Enterprise Modeling Using OOA Techniques

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Abstract

We show, by applying the Object Oriented Modeling Technique OMT to a real world example, some benefits of an object oriented approach to conceptual enterprise modeling (design). Two design strategies are investigated: The first views a business process to be the 'sum' of all those activities objects perform to achieve the goal of that process. The process, therefore, is not specified explicitly. The second strategy takes a workflow oriented view and treats a business process itself as a (for some time) persistent object that gets into different states in reaction to the activities of the (actor) objects involved. It is shown that, with some restrictions, OMT may be used for both strategies, and that following the second may help to reduce complexity because it allows for rather natural design results.

1. Introduction

An essential point of information engineering within an organization is the development of a comprehensive *information system architecture* [Ei94, Kr90, Sc92a, Tu91]. One of the basic building blocks of such an architecture is the so-called *enterprise datamodel* the aim of which is to integrate the various (sub)datamodels of the different enterprise divisions. The use of the notion

'datamodel' reflects the actual state of the art: Attention mainly is payed to the static aspects of an enterprise; dynamic properties (business processes and their causal and temporal interdependencies, i.e. the functional and dynamic model) are covered at most in part. So it is quite obvious, that the standard meta model actually used for enterprise modeling is the well known entity relationship model (ERM) [Ch76] or one of its numerous variants.

On the other hand, *Object Oriented Analysis (OOA)* more and more becomes the modern way of conceptual design in the information system life cycle [KKM93], introducing the integrated treatment of static and dynamic aspects of a given Universe of Discourse. So it is a rather selfsuggesting idea, to use OOA concepts for enterprise modeling in general and for business process modeling in detail.

Again there is a number of more or less similar OOA methods on the market, e.g., [CY91, Ru91, Ja92, WWW90]. However, independently of the specific choice of one of them, two basically different approaches for object oriented business process modeling can be distinguished:

- Understand a business process as the 'sum' of all those activities objects perform to achieve the goal of that process, see e.g. [FS93b].

- Understand a business process to be itself a (for some time) persistent object that gets into different states in reaction to the activities of the (agent) objects involved.

At first glance the first approach seems to be the more natural one. However, the second approach allows for more concise and transparent models due to the fact, that it corresponds to a workflow oriented view where the flow objects themselves are of central interest.

This paper addresses the question to what extent a well known OOA method is appropriate for both approaches to business process modeling. In detail, first results of a project are presented, that is to investigate the suitability of two specific method representatives in a real world environment of some complexity - the Chamber of Economics of Carinthia. The methods in question are the OOA-part of the Object Modeling Technique (OMT, [Ru91]) and the Semantic Object Modeling approach (SOM, [FS93b]). Within this paper we restrict ourselves to the former.

Section 2 of the paper gives a short synopsis of how the Austrian Chambers of Economics are organized.Within section 3 we then introduce the 'miniworld' of one of the Chambers typical business processes, i.e. Bill Appraisal, which will serve us for an example throughout the paper.

Section 4 points out some important aspects of object oriented business process modeling and gives a very short survey on OMT.

Section 5 then outlines parts of a conventional object oriented conceptual design using OMT, whereas within section 6, we present some design results where the Bill Appraisal process itself was modelled to be an object on its own. The paper closes with a short outlook on further research.

2. The Austrian Chambers of Economics Organization

The Austrian Chambers of Economics form a legal and politically independent organization, that is financed by its members, i.e., the entirety of all Austrian enterprises and business makers. Their mission is ".. to act in their member's common behalfs .." [HKG94] with, in particular, tasks like

- the representation of their member's interests in front of the parliament, the government and of the other administrative authorities,

- the appraisal of bills and other important decrees, federal as well as local ones,

- the representation through experts at public or semi-public institutions, such as funds, commissions, committees, consultants (e.g. consultant for foreign affairs, price commissions, agricultural fund, social insurance companies, assessorts at labour court, conciliation boards, arbitration courts for social insurance affairs and the cartel court).

In order to comply with these duties, the Chamber Organization is structured into two 'dimensions': into ***regional units*** (Chamber of Economics in each federal country and the Austrian Chamber of Economics, Vienna) and into ***professional divisions*** ('sections' and 'professional groups'). The chambers, burdened with the major part of the administrational issues, are organized in departments, some of them distributed over regional district bureaus. The professional divisions are governed by elected honorary officials and managed by employed secretaries. For an overview see figure 2.1.

