur independently of space and time.

When applying this knowledge to S-BPM and the development of organizations, organizational development using models of business processes is driven by the following characteristics: semanticity means that models based on the structure of language (as representations of the observable or anticipated reality) express organizational development opportunities. Productivity refers to situations achievable in the future. Substitutability implies the possibility of holding on to ideas that may become productive (in terms of the preceding sentence).

Consequently, the capability of speaking and articulating in natural language enables stakeholders, according to their relation to cultural evolution to actively participate in organizational development.

> Language allows the mapping of context with its own resources. Humans use their knowledge about language to describe processes and their embodiment in organizations.

2.5 Learning to Coordinate Speech, Thought, and Action

According to the findings of developmental psychology, the ability of individuals to learn a language is biologically determined. The environment only helps to trigger the biological potential. The receptor and articulation mechanisms of language according to their anatomical and physiological basis are already operational at the moment of birth. However, the brain regions required for the actual functioning of these mechanisms yet need to go through a further maturation process after birth. According to Chomsky, a speaker can only learn a language, when he has extracted the respective rules to construct linguistic utterances out of the abundance of utterances surrounding him as a child. These rules specify how the surface structure of a language is connected to the underlying deep structure. Mastering of all these rules has been referred to by Chomsky as linguistic competence. It is however an ideal claim, which will not be encountered in actual life. The actual speech capability is then speech performance.

According to Chomsky, there are universal principles that determine the types of grammatical regularities in the different languages; these should be innate to a child for language acquisition. What is to be determined by biology is a set of rules consisting of universal principles of structuring, which guide and channel the acquisition of grammar in the process of socialization. This control apparatus is called “LAD” (language acquisition device). It allows the child to induce general rules on how to form hypotheses from individual experiences with the language of its environment. In this way, it acquires a command of the grammar for that particular language. The constructive activity of the child in language learning comes to the foreground. Language is thus acquired in a long-lasting process. Since the child is fully engaged in the dynamic flow of the listener and speaker, it is able to understand what is meant by the (adult) speaker. Once the child knows what the

speaker means, it can recognize and explore the meaning of what this person says. The child therefore does not learn what a word means, but rather how an existing meaning, or a term or concept, can be described verbally. The anchoring of language learning is provided through recognizing the intention of the speaker.

Up to a certain point, the development of thought and language proceed separately. But then, approximately at the age of two, they meet: thinking becomes language, and language becomes intellectual. "There is indeed no way to make achievements of thought visible without language" (Zwisler 1999).

The development of language itself involves several steps, which are of importance for the recognition of semantics. The following are particularly important:

- The one-word stage (age 1–2 years): The child uses single words to express whole phrases or sentences. The meaning of the words is understood by the adults because of the context. The child understands much of what it hears, as can be observed from the fact that it carries out correlated actions.
- The spurt in the development of words (at the age of two): The vocabulary is growing from about 300 words at 24 months to 1,000 words at 36 months. Two- and three-word sentences are formed by the child's own rules, which are not copied from the grown-ups' language.
- The sentence period (at the age of three): At this time the child uses sentences that contain grammatical features of the grown-ups' language. The child can use functionally complete, but grammatically incomplete sentences.
- To 5 years of age: The child uses sentences of each type: incomprehensible sentences; functionally complete but grammatically incomplete sentences; simple sentences; connected sentences; complex sentences; and mixed forms of the latter two.

Sentences, in which the actual subject is not explicitly named, are hard to understand for children ("At night, a black cat is hard to see"—Who sees the cat here? The subject "any person" has to be added with cognitive effort). Chomsky used a doll in his investigations which he blindfolded. Then he posed the question: "Is the doll easy to see or hard to see?" Only children at the age of 7 years gave correct answers at a high enough rate to indicate that this was not coincidental. The latter is particularly significant because linking displayed content to the respective actors seems to be of high importance for understanding.

Equally important is the sentence structure. In a sentence, words are put into mutual relation. The two most important keys to understanding sentences are the sequences of words and their inflection. The child begins with the word that has the most importance and includes the focus on what it wants to say (-> semantics). One of the most difficult grammatical forms seems to be the passive sentence. Often children are not able to use it correctly until the age of seven. For its understanding, they need to reverse their thoughts.

