

# The Atoms, Molecules and Fibers of Organizations

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**Abstract.** The increasing demands concerning the modifiability and connectivity of business processes cannot be met adequately anymore by relying on best practices only. There is an urgent need for a reference conceptual framework for studying, modeling, analyzing and designing business processes. The Language-Action Perspective (LAP), in particular Habermas' theory of Communicative Action offers a sound and rigid foundation for such a framework. In this paper, the DEMO-framework is presented. It builds on the LAP-based theoretical foundation of the DEMO methodology (Demo Engineering Methodology for Organizations). Several other LAP-based frameworks have been proposed in the past years. They are evaluated in a comparative review with the DEMO-framework. Several shortcomings of these frameworks are revealed and discussed. The practical applicability of the DEMO-framework is demonstrated using a small example.

**Keywords:** Business Process, Communicative Action, Conceptual Modeling, Modeling Framework

## 1 Introduction

The implementation of ICT-applications in organizations all over the world has not only lead to an improved performance of their business processes, but also to increased demands concerning the agility of organizations and the consequent modifiability of the business processes. In order to survive in the dynamic and global business context, it has become imperative that a company is able to easily adapt its product and service assortment to the changing market needs. Otherwise said, a company must be able to evolve smoothly. This is currently a major problem. An other major problem is that a company must be able to enter easily into temporary or permanent alliances with other companies. Examples of those alliances are material supply chains and health care networks.

Both problems can only be addressed adequately if business processes can be easily modified as well as easily connected to each other. These requirements however cannot be met in a cost-effective way if the analysts and designers of business processes continue to rely mainly on best practices instead of sound theoretical achievements. There is a common agreement that sound solutions are module- or component-based. There is an urgent need for a conceptual framework for studying, modeling, analyzing and designing business processes that has the potential of becoming a reference framework both for practical applications and for the development of knowledge. The Language-Action Perspective (LAP) [2,8,13,15,19] offers an appropriate theoretical foundation for such a framework, because it brings to the front and clarifies the most elementary building blocks of business processes: the language acts or communicative acts.

The basis for the development of the proposed framework is the theory behind the DEMO<sup>1</sup> methodology for modeling (re) designing and (re) engineering business processes [7,9,10,18]. This theory is summarized in section 2. Only those parts are mentioned that are relevant for the purpose of this paper. The developed framework is in particular based on [11,12,14]. In the subsequent sections 3, 4, and 5, we present and elaborate on three conceptual layers at which the business processes in an organization can be understood. These layers are truly distinct, i.e. the entities in each layer have emergent properties. Analogous to the three layers distinguished in physics (and microbiology), we will speak of atoms, molecules and fibers. The framework is called the DEMO-framework. In two previous papers presented at LAP workshops, Weigand et al. [23] and Lind & Goldkuhl [14] have proposed other LAP-based conceptual frameworks. In section 6, the DEMO-framework is evaluated in a comparative review with these frameworks. Section 7 contains conclusions and suggestions for future research.

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<sup>1</sup> DEMO is an acronym for 'Demo Engineering Methodology for Organizations'. The methodology is primarily meant to demonstrate that Organization Engineering is a sensible and valuable concept, and that a sound theoretical basis can be provided for it.

## 2 Theoretical foundations

### 2.1 Communication

The common core in all definitions of the notion of organization that one can find in the literature is that an organization is a system of human beings with a particular purpose or mission. We take this common core as our starting point, but we make two accentuations. First, we take the purpose or mission of an organization for granted. Put differently, we adhere to a purely ontological point of view instead of a teleological one. Matters like purpose and mission do rightly and only belong to a teleological definition. Second, we highly support the meticulous distinction between system categories as put forward by Bunge [4,5]. In particular, we will not include in our definition of organization things like means and tools; we regard these as only supporting human beings in fulfilling their organizational roles. As Bunge points out, human beings are entities in different categories at the same time, e.g. they are physical entities, biological entities, and social entities. Otherwise said, human beings can be classified in different system categories. These categories should be thoroughly understood and carefully distinguished when trying to understand how human beings constitute organizations.

The single assumption on which DEMO is founded, is that the communication between human beings in organizations constitutes a necessary and sufficient basis for developing a theory of organizations. It means that we consider organizations to be systems in Bunge's category of social systems and thus regard human beings (which are the elements of these systems) in their manifestation of social individuals. Consequently, we abstract from the biological, chemical and physical nature of human beings, at the same time being aware that these human manifestations are necessary preconditions for the social manifestation. We also abstract from the technical aspects of the production of goods. Only the results of production activities are taken into account.

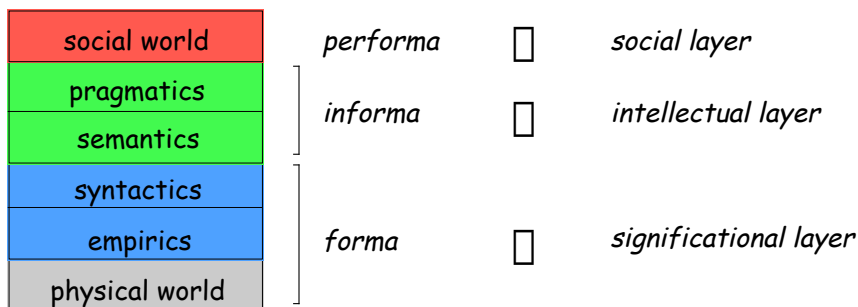


Figure 1: The semiotic aspects and the corresponding layers of communication

The scientific field of semiotics [21,22] provides a layered structure of aspects of communication, as exhibited in figure 1. For our purpose, we make some simplifications, which are shown in the right part of the figure. We take the aspects empirics and syntactics together as the *forma* perspective, and we include for the sake of convenience also the physical aspect of communication (the substance that carries signs). So, by taking the *forma* perspective on communication we mean that one (only) considers properties of the form. We also call it the *significational* layer of understanding, the layer at which one is aware of dealing with signs but without considering their meaning (yet). Next, We take the aspects semantics and pragmatics together as the *informa* perspective (the name refers to what is *in* the form). Now we are (only) concerned with the content or the meaning of signs. (Note. Contrary to other explanations one can come across, we consider pragmatics to be about the context and culture dependent usage of language constructs for conveying the intended (semantic) meaning, not about social effects). We also call the *informa* perspective the *intellectual* layer of understanding. The aspects dealt with so far originate from the traditional field of semiotics. The contribution of the Language/Action Perspective on communication is that it adds the important aspect of the social world in that it considers communication (also) as social action. This layer is also recognized by the branch of semiotics, called Organizational Semiotics [21]. Taking the *performa* perspective on

communication (the name refers to what one achieves *through* the form) means focusing (only) at these social effects. This perspective is therefore also called the *social* layer of understanding.

## 2.2 Organization

Rooted in the generic system definition as proposed by Bunge [5], we define an organization as a *social system*, i.e. a system of which the elements are social individuals or *subjects* who perform two kinds of acts: production acts (or P-acts for short) and coordination acts (or C-acts for short). By performing *production acts*, the subjects contribute to bringing about the goods and/or services that are provided to or delivered to the environment of the organization. A production act can be material or immaterial. Examples of material acts are all manufacturing acts as well as storage and transportation acts of goods. Examples of immaterial acts are the judgment by a court to condemn someone, the decision to grant an insurance claim, and appointing someone president. By performing *coordination acts*, subjects enter into and comply with commitments and agreements towards each other regarding the performance of production acts. The notion of coordination is taken broadly; it encompasses all interaction between subjects in an organization as well as between them and subjects in the environment.