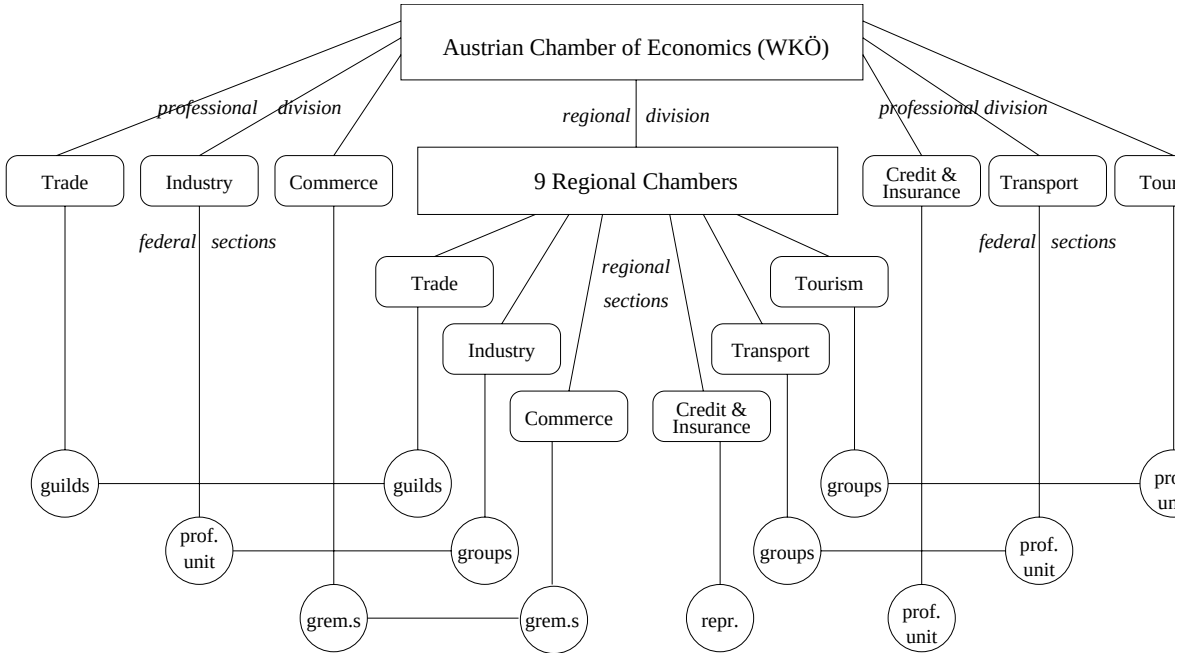


Figure 2.1: Organization of the Austrian Chambers of Economics

With respect to the professional divisions, both the Austrian Chamber of Economics (WKÖ) and the regional Chambers (WKs) consist of six socalled ***sections***, namely ***Trade, Industry, Commerce, Finance-, Credit- and Insurance Affairs, Transport and Tourism***. WKÖ comprises about 130 professional units, in general corresponding to professional groups on the regional level. Groups within the trade section are called ***regional and federal guilds***, respectively; regarding the commercial sections, they are called ***regional and federal gremiums***; within the regional sections of finance-, credit- and insurance affairs, they are called ***professional representatives***.

Professional groups and ***units*** are legal entities on its own. They have to pursue the interests of their particular branches, such as constructing engineers, glaziers, carpenters, electrical engineers, chemical industry, food trading, banking, forwarding agents, restaurants, etc.

The sections have to act for and to balance the interests of the various branches they comprise. On the chamber level, again, the matters common to all members have to be coordinated and divergent professional interests of subunits have to be balanced and harmonized. The WKÖ, finally, coordinates the matters concerning the entire Austrian economy.

3. The Business Process *Bill Appraisal*

Besides of regional bills and decrees no less than about 1000 federal bills p.a. have to be appraised by the Chamber organization. This leads to a substantial effort furnished by about 600-700 persons. In detail, the opinion on a given federal bill is formed on a federal basis: A large number of experts (belonging to or related with organizational units that are affected by the respective bill) throughout the organization is asked for their opinions. These are collected and brought together at the different levels of the organization. Obviously, this necessitates a procedure that provides for one and only one statement of the whole organization and does so within a given time schedule. This procedure is a democratic one and pertains to the basic concepts of the chamber system. It therefore is called ***balance of interests***.

For federal bills the main steps of that process actually are the following (see fig. 3.1):

Departmental distribution within WKÖ:
WKÖ receives the draft of a federal bill from the responsible federal ministry. It transmits that draft to its competent department (such as the department for social policy), to the federal sections and to professional units.

Federal distribution:
The competent WKÖ department then transmits the bill text together with additional information (identification key, distribution list, context of the bill, background information etc.) to the corresponding departments of all local chambers. The federal section and the professional units forward the bill to their corresponding sections and professional groups in the local chambers.

Regional distribution:
Within each WK the bill is distributed to the competent department, then to the competent section(s), subsequently to the competent professional group(s) and finally to the district departments and to the members.

Obviously, distribution must not always be effectuated throughout all these levels (and in fact is not) but may be interrupted at any level. On the other hand, at any of these distribution levels additional information may be enclosed.

Formation of opinion:
Any unit of the organization is free to consult (external or member) experts in the course of its opinion forming process. The formation of the common opinion starts at the final level of distribution. In the case of district department and member level, the opinions are collected either in written or in oral form and are put together into an appraisal by the manager of the respective professional group. This appraisal, which must always be written down, is forwarded by the manager of the professional group to the superior section.

On the level of the sections and of the departments the process of opinion forming is repeated on the basis of appraisals they received (consolidation of opinions). It is important that any appraisal is signed by the manager of the respective unit. The professional group and the section of the local chamber likewise forward their (consolidated) appraisal to the respective federal section and the professional unit.