Semantic development occurs initially through vocalizations. In this way, the child can achieve targets. The child only knows that a particular verbal behavior can lead to desirable consequences; the actual meaning of a particular word is still not known to him. Semantics is achieved by inductive extrapolation: the child takes those speech utterances from the environment which it hears frequently and

considers relevant for his needs and demands. These statements are memorized as best as possible and recalled in this form. Due to the variable use of these forms, the child then gradually recognizes that their individual positions can be taken by different words. The words in identical positions are turned into categories, and from their sequences syntactic rules for word positioning are derived.

A child does not operate only on the level of words, but also, and just at the beginning of language, with larger units. It is not only a cognitively motivated analyzer, but also, and primarily, a socially and emotionally motivated impersonator. The language rule sets do not only stem from internal but also external sources. The child does not learn the syntax in a direct way, but rather through conveyance of nonlinguistic conceptual information and linguistic semantic information; language acquisition is a highly active procedure.

These findings on language acquisition clarify which achievements are cognitively necessary for a successful language proficiency, even if they are intrinsically motivated. Active language acquisition lays the ground for the capability of people to interact, and ultimately for their coexistence in all systems of the society. These findings can be used to generate models of business processes and to contribute to organizational development. Considering the process of acquiring language skills, however, we have to recognize the inverse nature of S-BPM modeling through language constructs. The conscious use of syntax already allows the generation of meaningful content of models as shown in the sequel.

2.6 Models and Natural Language Semantics of Sentences

Models are representations of the perceived reality of humans. They can be formulated by means of natural language, even when they are processed by IT systems. The advantage of natural language descriptions is that they can be immediately understood by all people. And they are in line with natural language sentence semantics, as they contain subject, predicate, and object. What we call here natural language sentence semantics is considered the second level of sentence semantics in linguistics, with the semantic roles agent, predication, and theme (“Max plays the ball”). Level one corresponds to statements like “The ball is round.” The third and last level is equivalent to the semantic structures within parts of sentences (“Peter’s enjoyment of football brought luck”). For details, see Schmidt et al. (2005).

Natural language sentence semantics is familiar to all of us, as we invariably use it to communicate. However, natural languages have the disadvantage that they are frequently used in an incomplete and not sufficiently precise way. The results are different interpretations and misunderstandings.

The following illustrative example can be found in several Internet forums (Fig. 2.1):

A software engineer (programmer) and his wife:

Wife: Darling, we don't have any bread at home. Would you please go to the super market and buy a loaf? And if they have eggs, buy six!
Husband: Sure, darling.

After a while, he comes back with six loaves of bread.

Wife: Why did you buy six loaves, dear?!?
Husband: They had eggs…

Fig. 2.1 Example of a linguistic misunderstanding

What happened here? The woman has formulated her request incompletely. However, in ordinary settings, most people understand what she wants. But not the man, as his interpretation stems from language use that is neither common nor usual. Consequently, the result is curious. This example follows a pattern many jokes are built on. People interpreting the request of the wife in a syntactically correct way should actually come to the same conclusion the man did. They would have to buy seven loaves which, however, is not significant for the purpose of the story. This small example rather shows the limitations of colloquial use of formalizations.

Formal languages, in contrast to natural languages, have unique word semantics. Formal models are intended to convey abstract information. For the sake of a nonambiguous interpretation, they have reduced sentence semantics. Each model still can be interpreted in natural language by individuals. People are used communicating in complete sentences of the form subject, predicate, and object. If sentences are incomplete, problems in understanding occur. Therefore, sentences have to be complete in order to convey their entire meaning.

In modeling, essential aspects are differentiated from accidental or random aspects. Essential aspects describe the necessary elements for the formation of sentences. Such a distinction is also reflected in natural language: passive sentences are used when an action is in the foreground, without necessarily having to name the acting agent. Note: this sentence has also been written in passive voice, as the related subject, "a writer" is meaningless in this context. In order to form intelligible, complete sentences, it is advisable to create formal modeling languages that employ full natural language sentence semantics. This helps to avoid problems of comprehension and understanding.

> Natural language sentences have the structure "subject–predicate–object" for conveying meaning. For instance, "I am writing a book" basically describes a meaningful situation through this kind of structure. It allows subject-oriented business process modeling.