In order to abstract from the particular subject that performs an action and to concentrate on the organizational role of the subject in performing that action, the notion of *actor role* is introduced. It is defined as the ‘amount’ of authority to perform particular acts. In general, actor roles do not coincide with or map straightforward to organizational functions. An actor role may be fulfilled by a number of subjects (concurrently, i.e. the subjects do the same kind of work, as well as collectively, i.e. only together the subjects are able to play the role of actor), and a subject may fulfill concurrently, and of course successively, a number of actor roles. By an *actor* we understand a subject in its fulfillment of an actor role.

The result of successfully performing a production act is a *production fact* or P-fact. Examples of production facts (in the context of a library) are “membership M has started to exist” and “the fine for loan L has been paid”. The variables M and L denote an instance of the entity type membership and loan respectively. Only the facts as such are relevant, not how they are achieved, so we abstract from realization issues. Examples of coordination acts are requesting and promising a production fact, e.g. requesting to become member of the library. The result of successfully performing a coordination act is a *coordination fact* or C-fact. An example of a coordination fact is the being requested of the production fact “membership #387 has started to exist”.

In conformity with the distinction between production acts and coordination acts, we distinguish between two worlds in which each of these kinds of acts have effect: the *production world* or P-world and the *coordination world* or C-world respectively. A state of the P-world is a set of P-facts, and a state of the C-world is a set of C-facts (cf. figure 2). The creation of a fact of some type, e.g. “membership #387 has started to exist”, is a state *transition* in one of the two worlds, in this case in the P-world. A particular transition at a particular point in time (e.g. creating the P-act “membership #387 has started to exist”) is called an *event*.

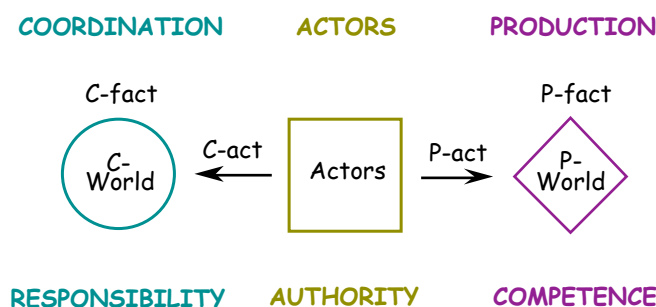


Figure 2 The operational model of an organization

Actors are the motors of an organization. They constantly loop through the so-called actor cycle in which they deal with their agenda (their to-do-list). An *agendum*<sup>2</sup> is a C-fact to which the actor is committed to respond. Depending on the particular agendum an actor is going to deal with, a particular *action rule* is executed. Next to and during dealing with his agenda, an actor can be addressed by another actor as the addressee of a coordination act that the other actor wants to perform. If this act is successful, the resulting coordination fact is added to the agenda of the addressed actor.

In the lower part of figure 2, three notions are mentioned: responsibility, authority, and competence. By *competence* is meant the ability of a subject to perform particular P-acts as well as the corresponding C-acts. Competence becomes primarily manifest in production. For instance, one is plumber or physician or judge by profession, i.e. one has the appropriate knowledge, expertise and experience that are necessary and sufficient for being a professional in a certain field. In order to be able to practice one's profession, it is commonly necessary to be appointed or employed by a corporate body (a company, a foundation, a governmental agency etc.). Through such an act, one gets the *authority* to practice on behalf of that institution. For instance, one is plumber in company X or physician in hospital Y, or judge at court Z. By virtue of the values and norms of the institution one represents as well as by virtue of the general cultural values and norms of the society one is member of, one is expected to exert the granted authority in a responsible way. This is what we mean by *responsibility*. For instance, the plumber is expected to interact responsibly with company X's clients, as is the physician with regard to hospital Y's patients, and the judge with court Z's defendants. Responsibility becomes primarily manifest in coordination.

### 2.3 Coordination acts

A coordination act is an act performed by one actor (called the *performer*) and directed to another actor (called the *addressee*). The generic structure of a coordination act is exhibited in figure 3. The example concerns the request by the subject John towards the subject Mary (who fulfills the actor role of registrar) to become member of the library. For the sake of a simple unique identification of persons being member of the library, we apply the notion of membership. So, every new case of a person becoming member, is conceived as the creation of a new instance of the entity type membership. In the example, the instance created is the one referred to by #387. One of the constituent facts of this membership is that John is the related person (the member).

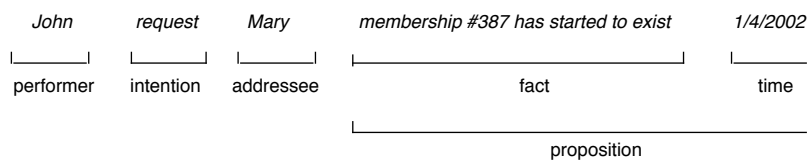


Figure 3 The structure of a coordination act

The *proposition* in a coordination act consists of a fact and an associated time. The *fact* is a production fact. The *time* attribute refers to the time window<sup>3</sup> in which the fact is the case (in which it is said to exist). The exact meaning depends on the intention. In the example of figure 3, its meaning is the requested starting date of the membership. The *intention* of a coordination act represents the 'social attitude' taken by the performer with respect to the proposition. The term is borrowed from Searle [20] and we use it to distinguish coordination acts from communicative acts where the term 'illocution' is commonly used to refer to the 'attitude' of the speaker. Examples of intentions in DEMO are: request, promise, state and accept. They correspond to the distinct illocutions in Habermas' category of regulativa [13]. A further explanation and account of this correspondence can be found in [6].

<sup>2</sup> The word 'agendum' is the singular form of the plural Latin word 'agenda'.

<sup>3</sup> We do not make a distinction between a point in time and a time period. In fact, a point in time is just a mathematical concept. Practically spoken, a point in time always has a duration and thus is a time period. This period however may be arbitrarily short.

Since subjects are not able to read each other's mind, coordination acts have to be brought about in communication, i.e. through a sequence of communicative acts, that goes through all three layers of communication (cf. figure 1). Figure 4 exhibits the typical kinds of acts that have to be executed. We distinguish between performative, informative, and formative acts. The combined square and circle at the top of the figure represents both the coordination act (the square) and the resulting coordination fact (the circle). They are identified by 'i(p)', where 'i' is the intention and 'p' the proposition. Actor A0 is the performer of the coordination act and A1 is the addressee. We take the example in figure 3 to explain figure 4, so the role of A0 is played by John and the role of A1 by Mary.