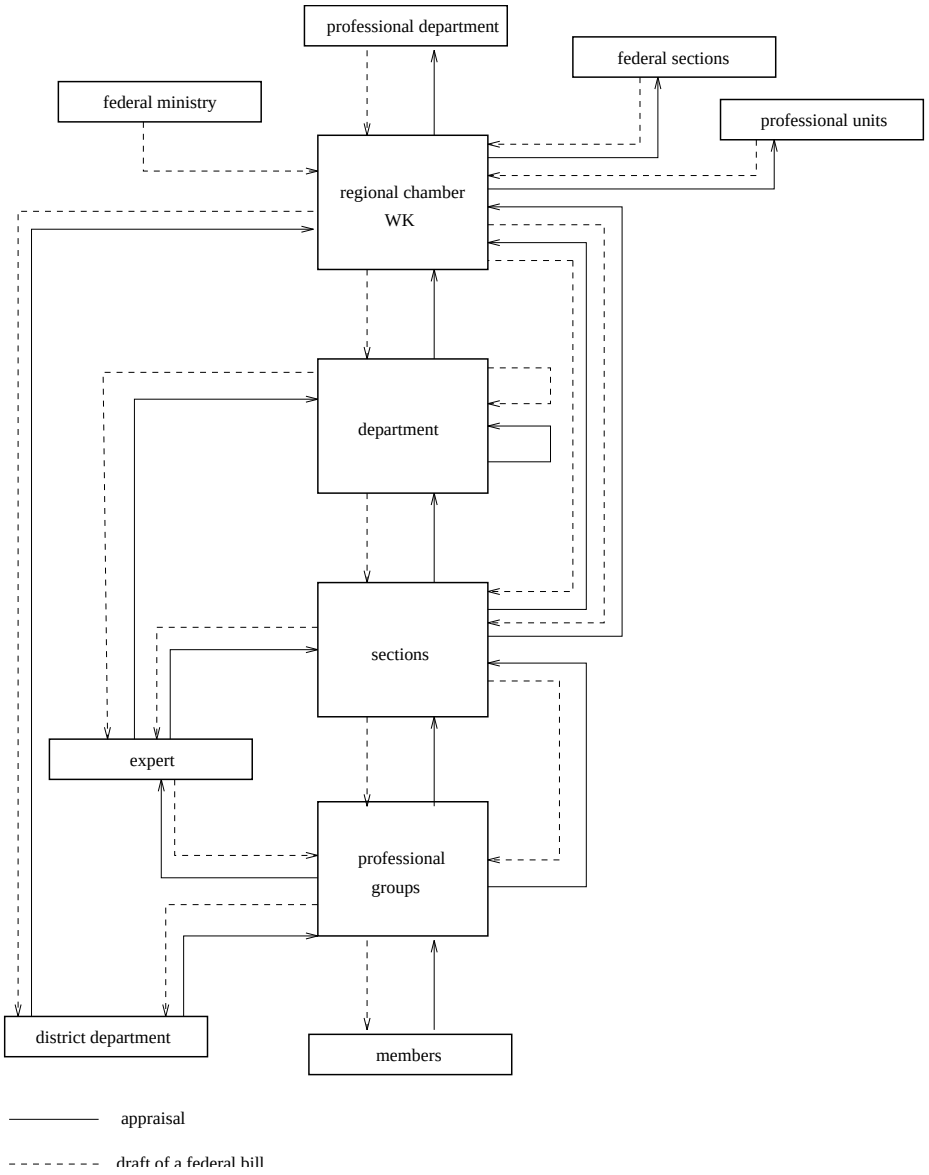


Figure 3.1.: Document flow for Bill Appraisal

A crucial point of this process is the deadline by which the appraisal has to be transmitted to the sending ministry. Therefore, in each distribution step, the distributing unit again sets a deadline to the receiving ones. It may occur that an organizational unit gets into difficulties to meet the given deadline and therefore requests the superior organizational unit for an prolongation. Either the latter is in a position to grant such an prolongation itself or it must forward the request up to the next level. If no prolongation is granted and/or in case of substantial lack of time no appraisal will be obtained from the requesting unit.

It should be clear by now, that computerizing this process on the basis of a workflow system might allow for substantial savings in pass through times and administrational efforts. It is not at least for that reason that we choose it to be investigated within our study.

4. Object oriented business process modeling

There are two approaches to view an organization when using object oriented modeling concepts: A *structure-oriented* and a *behavior-oriented* approach. The first one corresponds to the classical system theoretic approach [KKM93] (that has been adopted by most of the methods of object oriented analysis), i.e., to view a certain universe of discourse (UoD) as a system of interrelated agents that cooperate to reach the common system goals by interchanging flow entities (e.g. messages). As a consequence, business processes are not modeled explicitly as objects on their own but are derived from sequences of object activities and message passing actions.

In contrast to that, the behavior-oriented approach considers business processes on their own [MHH93, FS94] by viewing the dynamical aspects of an organization as a system of business processes. Within this context, a business process my be seen as a bundle of goal directed *actions* that are performed by *actors*, i.e., the organizational units. The actions have causal and temporal interdependencies and are performed sequentially and/or concurrently.

Commonly, a business process is expected to have a defined result, e.g. some document(s), events etc.. In the course of an action job orders and/or messages are exchanged between the actors involved [FS93b]. This, usually, is done using documents of any appropriate kind. The documents which are affected by a given business process may be seen as interrelated [Sc92b].

Organiszational units are the active elements within an organization. When performing an action it does so in order to accomplish one or more *tasks*. Depending on its nature the accomplishment of a task might be fully or partly automated using technical support like machines, information systems etc. [Sc91a].
Similarily, we may distinguish business processes corresponding to the degree as to which their execution can be determined (e.g., in the sense of proceduralization). A purchase process, e.g., might be fully specified without free hand to its actors whereas a trading process might leave unpredictable decisions to its actors and therefore is not completely determined.

In general, a business process may not be completely determined, whenever units are involved to it which are authorized to decide on and/or to "invent" the concrete action to perform. A method for modeling business processes, therefore, has to allow for that kind of indeterminism.
Even if not made explicit, as is done for example in [SST93], OOA methods do so because of their

(common) fundamental abstraction concepts that may be applied inversely during a modeling process (generalization/specialisation, aggregation/decomposition).

What we want to discuss within this paper is to which extent such methods may be used to model organizations and their behavior from both viewpoints mentioned before. This is done by using, as an example, one of the most popular OOA methods, namely the Object Modeling Technique (OMT, [Ru91]) and applying it to the restricted miniworld of Bill Appraisal within the Austrian chamber of economics organization.

OMT offers concepts to describe a system from three different but related viewpoints, each capturing important aspects of that system.

The *object model* captures the static aspects of the system by defining the objects, their structure and their interrelationships. It's graphical representation is done using a so-called *object diagram* which contains, similarly to entity relationship diagrams, representation concepts for classes, associations (relationships), attributes, multiplicities, generalizations and aggregations.

The *dynamic model* covers the behavioral properties of the system by means of finite state automata with input which are graphically represented using so-called *state diagrams*. Finally, the functional model defines, on a non-procedural level, the activities of the active elements (the objects), i.e., it describes, what the system does. Data flow diagrams [Yo89] are used for their representation.

Despite of some deficiencies (see, e.g., [KKM93]) OMT allows for a comprehensive conceptual design of important UoD aspects thus providing a basis for the next step in oo system development, i.e., object oriented design (OOD).

5. Conventional Approach using OMT

Within this section we sketch the conceptual model of the Bill Appraisal miniworld using OMT. Of course, only a simplified version fits into this papers limited space. In particular, we disclaimed, from the static model, the introduction of any object attributes. The dynamic model is restricted to the state automata of the most important objects that are involved in Bill Appraisal, e.g., organisational unit, manager and typist.