Natural languages are used for communication between people. In terms of business processes, models describe the activities and communications of the

people involved, application systems, machines, data, and other aids or tools. A business process is the medium to produce a reference for all participants to the activities they perform and techniques they use. On the one hand, there are actors or users who express how they (should) perform their activities. On the other hand, there are developers who integrate certain application programs in a process, and other stakeholders, who, e.g., assess the business process. A business process model provides all stakeholders with a common understanding of business operations. Such models must thus be understood not only by the experts who create them, but also by those who later (are expected to) work according to the model, and who should enrich it by providing additional information.

There is a description language for models that humans are generally familiar with, and which is basically sufficient for a first description of business activities: the natural language. The advantage is that it is known to all stakeholders and can be immediately understood and used. Task or process descriptions are therefore almost always initially documented in natural language statements and complemented with diagrams. Natural languages have three major semantic components. These are the subject of an action as a starting point, the predicate as the action being performed, and the object as the target of the action. These three elements define a complete sentence with the appropriate natural language sentence semantics. This facilitates the description of business processes, since in processes there are also actors who perform actions on certain objects.

In Fig. 2.2, a business trip process is broken down into to its components: subject, predicate, and object.

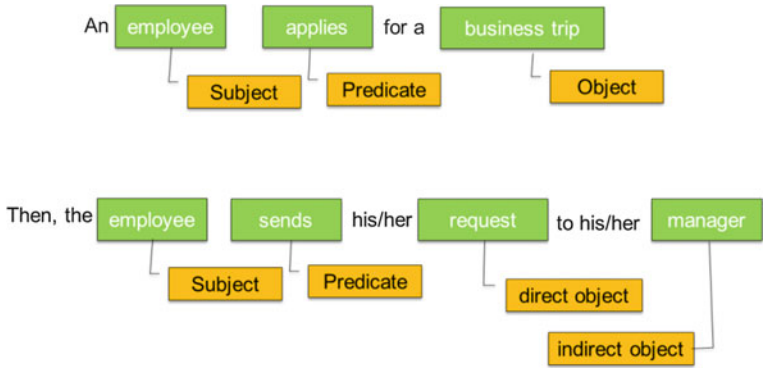

Fig. 2.2 Process description in natural language

2.7 Formal Languages and Natural Language

In theoretical computer science, the theory of formal languages plays a central role. It has been proved that programming languages are formal languages, which can be processed by a machine (Hopcroft et al. 2001). This is one of the most important statements of theoretical computer science. Yet natural languages cannot be fully described by formal languages, as natural languages have greater expressive power.

The relationship between formal and natural languages is also the subject of linguistics. Here, "langue" as a convention in a language system is distinguished from "parole" as content that is dynamic and context dependent. In the 1980s, Chomsky has continued to develop the terms further and introduced the names i-language for internal language and e-language for external language (Chomsky 1986). In a linguistic sense, the natural language sentence semantics is an i-language and more powerful than a formal language in the classical sense of computer science. We all are familiar with it, since it is used in daily communication.

As already described, natural language however also contains elements of e-language, which can be interpreted differently and may cause misunderstandings. Formal languages, in contrast, have a fixed (and thus possibly reduced) word semantics. In addition, in formal models a reduced set of semantics is used. This facilitates the automated processing of expressions in a certain language.

In modeling, one or even two of the standard sentence parts subject, object, and predicate are often omitted. For instance, when using flowcharts, only predicates (actions) are considered. Subjects and objects can be added as comments on the individual actions. But as such they are not fully integrated in the model. Data structure descriptions consider only objects, without dwelling on the actions or the starting point of the actions.

Formal models can be interpreted differently in business process modeling and software development. To avoid misunderstandings and ensure clarity, they also have to be translated into natural language, even when a reduced word or sentence semantics is used.

> For modeling, it may be necessary to once again bring the subject, as acting element in a system or as the starting point of an action, into the foreground, or to the beginning of the flow of thoughts.

2.8 Subject-Oriented Construction of Business Process Models

We now show on the basis of a simple example—an application for a business trip—the mapping of a language-based representation to a subject-oriented model. In doing so, the subject moves to the focus of attention. This method is the core of S-BPM. We show which parts of the standard semantics subject, predicate, or object are essential and which are accidental, and how the sample process is described in the respective modeling style.