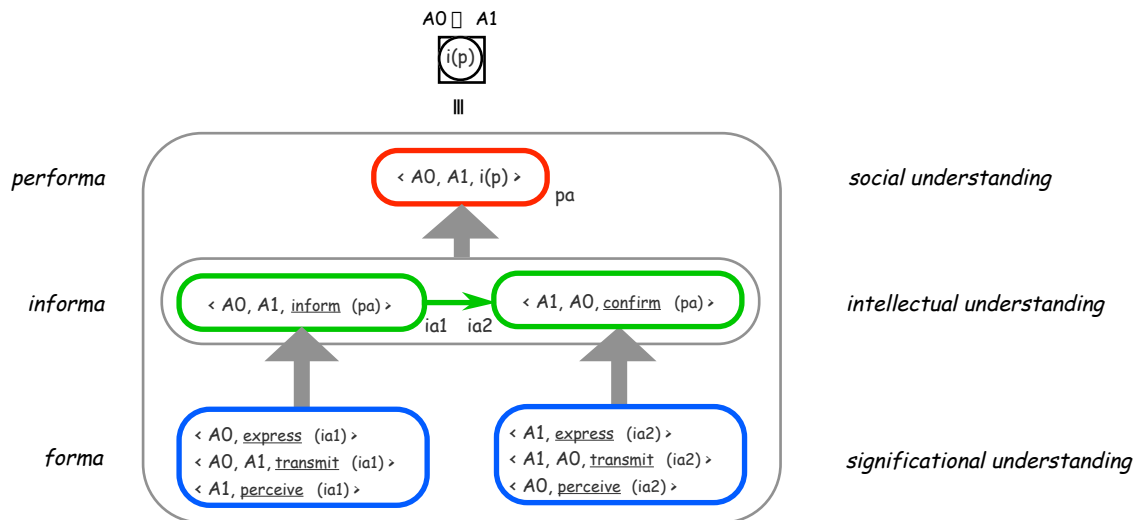


Figure 4 The process of performing a coordination act

One can also read figure 4 as expressing the three conditions regarding communication that must be satisfied for successfully performing a coordination act: the *performa-condition*, the *informa-condition* and the *forma-condition*. By the *performa-condition*, we mean that the social understanding is raised in Mary. In the given example it is the understanding of being committed to respond in a socially appropriate way to the request (i) by John regarding him becoming member of the library (p). The *performa-condition* is satisfied if the performative act, noted as < A0, A1, i(p) > succeeds. Satisfying the *performa-condition* equals guaranteeing the exclusion of social distortion.

A necessary precondition for the *performa-condition* is the *informa-condition*, by which we mean the establishment of the intellectual understanding of the coordination act by Mary. It is satisfied if both informative acts, < A0, A1, inform (pa) > and < A0, A1, confirm (pa) > succeed. Satisfying the *informa-condition* equals guaranteeing the exclusion of semantic and pragmatic distortion. This condition is usually established through so-called *informative exchanges*. Basically, such an exchange consists of the mentioned inform act and confirm act regarding the performative act (pa), but it may also contain a number of question-assertion pairs. Consider for example the next part of a possible talk between John and Mary:

John: *Being a member doesn't seem to be bad.*  
 Mary: *Do you want to become a member yourself or is it for one of your children?*  
 John: *No, I mean myself.*  
 Mary: *Ok, I got what you want.*

The first sentence represents an inform act by John. Mary is however not completely sure about its intended content, and therefore she asks a question (second sentence) to which she gets a definite assertion (third sentence). In the fourth sentence she confirms the inform act. In doing this, Mary also conveys that she understands (intellectually) the performative act.

The *forma-condition* concerns the establishment and well functioning of a communication channel between John and Mary, through which they are able to perform the formative acts that realize their informative acts. Satisfying the forma-condition equals guaranteeing the exclusion of physical, empirical, and syntactic distortion. The forma-condition is often verified by so-called *formative exchanges* between the actors, consisting of utterances like “Do you hear me?” and “Yes, loud and clear”. For example, at the forma-layer, the informative act, noted as  $\langle A0, A1, \text{inform}(pa) \rangle$ , is referred to as ‘ial’. Bringing about this act consists of expressing the content in a sentence by John, transmitting the sentence by John to Mary, and perceiving the sentence by Mary. The particular way of doing and the usage of means at this communication layer are commonly called *communication technology*. If John and Mary communicate face-to-face, the forma-condition is satisfied by the presence of air surrounding them to transport sound waves and by the presence of the sense of hearing in both John and Mary. For other communication channels, other sorts of conditions hold.

A coordination act is considered to be *performed* if the performa condition is satisfied (which implies as we have seen the satisfaction of the other conditions). In that case, the coordination fact is created. The ultimate evidence of the coordination act being performed is provided by the future behavior of the addressee.

## 2.4 Production acts

Performing a production act means bringing about the production fact that is stated in the proposition of a coordination act. As we will see in section 4, this is always done as part of carrying through a transaction. An important issue in the identification and modeling of production acts is the granularity of the ‘product structure’. In principle one is free to choose the granularity one wants. However, this choice has consequences for the level of detail at which one will be able to know and analyze the organization. If one thinks of designing and implementing supporting information systems based on the model, the choice also determines the level of detail at which one will be able to monitor and control the business processes. Usually, there is no problem in determining the granularity level with regard to immaterial production facts. For example, making a diagnosis by a physician is a single undecomposed act. It may be necessary to have a number of physical examinations done and to do a number of inquiries in the patient’s history etc. Commonly, however, this remains surveyable. With regard to material acts, things may easily get out of hand. For example, in a manufacturing context, one may go down to the level of the ‘bolts and nuts’ in specifying P-facts. The relevant question then is whether one is really interested in knowing, monitoring, controlling etc. the business processes in such detail. Regarding both material facts and immaterial facts, one has to make a sensible choice in practical situations. All details left out from the model by that choice could be added informally by means of *work instructions* as comments to the action rules. This is also a common practical solution.

## 3 The atomic layer

As was explained in section 2, we make a distinction between coordination acts and production acts. Coordination acts are always, either directly or indirectly, about production acts or, more precisely, production facts. For example, one may request, promise, state and accept the production fact “the goods of customer order #1445 are shipped to the customer’s delivery address”. This is a material fact, which can only be brought about by a material act, viz. the transportation of physical items from one location to the other location. However, one may equally well request, promise, state and accept the production fact “Fernando Flores has got the best paper award of LAP’02”. This is clearly an immaterial fact, to be brought about by an immaterial act. This act then is the decision, or the judgment if one likes, by presumably a jury that has got the authority from the LAP community to take this kind of decision. The important point now is that this jury may take the decision as expressed above but not state that it has taken the decision. Although this situation makes not much practical sense, it is important from the theoretical point of view, because it clarifies the distinction between (immaterial) production acts and coordination acts. Only if the jury *states* (coordination act) the fact that Fernando Flores has got the best paper award of LAP’02, and only if subsequently the fact is *accepted* (by the LAP community as the original requester), does the fact become a real fact. It does so because the

jury has exerted its authority in a socially responsible way (which is endorsed in the acceptance act by the LAP community). These are the necessary and sufficient conditions for making immaterial facts come into existence. Suppose for example that the LAP community rejects the statement of the jury (for whatever reasons). In that case, the production fact does not come into existence, i.e. Fernando Flores has not got the best paper award of LAP'02.

What about material facts? When do they come into existence? The answer is quite simple: in the same way as immaterial facts do. This may sound astonishing at first sight but it is nevertheless true. To explain it, let us return to the material fact: "the goods of customer order #1445 are shipped to the customer's delivery address". Suppose that the producer of this fact, presumably some expedition firm, has moved the goods to the correct location. Contrary to immaterial acts and facts, such a material act and fact can be observed by people (with or without the help of artificial sensory devices). At least that is how it seems to be for many people. However, how can one be sure that the physical items that are dropped at the customer's location are the goods of customer order #1445? In addition, who is going to assure this? Quite obviously, the transportation cannot be assured by some passer-by who happened to see the dropping of the physical items. However, it can also not be assured through the mere observation (of the objective fact) by the customer or by the expeditor. It needs more; it needs similar coordination acts as were needed for the immaterial fact. In other words, there must be a statement by the producer of the fact (the expeditor) and there must be an acceptance by the requester, i.e. the supplier of the order (Note that the customer who ordered the goods does not participate in this process. This will be elaborated in section 7).