The complete model is documented in [Ba94]. The pictures have been produced by using OMTool, a software product of the General Electrics Company.

Figure 5.1 shows the main structural object, namely *organisational unit*, with its relationships to bills to appraise (*delegation*), returned opinions and involved persons. Organisational units may be sub- or superunits of others (hierarchy). As a consequence the *delegation* and *return* relationships each express that forwarding bills and returning opinions always involve a super-and a subunit. There is no way in OMT to express that, e.g., a *delegation* instance only might relate units that are related by a *structure* instance, too.
More generally, relationships between relationships are not covered so that additional consistency constraints have to be introduced. For reasons of simplicity such constraints are omitted within this paper.

A conceptual schema of the behavior of managers with respect to Bill Appraisal is given in figure 5.2. At first glance, this state diagram looks confusing, a problem that could be avoided by consequently using abstractions like generalization and aggregation and/or dynamic user interfaces. For the purpose of the paper, however, we had to put it onto one single page.

Note that alternatives of the course of action of Bill Appraisal come up as different state transitions of managers. To a smaller extent this is also true for organisational unit and secretaries. Trivially, it should be possible to interrupt a manager for emergency calls and exception handling when being engaged in Bill Appraisal activities.

That, again, has been omitted for simplicity just like all the work manager do when not involved in Bill Appraisal; after all, managers are supposed to never being 'idle' ....

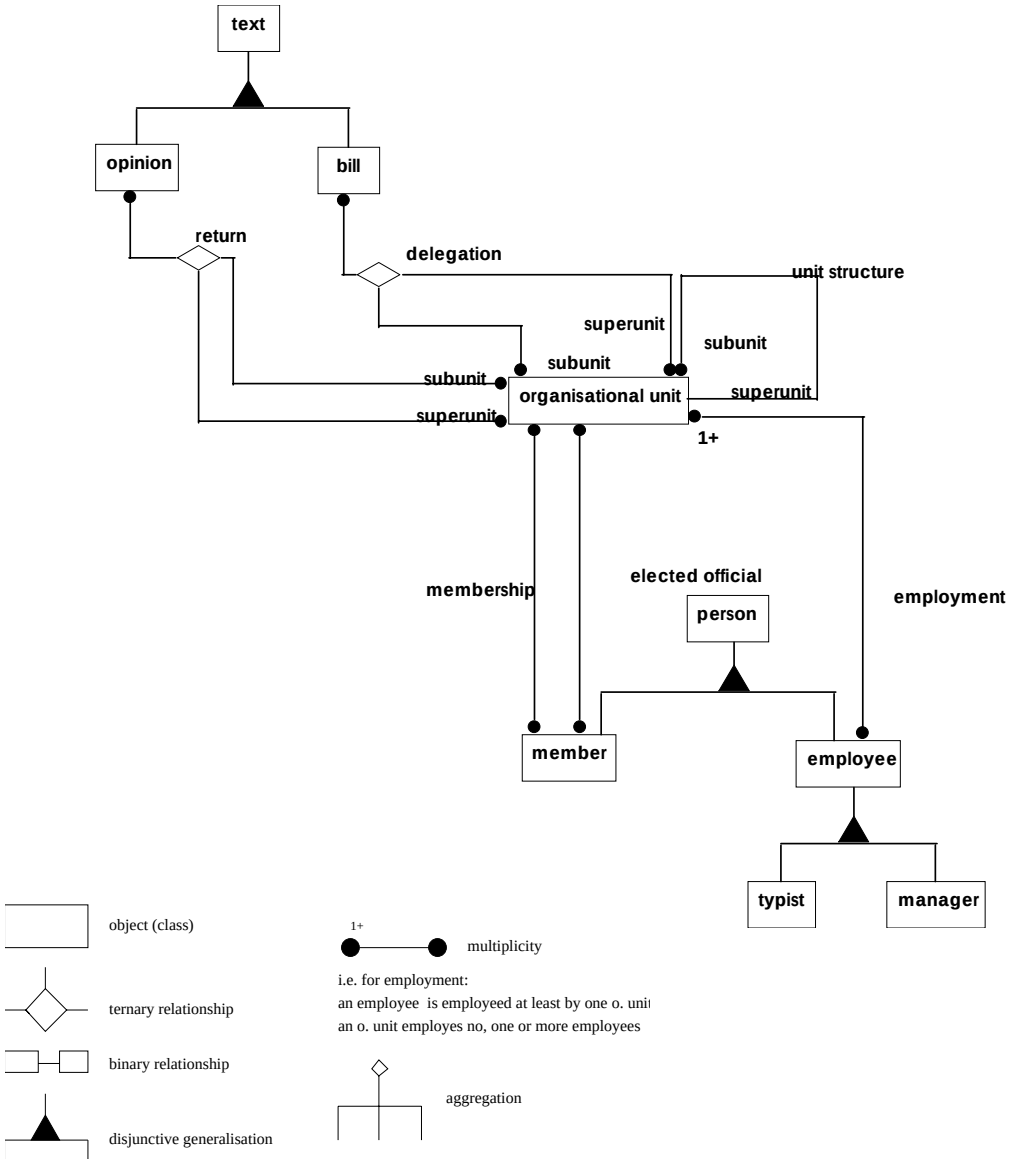
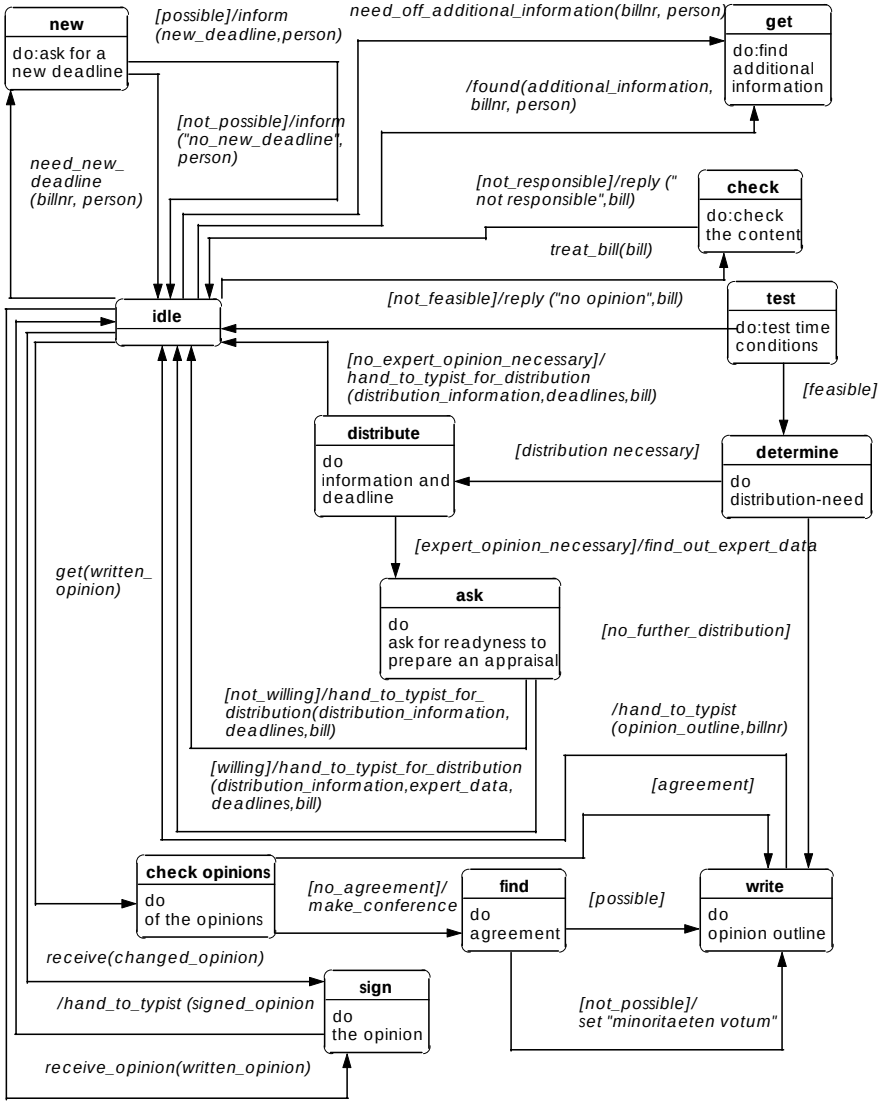