Figure 2.3 shows the natural language description of a business trip application process.

An employee applies for a business trip. His manager checks the request and informs the employee whether he approves or rejects the request. The approved request is forwarded to the travel office which does all the travel arrangements.

Fig. 2.3 Natural language description of the business trip application process

The subject-oriented description of a process starts with the identification of process-specific roles involved in the process, the subjects, and the messages exchanged between them. When sending messages, the required data is transmitted from the sender to the receiver. Thus, with the message "business trip request" sent by the employee to the supervisor, among other things the start and end date are transmitted.

Figure 2.4 shows the interaction structure of the process.

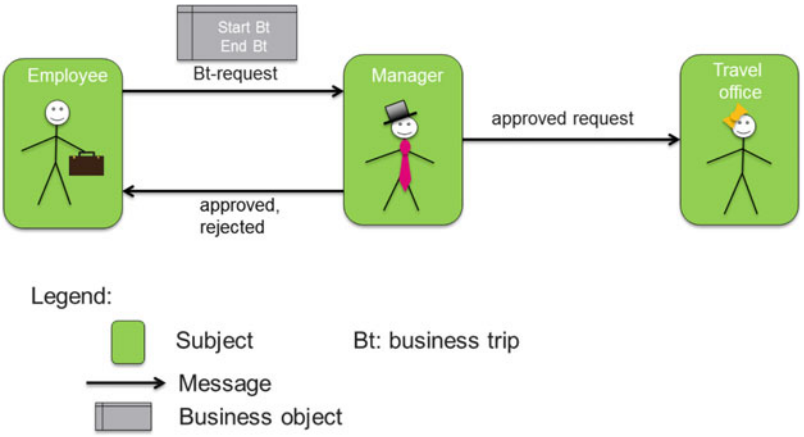

Fig. 2.4 The application process with the involved subjects and their interactions

In a further refinement step, it is now described which activities and interactions the subjects have to perform during the execution of the process and in which order, i.e., the behavior of individual subjects is defined.

We first consider more closely the behavior of the employee from his perspective. This can be formulated in natural language, as exemplified in Fig. 2.5.

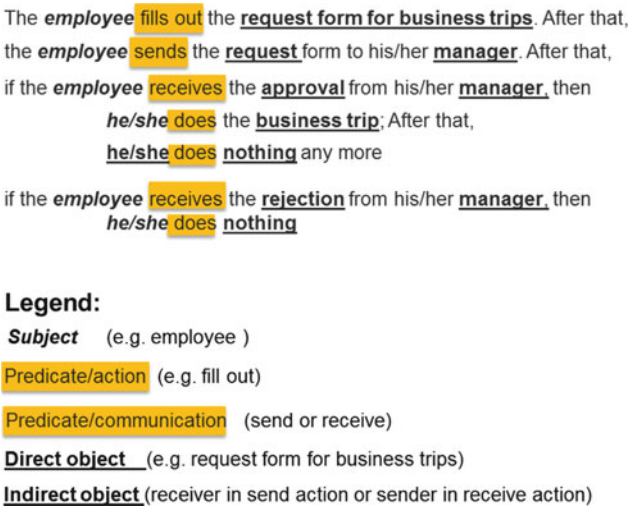

Fig. 2.5 Natural language description of the behavior of the subject employee when applying for a business trip

The phrases used are bumpy and the process can be decomposed into alternative paths, so that a pictorial representation appears clearer. In the following, we will therefore use a graphical representation. Figure 2.6 shows the order in which the employee sends and receives messages, or executes internal actions, and in what states he is in during the corresponding action.