It appears that what people commonly call a material act/fact is mostly the combination of an immaterial act/fact and a material act/fact. The confusion is caused by terms like delivering and buying. When one buys e.g. a loaf at the bakery's shop, the fact one wants primarily to come into existence is the property of some loaf. Because the act of handing over the loaf physically by the baker counts as stating that the property is transferred [19,20], the 'transportation' act and the statement now seem to be one and the same action. A similar reasoning holds for taking the loaf and accepting the property transfer. Clearly, the most important act/fact is the property transfer, and clearly, this is an immaterial act/fact. Let us now look at buying a car or a house. The only important difference with buying a loaf is that you do not hand over cars and houses. Instead, you 'point to' the car or the house, i.e. you somehow uniquely identify the particular car or house that the purchase is about. In order to enjoy the benefit (in juridical terms: the usufruct) of the purchased thing, it is mostly necessary to physically move the thing, as is the case with the loaf and the car (the only logical exception are the immovables). So, in the case of buying a loaf, there is not only the property transfer, but there is also the transportation of the loaf. Only because it is mostly considered a non-relevant detail, it is neglected as a separate act. This act is however of the same nature as the shipping of the goods of customer order #1445.

The conclusion so far is that there is a principal distinction between coordination acts on the one hand and (material or immaterial) production acts on the other. There is not so much a principal distinction between material and immaterial acts. Regarding the creation of production facts, we have seen that the moment at which they come into existence, is not the time of performing the production act but the moment at which the corresponding acceptance act is performed. Therefore, we consider the coordination acts as *atoms* of organizations.

There is a second kind of atomic building block in an organization, directly related to coordination acts. The performance of a coordination act, and consequently the establishment of a coordination fact, is the result of executing a certain action rule. As explained in section 2, an actor constantly loops through its agenda. Every actor cycle starts with selecting the next agendum to deal with (recall that an agendum is just a coordination fact). Dealing with an agendum comes down to making a choice out of a set of possible acts and performing that act. Which possible acts there are and how the choice has to be made, is contained in an *action rule*. There is a specific action rule for every agendum. Figure 5 exhibits as an example three action rules that regard the creation of memberships in a library. A pseudo-algorithmic notation is used to specify the action rules. The example corresponds with figure 8.

actor	agendum	action rule
A1	on <u>requested</u> T1 (M)	<b>with</b> P is member of <u>new</u> M <b>do</b> <b>if</b> age (P) > minimal age for membership <b>and</b> number_of_members < maximum_number <b>then</b> <u>promise</u> T1 (M) <b>else</b> <u>decline</u> T1 (M) <b>fi</b> <b>od</b>
A1	on <u>promised</u> T1 (M)	<b>do</b> <u>request</u> T2 (M) <b>with</b> fee (M) is remaining_fee (M) <b>od</b>
A1	on <u>accepted</u> T2 (M)	<b>do</b> <b>if</b> <u>promised</u> T1 (M) <b>then</b> < <i>decide to start membership M</i> > <u>state</u> membership M has started <b>fi</b> <b>od</b>

Figure 5 Examples of action rules

The first action rule regards the being requested of the start of a new membership (M). It specifies that the addressed actor may promise to start the membership if the associated member is old enough and if the maximum number of members has not been reached yet. Otherwise, the actor should decline the request. The second action rule regards the being promised of the start of a new membership. It specifies that first the membership must be paid for. The amount to be paid is a derived fact, referred to by ‘remaining fee’. If the payment is settled, the production act ‘decide to start membership M’ is performed, which is stated thereafter towards the requesting actor. This is contained in the third action rule, for which the agendum is the event ‘accepted T2(M)’. In order to exclude the occurrence of such an event without the being promised of T1(M), this condition is added to the action rule.

Executing an action rule means eventually performing exactly one coordination act, resulting in exactly one coordination fact. Performing this coordination act may have been preceded by the performance of other acts, including a production act. These are however indivisible parts of the action rule. Therefore, we consider action rules as the second kind of *atoms* of organizations, next to coordination acts. Every action rule applies to exactly one type of coordination fact and is executed by exactly one actor, namely the actor for which the C-fact is an agendum.

In order to avoid any misunderstanding about the concept of coordination act, we transform the provided narrative definition in the EBNF-notation (Extended Backus Naur Form) below. For the sake of conciseness, the notion of C-fact (the result of a successful C-act) is defined instead of the C-act. The terminal terms are italicized for clarity.

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< C-fact > ::= < performer > < addressee > < intention > < proposition >
< performer > ::= < actor >
< addressee > ::= < actor >
< intention > ::= request | promise | state | accept |
                 decline | quit | reject | stop |
                 cancel | allow | refuse
< proposition > ::= < P-fact > < time >
< P-fact > ::= < elementary state of affairs in the P-world >

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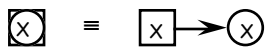
Similarly, we express the definition of action rule in EBNF:

$$\langle \text{action rule} \rangle ::= \langle \textit{guideline for dealing with a particular C-fact type by the actor for whom this C-fact type is an agendum type} \rangle$$

## 4 The molecular layer

Coordination and production acts appear to occur in particular patterns, called interactions. Up to now only one kind of interaction is considered in DEMO, namely the transaction. A *transaction* is defined as a finite sequence of coordination acts between two actors, concerning the same production fact. The actor who starts the transaction is called the *initiator*. The general objective of the initiator of a transaction is to have something done by the other actor, who therefore is called the *executor*. The initiator is also called the *customer* of the transaction and the executor is also called the producer or the *supplier*. The objective of the customer is to let the supplier bring about a production fact.

So, the process of a transaction is a sequence of acts and resulting facts. Such a process can adequately and conveniently be modeled as a (colored) Petri-Net [1,17]: the transitions (boxes in the Petri-Net Diagram) represent acts and the places (disks in the Petri-Net Diagram) represent facts. Because of the special character of interaction processes, a special type of Petri-Net is introduced, called the CAP-Net (from Coordination-Actors-Production). It is a further improvement of the net as presented in [3]. A distinctive feature of the CAP-Net is that every transition (act) has exactly one output place (fact). This feature offers the possibility to simplify the diagrammatic representation as drawn below. Instead of drawing separately a box for an act X and a disk for the resulting fact X, connected by an arrow from the box to the disk, the disk is drawn inside the box. X now stands for the intention of the act (e.g. request) as well as for the intention of the resulting fact (e.g. requested).



The generic process of a transaction is exhibited in figure 6. It takes place in three layers, which are based on Habermas' theory of communicative acts. In the success layer, everything goes smoothly. This means that a request is followed by the promise, which is followed by the statement (which is preceded by the non-communicative production act), which is followed by the acceptance of the production fact. If the actor whose turn it is thinks that proceeding in the success layer is not appropriate, one falls into the discussion layer. The ground for declining a request by the executor of a transaction or for rejecting a statement by the initiator, is in principle a mixture of the three *validity claims* of Habermas' theory [13]. Falling in the discussion layer means practically that the two actors must 'sit together', discuss the situation at hand and negotiate about how to get out of it. As an example, let us take the declination of the request of John to Mary to become member of the library (cf. figure 3). The first validity claim that may play a role is the *claim to truth*. As was specified in the corresponding action rule (figure 5), this is violated if the maximum number of members has already been reached. But also other circumstances may offer sufficient ground to decline based on the claim to truth. For instance, if Mary knows that the library will be discontinued within a few weeks, she rightly has to decline the request (Note. This example shows that action rules are no algorithmic prescriptions but guidelines, the executing actor always remains responsible for taking a well-considered action). The second validity claim that may play a role is the *claim to justice*. An example of declining because of this claim is the case that John asks Mary to become member of the library when Mary is not on duty, e.g. when John happens to see her in the theater. Mary may rightly argue that it is socially not just to request her for a membership in that situation. The third validity claim that may play a role is the *claim to sincerity*. If e.g. John has applied for membership several times already today but every time withdrew the request without reason, Mary rightly will doubt on the sincerity of John. In principle, John and Mary may be able to solve their problem in a discussion. If they do, the process returns to the success layer by means of a renewed request by John (the arrow from 'declined' to 'requested'). If they don't, the process falls in the failure layer by means of a quit by John. The transaction then ends unsuccessfully. The discussion layer includes also

Habermas' discourse [13]. A discussion transfers into a discourse if it is not anymore about the proposition of the transaction but about the backgrounds of social values and norms of the participants. These backgrounds may differ too much to make carrying through transactions meaningful, however this difference may be solved in a discourse. In the example given it could be that John would be very surprised by the decline of Mary based on the claim to sincerity because 'in his culture' his behavior is quite acceptable.