Figure 5.1: Conventional approach, static model



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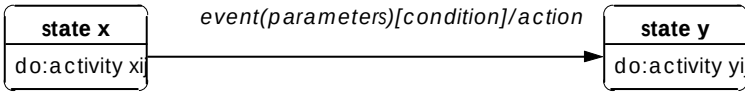

Figure 5.2: Conventional approach, state diagram of object manager

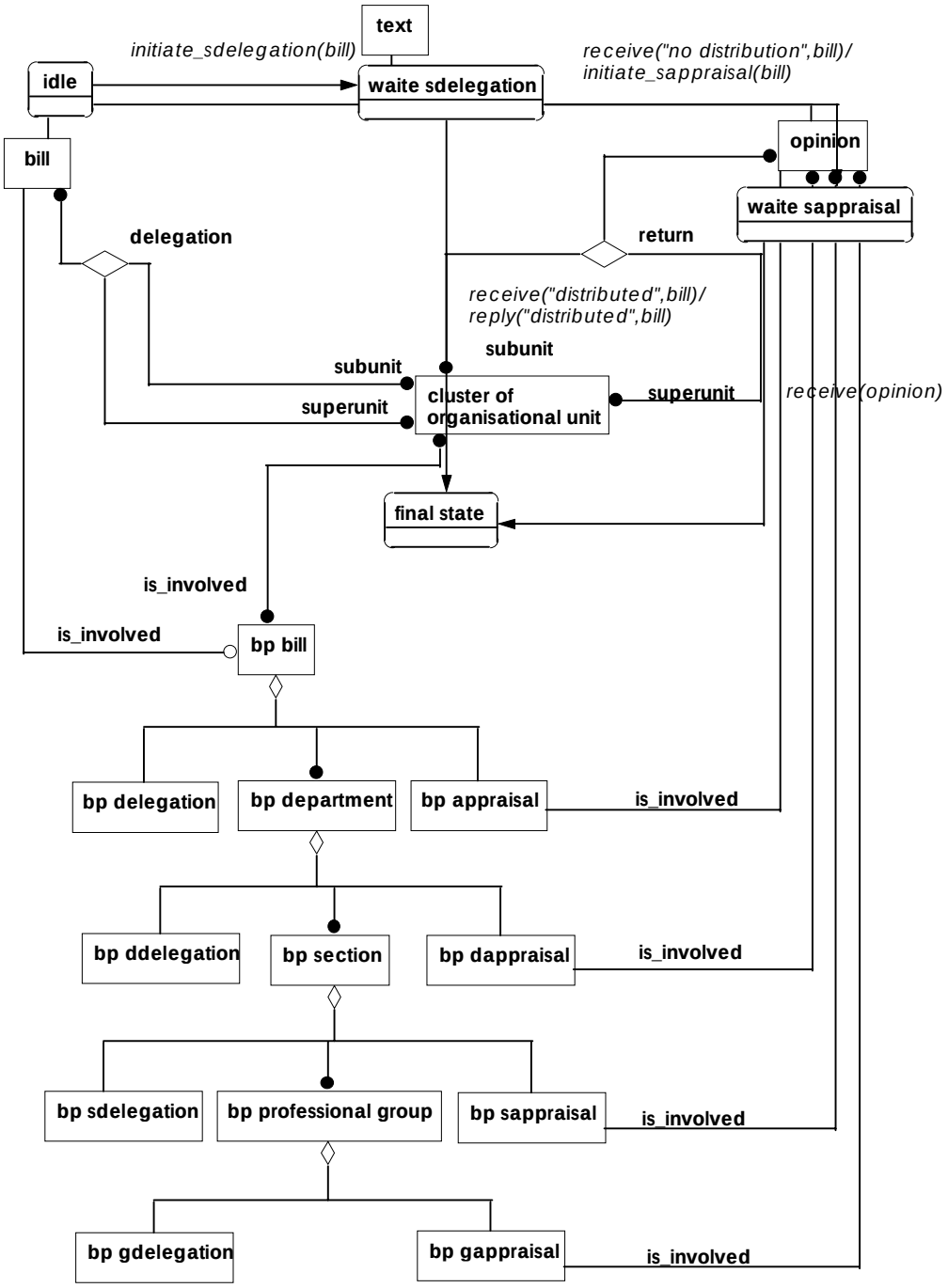

Figure 6.1: The object bp bill

6. Business process oriented approach using OMT

We now proceed to view business processes as objects on their own. This leads to an extension of the static model (figure 5.1) by an object (class) *bp bill* as shown in Figure 6.1. Since Bill Appraisal may be modularized into subprocesses following the organizational levels of the Chamber Organization a decomposition hierarchy has been introduced in our static model. This leads to very simple dynamic models of the 'module processes', see figures 6.2 -6.4 for the state diagrams of the top level processes bp department, bp delegation and bp appraisal. The diagrams for the lower level process may be derived analoguously. Note that the Chambers business rules for Bill Appraisal now are associated with the process itself and not spread over the behavior of the actors involved.

Figure 6.5. illustrates this fact: the managers state diagram now does contain any 'control structure element' with respect to Bill Appraisal: He makes decisions and 'tells' them to the process (by message passing).

Again, the presented schemata are incomplete. E.g., the static model should specify that an opinion is formed by one and only one appraisal bp. As has been mentioned already this OMT has no modeling concepts to cope with restrictions concerning relationships between relationships, so that additional consistency constraints would have to be introduced.

The state diagrams do not contain names for events if these may be trivially derived from the corresponding state.

On the basis of the foregoing comments, the introduction to Bill Appraisal given in sections 2 and 3, and the legends of figures 5.1 and 5.2 the schemata should be understandable without detailed explanations.