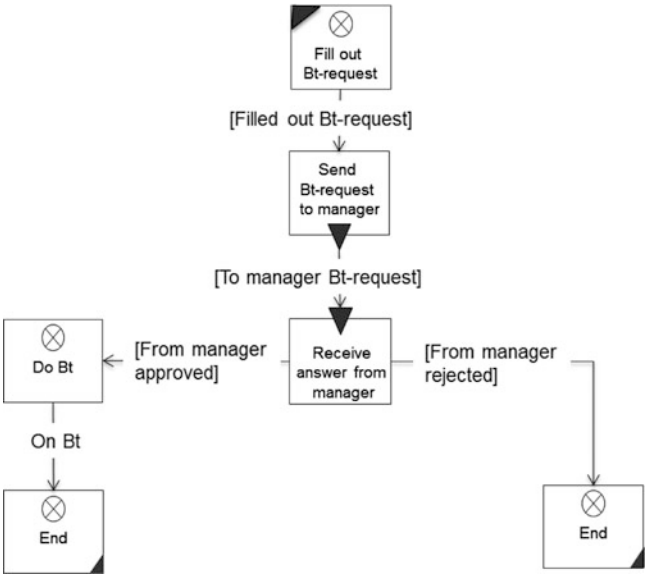

Fig. 2.6 Graphical representation of employee behavior when applying for a business trip

The initial state is marked by a triangle in the upper left corner. It is a function state in which the employees complete their business trip request. Then they come by way of the state transition "request completed" in a send state in which they send the application to the manager, before entering the receive state, in which an answer is received from the manager. Here, the applicants wait for the response of the manager. In case they receive a rejection message from the manager, the process is complete. In case the employees receive the message "approval" from the manager, they go on the trip on the agreed date and the business trip application process is completed.

The behavior of the manager is complementary to that of the employee (see Fig. 2.7). Messages sent by the employee are received by the manager, and vice versa. The manager therefore waits first in a receiving state for a business trip request from the employee. After receiving the application, he goes to a state of checking which leads either to the approval or rejection of the request. In the second case, a send state follows to send the refusal to the employee. In the first case, the manager moves first to a send state for transmitting the approval to the applicant and proceeds then into a state of informing the travel office about the approved business trip request.

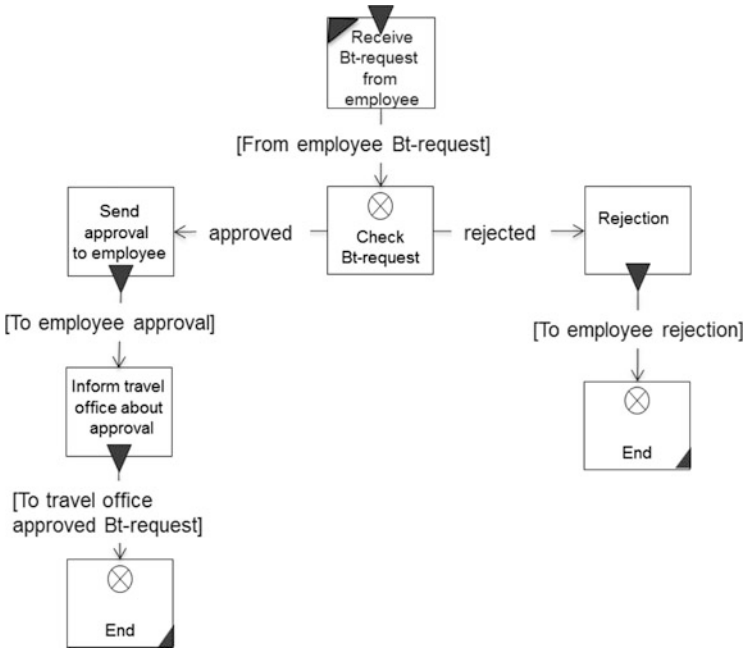

Fig. 2.7 Graphical representation of the behavior of managers when handling a business trip request

Figure 2.8 shows the behavior of the travel office. It receives the approved business trip request and stores it. Then its process terminates.

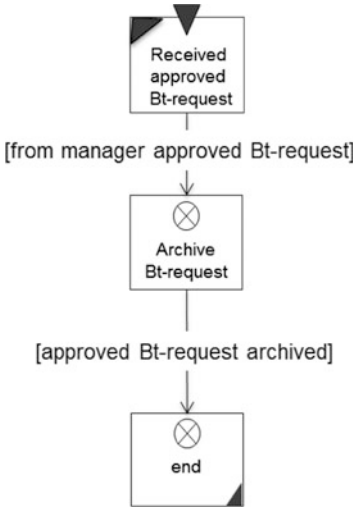

Fig. 2.8 Graphical representation of the behavior of the travel office when processing the application

In this example:

- The subjects involved in the process
- The interactions taking place between them
- The messages they send or receive during each interaction
- The behavior of the individual subjects

are described as they represent the essential elements of a subject-oriented model.