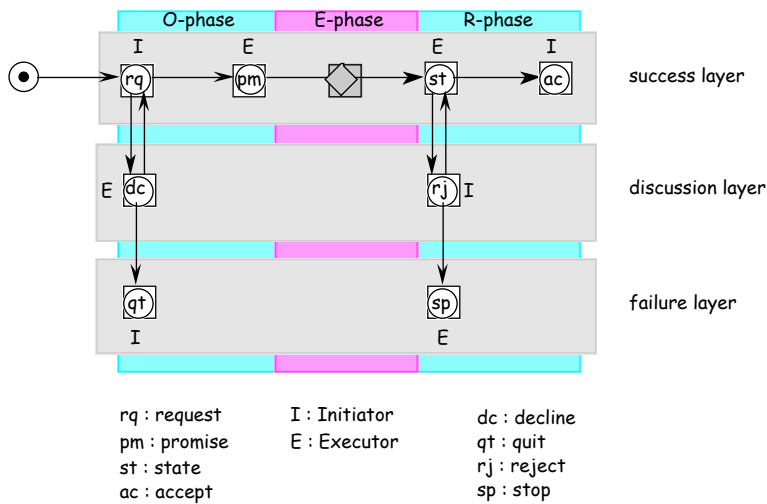


Figure 6 The generic process of a transaction

The generic process of a transaction consists of three phases. In the order phase or O-phase, the initiator and the executor try to reach agreement about the production fact that the executor is going to produce for the initiator. In the execution phase or E-phase, this production fact is actually brought about. This is represented in figure 6 by a gray diamond (the P-fact) in a gray box (the P-act). In the result phase or R-phase, the initiator and the executor try to reach agreement about the production fact that is actually produced (which might differ from the one that was originally requested).

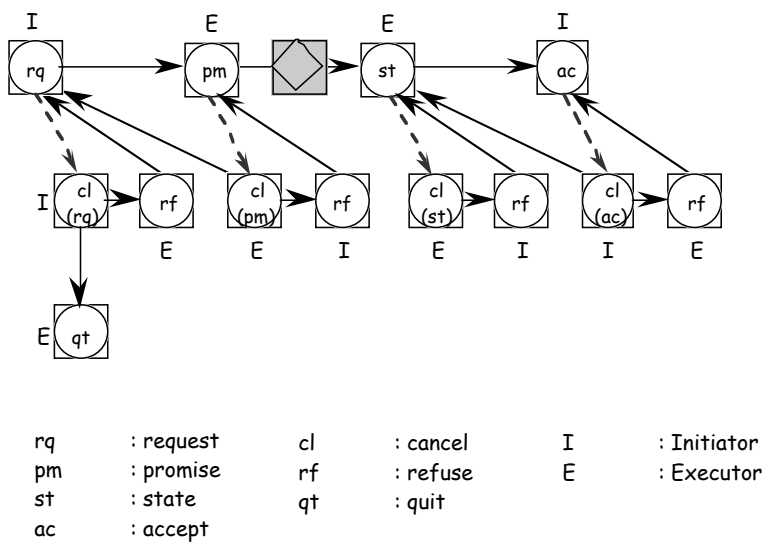


Figure 7 The cancellation patterns of a transaction



A *fiber* is defined as a collection of interconnected transactions together with their associated actor roles. One of them is the so-called independent transaction; it is initiated externally. Interconnected means that the transactions are causally or conditionally linked. We say that transaction A is *causally linked* to transaction B if and only if either A is initiated from within B or B is initiated from within A. We say that transaction A is *conditionally linked* to transaction B if and only if A has to wait for B being in a particular state in order to be able to proceed, or vice versa. This notion of fiber seems to correspond largely with the common notion of business process. Therefore we adopt the term ‘business process’ and use the definition of fiber as a more precise and exact definition of the notion of *business process*. As an example of a business process, again in the context of a library, figure 8 exhibits the process of becoming member of the library. It consists of two interconnected transactions. Transaction T1 concerns the creation of P-facts of the kind “membership M has started to exist” and transaction T2 concerns the creation of P-facts of the kind “the remaining fee for membership M is paid”.

Figure 8 shows the extensive version of the CAP-Net, contrary to the compact version that was used in figure 6 and figure 7. C-acts and C-facts are now drawn separately, boxes represent C-acts and discs represent C-facts. The three (elementary) actors involved are represented by gray-lined rectangles, identified as A0, A1 and A2. The performer of an act is indicated by placing the act in the corresponding rectangle. The addressee of an act follows from the arrow that goes from the disc to a box. For example, the performer of the request act (rq) in transaction T1 is A0 and the addressee is A1. Only the transaction processes at the success layer are shown (cf. figures 6 and 7). Figure 8 exhibits the interconnections between the transactions T1 and T2. In dealing with the agendum promised (pm) of T1, actor A1 not only performs the P-act of T1 but also the request (rq) of T2. This connection between T1 and T2 is an example of a *causal link*. However, A1 has to wait for performing the P-act until T2 has reached the status accepted (ac). This *conditional link* between T2 and T1 is represented by the dotted arrow. Note that the CAP-Net shown in figure 8 is in accordance with the action rules of figure 5.

Taking again John and Mary as the acting subjects, it follows that John plays the actor roles A0 and A2 and Mary plays the role of A1. After having promised to John that she will make him member of the library (the result of T1), she asks John to pay the fee. As soon as the payment is settled (the result of T2), she proceeds T1 by performing the state-act (st). John completes T1 successfully by accepting the result. As we have remarked already in section 2, such an acceptance act is very often performed tacitly and therefore hard to find if one models business processes as ‘flat’ sequences, i.e. without imposing the transaction concept of DEMO. Nevertheless, these acts do exist, which becomes apparent from any situation of breakdown. For example, if John is not satisfied with the state-act of Mary in T1 (e.g. because the stated starting date is not in accordance with what was agreed upon in the order phase of T1), John will explicitly reject (rj) the statement by Mary (cf. figure 6).

Although the business process exhibited in figure 8 is a very simple one, the diagram shows how transactions can causally and conditionally be interconnected in order to constitute, in principle arbitrarily, complex business processes. The most important emergent property of a business process (or fiber) is that it provides a particular service, the delivered final product, to the initiator. In the example given, this service is the being member of the library and having got the associated rights, like e.g. to be allowed to borrow books.