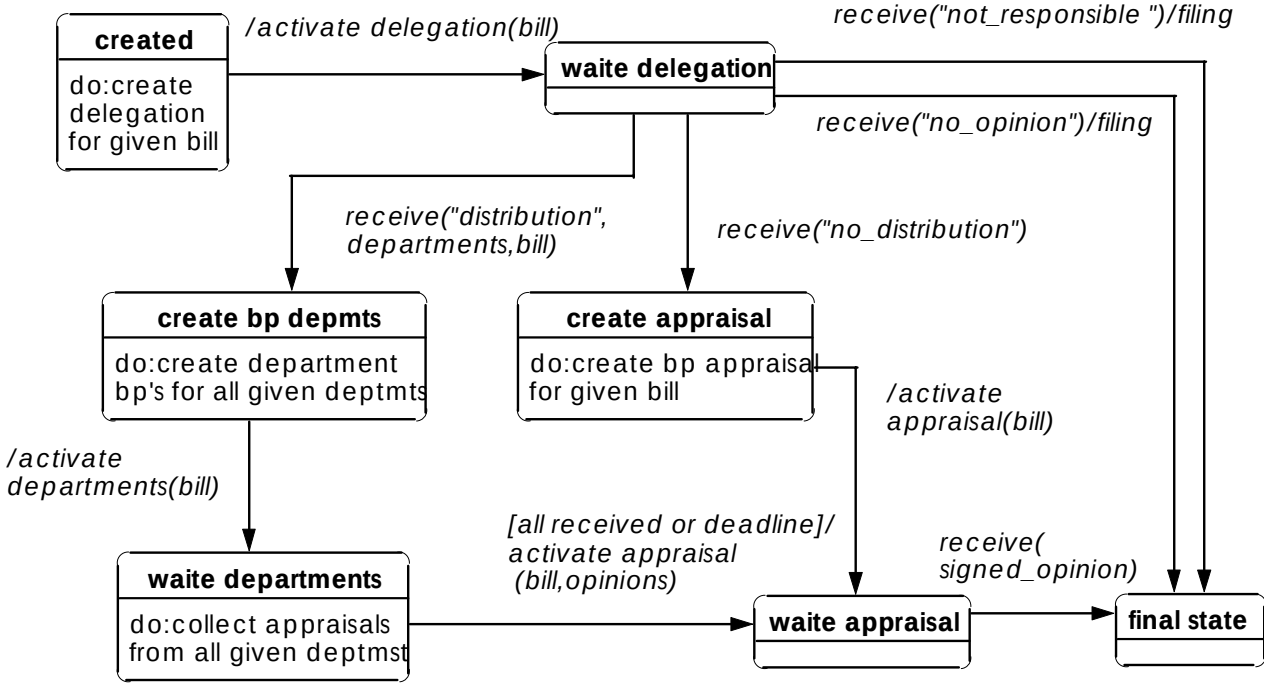

Figure 6.2: State diagram of bill

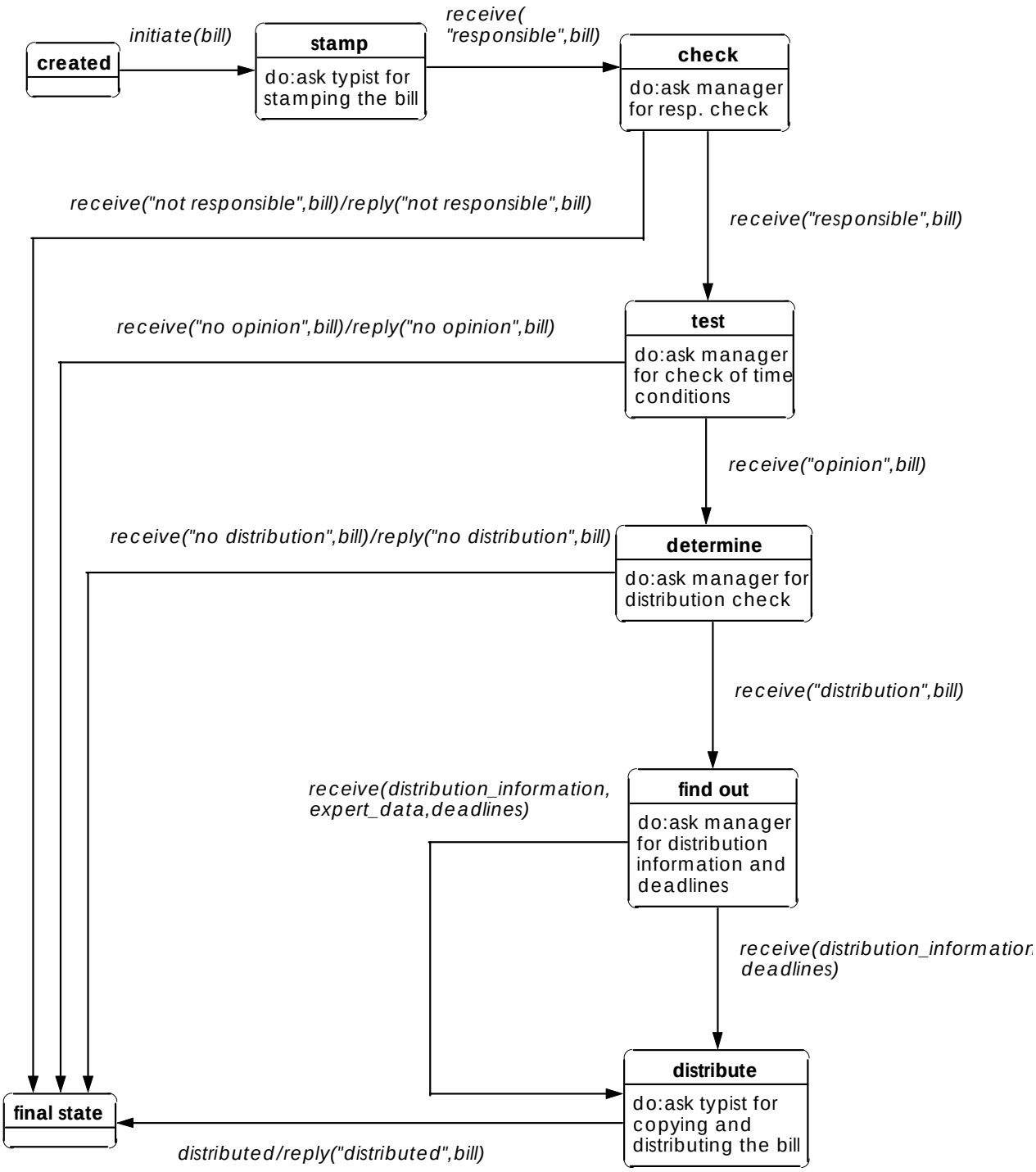

Figure 6.3: State diagram of bp delegation

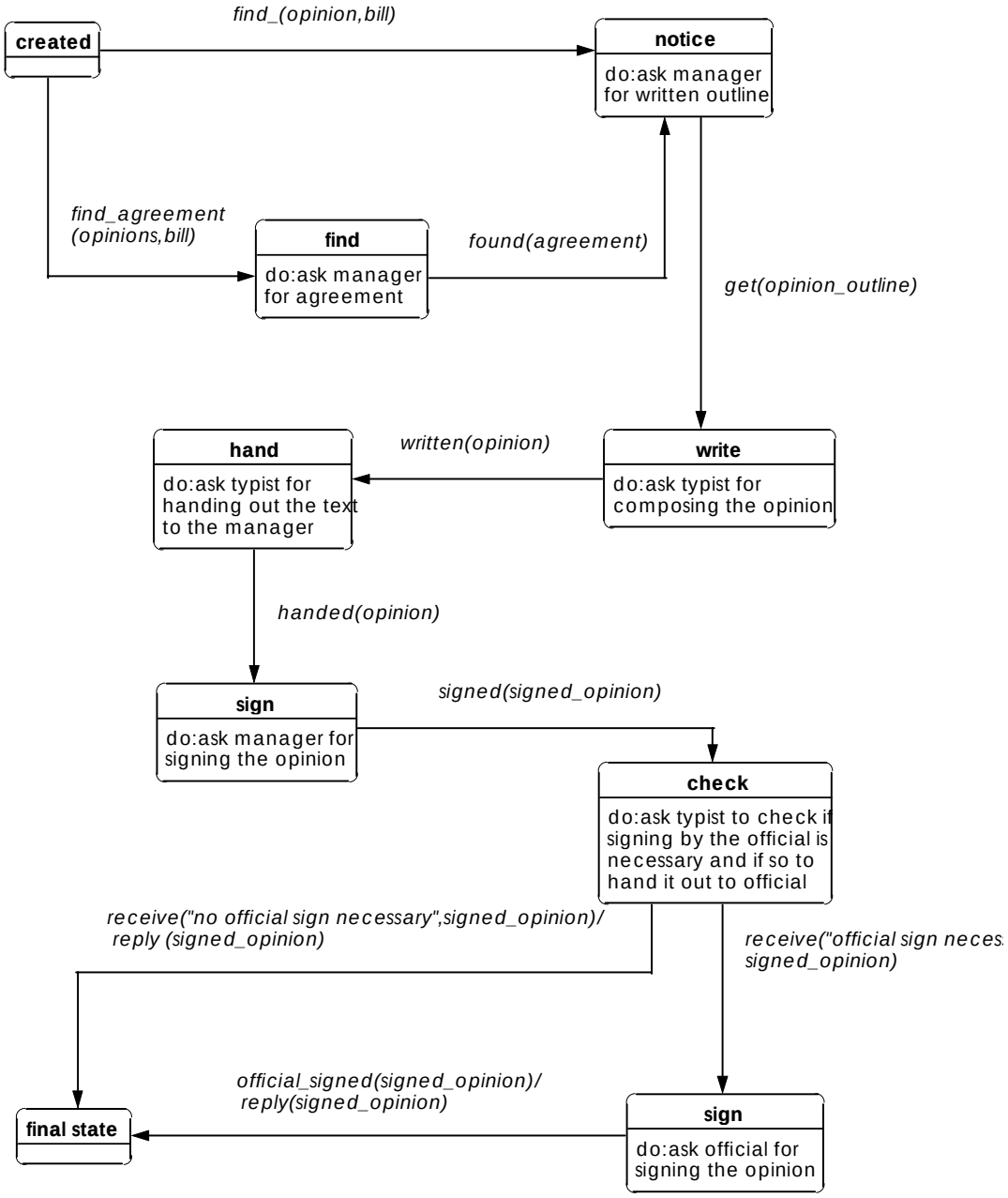

Figure 6.4: State diagram of bp appraisal

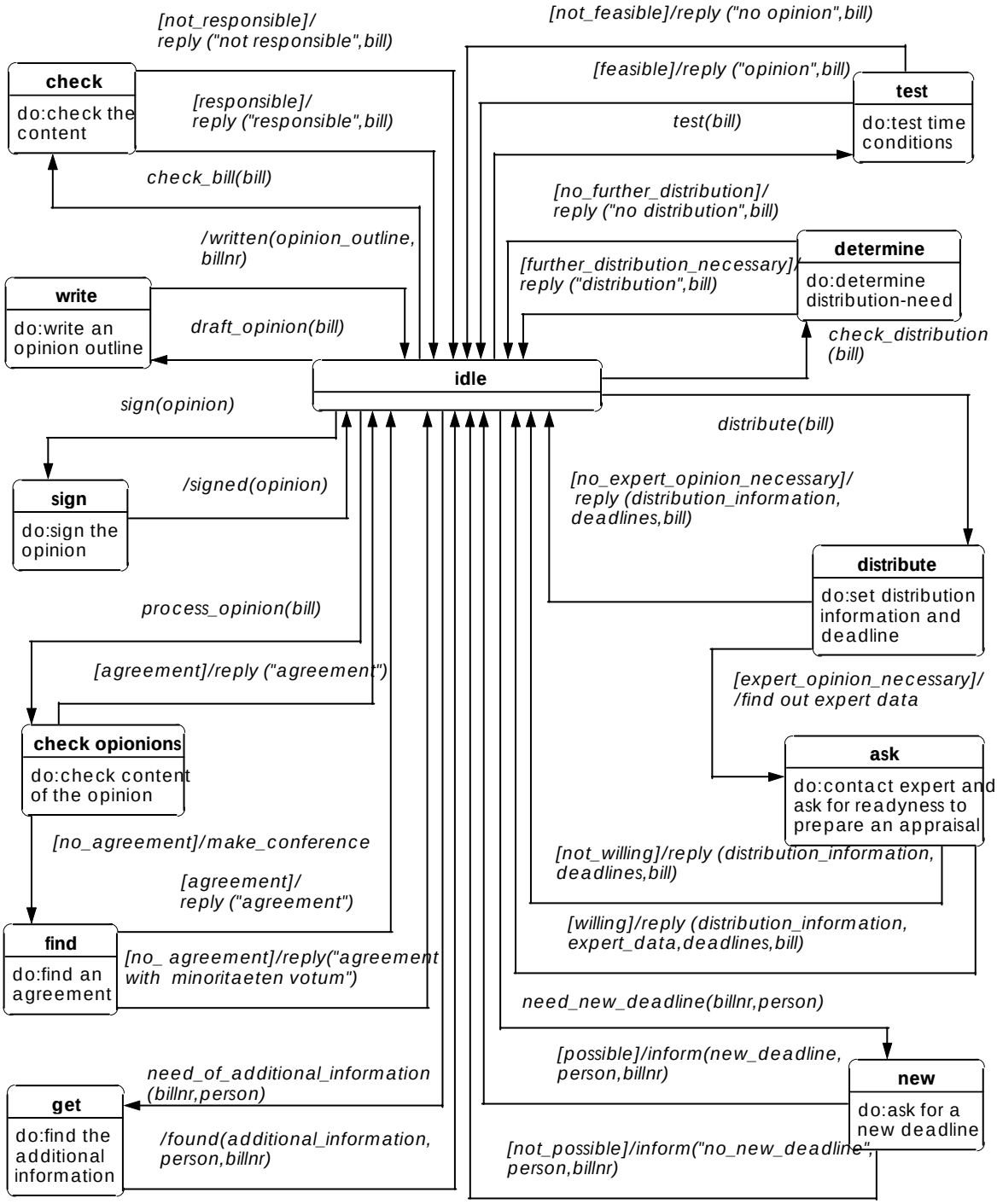

Figure 6.5: State diagram of manager, bp oriented approach

7. Summary

The example discussed within this paper suggests that enterprise modeling using a business process oriented approach leads to comprehensive but less complex models than other approaches do. The main reason for that seems to be the fact that modeling business processes as objects on their own allows to capture the control logic of a business process more naturally than by mixing it into the behavior specifications of the actors involved. Trivially, such an approach needs to rely on an object oriented design method. The study shows, that OMT, a popular OOA method, may be a candidate for that purpose. However, user defined consistency constraints are necessary for really complete designs because of some deficiencies of the modeling concepts offered by OMT. Our experiences with a couple of other OOA methods [K^4M94] show that this critique my be generalized to all methods we investigated.

A (intended) side effect of our study is the fact that its results enter into a business process reorganization project of the Austrian Chambers of Economics.

Actually we are investigating the practicability of SOM [FS93b] within the given universe of discourse. Further research is dedicated to the integration of organizational and operational issues of enterprise modeling on a more fundamental level incorporating results of modern organization theory. For first results see [Ko94].

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