The description of a subject determines the order in which it sends and receives messages and performs internal functions. Its behavior thus defines the order in which the subject processes which predicates (operations). This may be the standard predicates sending or receiving, or other predicates that are defined on the corresponding objects.

> Although subjects constitute organizations, their interaction establishes what happens in the sense of business processes. So never forget the exchange of messages that goes along with the exchange of task-relevant data.

Therefore, an operation needs to be assigned to each individual state and state transition in a subject description, whereas it is not important how the operation is defined. This can be done by an object or using natural language. Therefore, in the following explanations for function, send, and receive states, we do not use the term method or operation but rather the general term service:

- Function state: An internal function is assigned to a service. Upon reaching this state, the associated service is executed. The end conditions of the executed service correspond to the exits of the respective internal state function.
- Send state: The output of a send state is associated with a service via a message name. This is triggered before the transmission process and determines the values of message parameters which are to be transmitted with the message.
- Receive state: Each output of a receive state is also associated with a service via the message name. Once a message is accepted, this service is initiated as intended in the state. The service takes the message received with the parameter values and processes them.

Services are used to assign a specific meaning to the individual steps captured by a subject behavior model. They are triggered synchronously, i.e., a subject does not enter the corresponding next state, unless the used service has been also completely processed.

Using the example of the employee behavior in the business trip request, Fig. 2.9 exemplifies how the predicates addressed in a subject can be defined using an object (class definition in the sense of object-oriented representations).

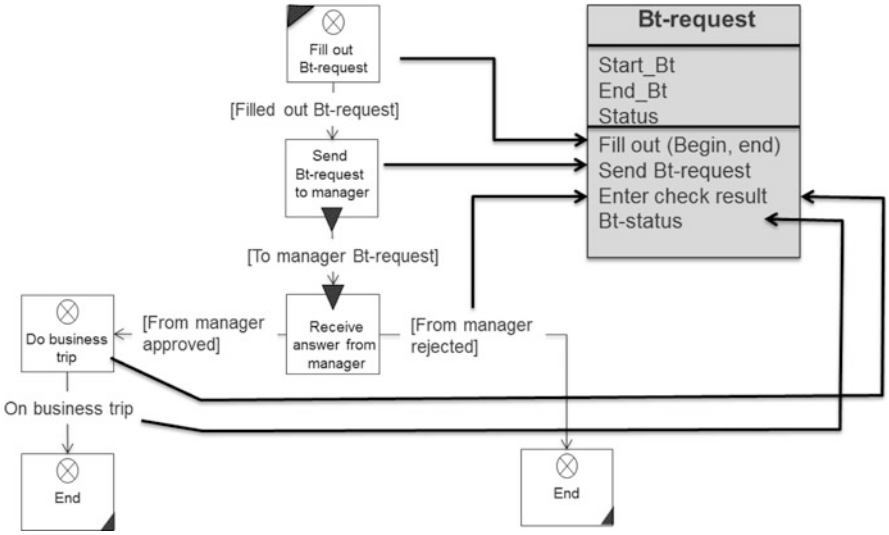

Fig. 2.9 Predicate definition in the behavior of a subject using an object

References

Bühler, Ch.: Kind und Familie: Untersuchungen der Wechselbeziehungen des Kindes mit seiner Familie, Jena 1937.

Chomsky, N., Knowledge of Language, New York 1986.

Hopcroft, J.E.; Motwani, R.; Ullman, J.D.: Introduction to Automata Theory, Languages, and Computation Second Edition, Upper Saddle River 2001.

Schmidt J.E.; Rabanus S.; Vilmos A.: Syntax, http://web.uni-marburg.de/dsa//Direktor/Rabanus/SS2005/Grundlagen.pdf, 2005.

Zwisler, R (1999): Sprachentwicklung, http://www.psychologie.uni-regensburg. de/~zwr02102/scripts/Sprachentwicklung.html (99-07-01), Download on August 13, 2010.