For the sake of completeness, we express also the definition of business process in EBNF:

< business process > ::=            < structure of causally interconnected transactions for delivering a particular final product to the environment >

## 6 Comparative evaluation of the framework

In this section, we compare our framework with the frameworks proposed by Weigand et al. [23] and by Lind & Goldkuhl [15]. We will do so after a critical discussion of these frameworks. The two frameworks are exhibited in figure 9. The different orientations of the representations (bottom-to-top hierarchy for Weigand et al. and top-to-bottom hierarchy for Lind & Goldkuhl) are left intact.

Both Lind & Goldkuhl and Weigand et al. agree on the view that communicative acts or speech acts are atomic building blocks of business processes. In both frameworks, these acts constitute the first layer. Lind & Goldkuhl however state that communicative acts are not the only atomic building blocks. To quote them: “However, we claim that speech act can not be used as *the* basic unit of analysis, since business interaction cannot be reduced to only speech acts. Business interaction needs to also include material acts since for example treatment and delivery of physical goods are essential in business interaction.” They suggest calling communicative acts and material acts collectively business acts. There are two observations we like to make. First, although Weigand et al. do not mention material acts explicitly as atomic building blocks, they certainly are aware of the existence of material acts, e.g. deliveries of goods, in their presentation and discussion of the other layers of their architecture. Second, if material acts should be included as atomic building blocks, why not also immaterial acts, like making a diagnosis by a physician or passing a sentence on a defendant by a judge, or some other expert decision or judgment? Such an asymmetry in dealing with material acts and immaterial acts seems to be unjustified, as we have demonstrated in section 3. What Lind & Goldkuhl apparently do, is to consider immaterial (production) acts as a kind of communicative act. They do not provide an explicit account of this position, however.

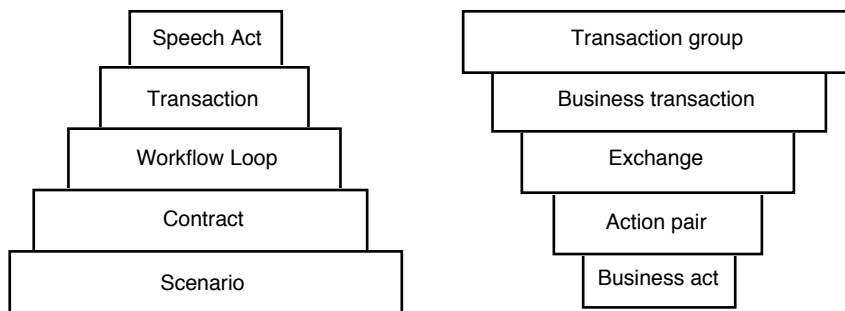


Figure 9 The frameworks of Weigand et al. (left) and of Lind & Goldkuhl (right)

For the second layer, Weigand et al. introduce the notion of *transaction*, defined as “... the smallest possible sequence of actions (speech acts) that leads to a certain deontic state ...”. Although deontic logic is quite another discipline, we consider the notion of deontic state to be covered by our notion of C-fact.

Lind & Goldkuhl introduce the notion of *action pair* for the second layer, defined as follows: “... one business act functions as a trigger for another act, which will have the function of a response”. Although they claim to have a more general concept than the transaction of Weigand et al., our observation is that the notions are to a high extent equivalent. In our terminology, it is the notion of a C-act resulting in a C-fact that serves as an agendum for some actor. When dealing with this agendum, this actor responds by performing a C-act that results in a new C-fact.

In spite of our agreement with the observation that C-acts (or speech acts or business acts) come into pairs (action and re-action), we reject the idea that this justifies a new framework layer because these pairs cannot occur in isolation. They always occur as parts of a larger pattern, viz. a complete transaction. In other words, the action pair of Lind & Goldkuhl, and, for that matter, the transaction of Weigand et al., is not a higher-level building block.

For the third layer, Weigand et al. introduce the notion of *workflow*, defined as “...a set of related transactions aimed at some goal” and commented by “This pattern expresses that actions

are always executed for someone ...”. Our understanding of this notion of workflow is that it equals our notion of transaction.

Lind & Goldkuhl introduce the notion of *exchange* for the third layer, defined by: “...one actor gives something in return for something given by another actor”. From the further explanation they provide, we understand that an exchange consists of two related workflows (as defined by Weigand et al.). For some (unexplained) reason, Lind & Goldkuhl don’t like ‘asymmetry’ in the sense that (our) transactions could take place without a ‘counter’ transaction. However, this is quite common practice. Think for instance of any free service. Therefore, we reject the idea that the notion of exchange justifies a new layer of building blocks.

For the fourth layer, Weigand et al. introduce the notion of *contract*. From its description, it appears that they agree with Lind & Goldkuhl in their rejection of asymmetry. To our understanding then, the notion of contract equals more or less the notion of exchange of Lind & Goldkuhl. However, Lind & Goldkuhl themselves consider the notion of contract to be equivalent to their notion of *business transaction* that they introduce for the fourth layer. Unfortunately, both groups of researchers provide insufficiently precise definitions and/or explanations to proceed the discussion of the frameworks on this fourth layer fruitfully. The same holds for the fifth layer at which Weigand et al. introduce the notion of *scenario* and Lind & Goldkuhl introduce the notion of *transaction group*.

Partly as a comprehension of the frameworks of figure 9 and partly as a more concise alternative, we propose the framework exhibited in figure 10. It has only three layers. However, these layers constitute a true hierarchy of distinct layers. First, every layer (except the bottom one) consists of concepts that are compositions of concepts of the lower layer, and the concepts in every layer (except the top one) are components of concepts of the higher layer. Second, the entities at every layer have emergent properties, i.e. properties that are not possessed by its components separately.

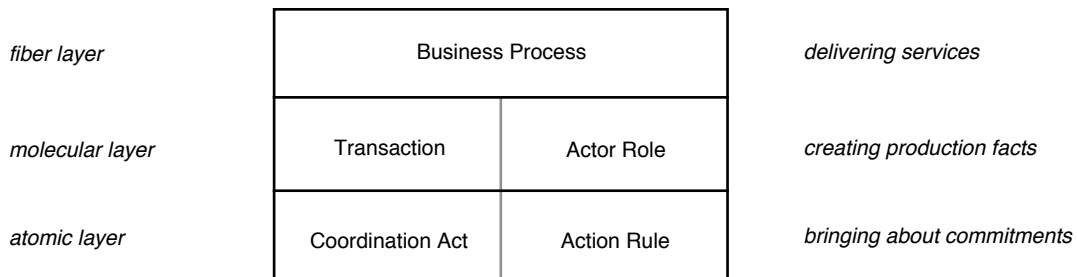


Figure 10 The DEMO-framework

In the atomic layer there are the *coordination acts* on the one hand and the *action rules* on the other hand. As we have discussed and shown above, every action rule corresponds to a particular coordination fact type. The emergent property of this layer is the bringing about of commitments between actors. In the molecular layer, we have the *transaction* as well as the *actor role*. Every actor role is specified by the set of action rules that a player of the role is authorized to execute. The emergent property of this layer is the creation of production facts, as the results of successful transactions. In the fiber layer, we only have the *business process*, composed of transactions and actor roles. The emergent property of this layer is the delivering of services (final products) to the environment of the organization.

Barring all possible misinterpretations, our conclusions of the comparison of our framework (figure 10) with the frameworks of Weigand et al. and of Lind & Goldkuhl (figure 9) are as follows. The first (top) layer of the framework of Weigand et al. and the first (bottom) layer of the framework of Lind & Goldkuhl correspond with the first (bottom) layer of our framework. The second and third layer of both the framework of Weigand et al. and the framework of Lind & Goldkuhl together correspond to our second layer. From this observation, it follows that the second and third layers of both frameworks are not principally different, but instead contain

variants (e.g. subtypes or supertypes) of our notion of transaction. The fourth and fifth layer of both the framework of Weigand et al. and the framework of Lind & Goldkuhl together correspond to our third layer. From this observation, it follows that the fourth and fifth layers of both frameworks are also not principally different, but instead contain variants (e.g. subtypes or supertypes) of our notion of business process. As a final remark, both Weigand et al. and Lind & Goldkuhl do not explicitly deal with the ‘active’ components, viz. the action rules and the actor roles.

## 7 Practical application of the framework

In this section, we will illustrate the modeling of organizations in DEMO, taking as the example case a pizzeria. The pizzeria is owned by the Owner who started once on his own but who now has two employees: his daughter and a boy. The process of fulfilling a customer order is as follows. The Owner takes an order from a customer. He then asks the daughter to bake the pizzas. After having baked the pizzas, the daughter hands them over to the boy and asks him to bring them to the customer. The boy jumps on his bike, rides to the customer’s address and gives the pizzas to the customer. Since we will focus on modeling the business system independently of its realization (cf. [9]) we do not need more detail.

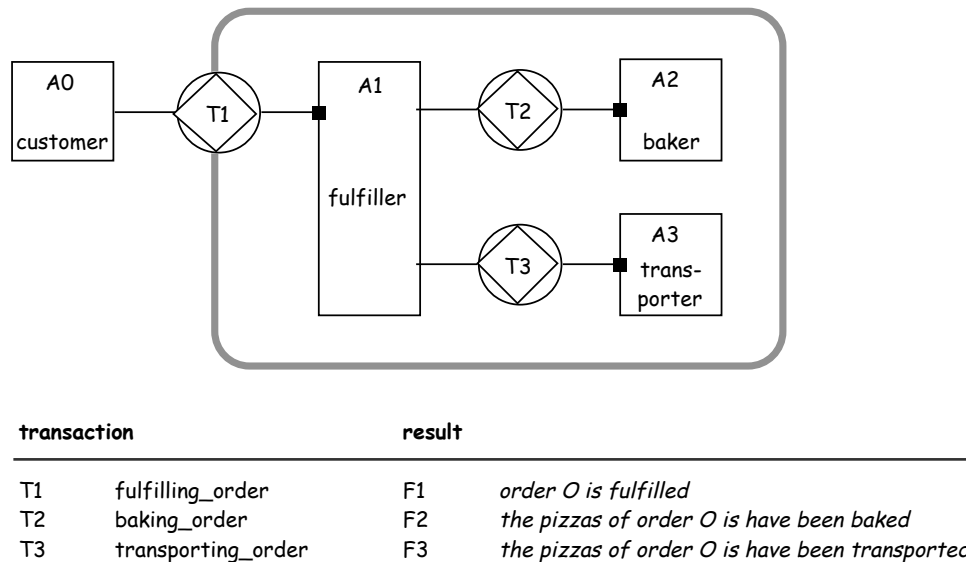


Figure 11 Interaction Diagram and Interaction Table of the pizzeria

The starting point in modeling is the identification of the products that are supplied to the environment of the organization at hand. In the current case, this is fulfilling customer orders. This becomes the first transaction to be identified. The production fact or transaction result is that a particular order is fulfilled (transaction T1 in the Interaction Table in figure 11). Because the customer is an actor in the environment of the organization, this transaction T1 is drawn on the system boundary in the Interaction Diagram (upper part of figure 11). In this diagram, a circle (the generic symbol for coordination) in which a diamond is drawn (the generic symbol for production) represents a transaction. This symbol is connected by straight lines to two actor roles. One of them is the initiator of the transaction; the other one is the executor. The small black box on the edge of the actor box at the junction with the transaction link indicates who is the executor. For the customers of the pizzeria, only the transaction type T1 is relevant. It ‘includes’ everything that needs to be done for the Owner to responsibly state that a transaction T1 is executed. Therefore, the correct interpretation of a transaction T1 is that it concerns the transfer of property of one or more pizzas from the pizzeria to the customer. The Owner, in his role of executor of T1, apparently finds that two other transactions have to be carried through before he can responsibly state a transaction T1. These transactions are T2 (baking the pizza’s) and T3 (delivering the pizza’s). Both are listed in the Interaction Table in figure 11. In this table,

one finds the variable ‘O’ in all three transaction results (production facts). Every instance of O is a particular customer order. So, a concrete instance of a customer order could be order #941. This customer order instance is determined by the concrete customer (i.e. the person who is playing the role of initiator), the order entries (the ordered pizza types and the number of pizza’s of each type), and the point in time of ordering.

Let us assume that the initiator of order #941 is Mary and that there is only one pizza ordered, of the type Capriccioso. The correct interpretation of the corresponding transaction result would be: *Mary has become owner of a pizza Capriccioso*. The particular pizza, of which Mary has become the owner, is the physical outcome of a particular instance of transaction T2 (the baking of the pizza of order #941). Mary has got access to this pizza because of the result of the corresponding transaction of type T3 (transporting of the pizza of order #941). The initiator of transactions T2 is actor A1 (fulfiller) and the executor is actor A2 (baker). The initiator of transactions T3 is also actor A1 (fulfiller) and the executor is actor A3 (transporter).

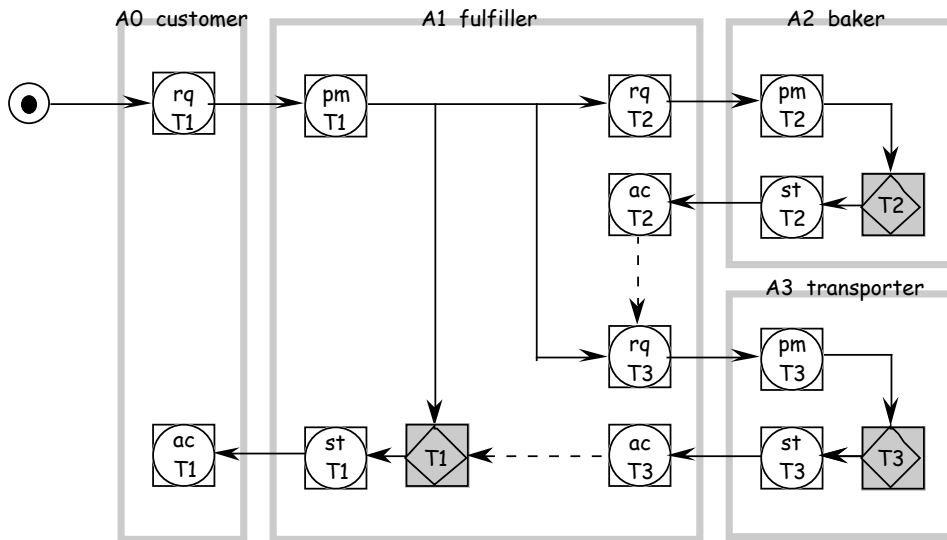


Figure 12 Process Step Diagram of the pizzeria

Figure 12 exhibits the Process Step Diagram of the business process of figure 11, as a compact CAP-Net. It has to be interpreted as follows. Some unknown coordination world state (indicated by the circle with the dot in it) is an agendum for actor A0. In dealing with that agendum, A0 performs a request for a T1 (fulfilling a pizza order). The being requested of T1 is an agendum for A1. In dealing with that agendum, A1 performs three acts: the production act of T1, the request act of a T2 and the request act of a T3. A1 succeeds immediately in performing the request for the T2 (the baking of the pizza). The performing of the request of the T3 (the transporting of the pizza) has to wait for the baking to be completed. This wait condition is represented by the dotted arrow from the fact ‘ac T2’ to the act ‘rq T3’. Likewise, the performing of the production act of T1 (the actual transfer of ownership of the pizza) has to wait until the transporting of the pizza to the delivery address has been completed. This wait condition is represented by the dotted arrow from the fact ‘ac T3’ to the production act ‘T1’. Concretely, this condition means that actor A1 waits for performing the production act ‘T1’ until the pizza is at the delivery address.

Although the assignment of actor roles to subjects is independent of the correctness of the so-called essential model in figure 12, the diagram suggests an *ideal role assignment*, which is defined as the assignment that requires no additional communication next to the necessary communication to perform the coordination acts. The ideal role assignment in the pizzeria is that the Owner plays actor role A1, the daughter actor role A2 and the boy actor role A3.

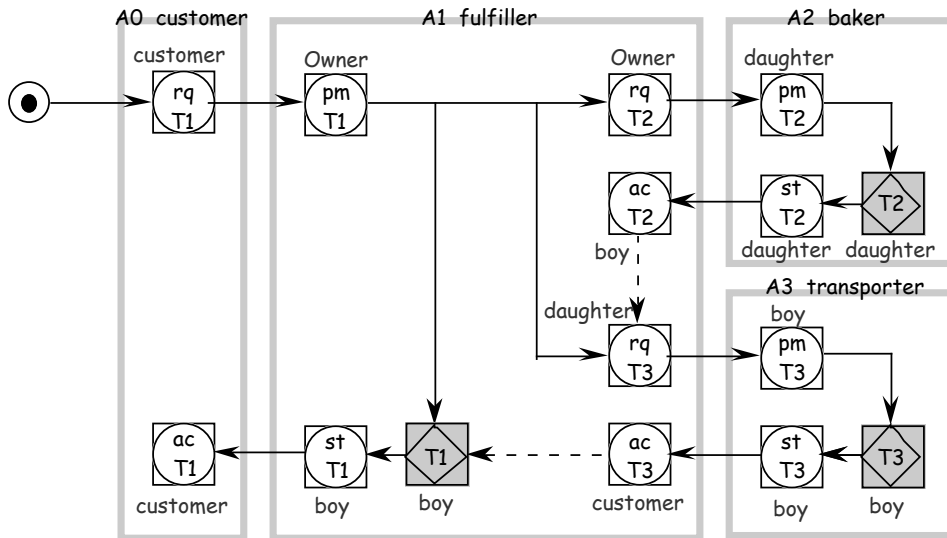


Figure 13 Process Step Diagram of the pizzeria with actual role assignments

In figure 13, the same process is shown, but now, the actual role assignments are shown. The diagram has to be interpreted as follows. A customer, e.g. Mary, orders a pizza from the Owner (rq T1). The Owner tells Mary that he will do that (pm T1). The Owner then asks his daughter to bake the pizza (rq T2). The daughter nods (pm T2) and starts to bake the pizza. When it is finished, she gives the pizza to the boy (st T2) and the boy accepts it (ac T2). Note that the boy now takes over the actor role A1 that was played by the Owner before. Next, the daughter takes over the actor role A1, in asking the boy to bring the pizza to the customer (rq T3). The boy nods (pm T3) and brings the pizza to the customer's place. There he hands over the pizza to the customer. This act counts as stating both that the pizza has been transported (st T3) and that the ownership of the pizza is now transferred (st T1). By taking the pizza and possibly thanking the boy, the customer both accepts T3 and T1. Apparently, the boy takes over the role of actor A1 in the completion (result) phase of transaction T1. Also apparently, the role of actor A1 in accepting the result of T3 (the transportation of the pizza) is played by the customer.

In DEMO, a distinction is made between three kinds of role assignment, called authorization, delegation and propagation. By *authorization* is meant the more or less permanent assignment of actor roles to organizational functions (or subjects). In the pizzeria case, it is assigning to the Owner actor role A1, to the daughter actor role A2 and to the boy actor role T3. Authorization comes down to assigning the role of executor of a transaction. It implies the authority of playing the role of initiator in all transactions that are started from within the transaction of which one is executor. This 'ideal' assignment may be 'overruled' by delegation and propagation. In any actual situation, the assignment of the promise act is decisive for determining who is the authorized executor of a transaction. In the pizza-case, the next authorizations apparently hold:

The Owner is authorized to be the executor of T1 (and consequently to be the initiator of T2 and T3).

The daughter is authorized to be the executor of T2.

The boy is authorized to be the executor of T3.

Any transfer of authorization by the (primary) executor of a transaction to someone else, is called *delegation*. It always concerns only a part of a complete transaction, since the (primary) executor always performs at least the promise act. In the pizzeria, we find the next delegations:

The actor role A1 is delegated to the boy for the accept step of T2.

The actor role A1 is delegated to the daughter for the request step of T3.

The actor role A1 is delegated to the boy for the state step of T1.



the proposition expressed by the performer of a coordination act, one needs additional (informative) communicative acts. These informative acts fall in Habermas' category of constativa, where the dominant claim is the claim to truth. The third category, the expressiva (with the claim to sincerity as the dominant claim) is not taken into account for reasons explained elsewhere [6].

The proposed DEMO-framework is evaluated in a comparative review with two other frameworks [15,23]. The differences between the three frameworks seem to be large at first sight but, fortunately, several of them are not conceptual but just nominal. Nevertheless, one has to agree also on names. The more serious differences are the conceptual ones. Several of them seem to be rather small but the lack of clear and formal definitions does not allow for definite conclusions. Perhaps this should be a recommendation for future research efforts in the LAP community: to be more precise about and preferably to provide formal definitions of the core concepts. Formality however does not make sense without conceptual rigor. For example, in a true hierarchy of layers, every layer (except the bottom one) consists of concepts that are compositions of concepts of the lower layer, and the concepts in every layer (except the top one) are components of concepts of the higher layer. Next to that, the entities in each layer should possess emergent properties, i.e. properties that are not possessed by its components at the lower layer. As we have shown, this property does hold for the DEMO-framework but it does not hold for the other two frameworks. Finally, we strongly like to adhere to Ockam's razor, i.e. to use as few distinct concepts as possible for describing and explaining things. According to this principle, we have restricted the number of layers to three. This does not mean that more layers are never needed, it only means that for the moment there is insufficient evidence for including a next layer. In over seven years now of experiences in applying the DEMO methodology to practical cases, we did not face problems that could not be solved satisfactorily in the proposed conceptual framework. Once more, this does not exclude that an extension or modification of the framework may turn out to offer solutions that are more elegant or to be just necessary.

We think that one can never claim to have a model that is sufficient for studying the organization. There are numerous points of view related to numerous different interests one can have in studying organizations. It only makes sense to investigate the appropriateness of a modeling approach or to compare modeling approaches for some well-defined point of view. We also think that it is wise to stick to one point of view at a time. In particular we think that it is wise to separate the essential (realization independent) issues from their realization. Separation of concerns is a proven scientific principle. Because of this separation of concerns, the assignment of actor roles in DEMO is not dealt with at the same time as the essential transactions between the actors. As we have shown in this paper the topic of actor role assignment is surely completely covered by DEMO. Moreover, a useful distinction is made between authorization, delegation and propagation. Next to that, general rules have been formulated that govern the delegation and propagation of authority.

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