

# Towards a LAP-based Information Paradigm

Jan L.G. Dietz

Delft University of Technology, Delft, The Netherlands

j.l.g.dietz@ewi.tudelft.nl

## Abstract

It is postulated that the current information era requires that the concept of information be reconsidered: a new information paradigm is needed. Two issues concerning this paradigm are investigated: integrity and authenticity. They are investigated both from the Language/Fact Perspective and from the Language/Action Perspective. The integration of the two perspectives offers the appropriate scientific foundation for the new paradigm.

## 1 Introduction

The amount of information that is currently directly accessible, particularly via the Internet, is already beyond the imaginative power of most people, whereas it is still growing at an enormous rate. At the same time people tend to communicate more and more by means of modern information and communication technology (ICT) instead of face-to-face. The dramatic changes in everyone's life that are caused by the pervasive effects of modern ICT raise serious problems, e.g. regarding the integrity and the authenticity of information. Currently, the term 'information' is so widely and so frequently used that there is hardly any general consensus about its meaning. Moreover, in expressions like "information society" or "information age" it has nearly lost any semantic connotation, it merely serves to convey some grand idea or emotion. This is not bad per se; natural languages need such 'semolina' words [De Bono, 1978]. However, within any professional domain, it is necessary to (re) define the term precisely.

The prevailing perspective on information is the one that is taken by the conceptual modeling approaches to databases and information systems. The Entity-Relationship (ER) Model [Chen, 1976] is the most popular one of these. Unfortunately, it is also the least lucid one because of its foundation on an inconsistent set of concepts - entity, relationship and attribute – and because of the lacking of a deterministic modeling method. It is necessary to have the technique

of normalization in order to correct the errors that people inherently make when applying ER-modeling. The natural language based approaches, like NIAM [Nijssen, 1976] and ORM [Halpin, 2001], do not suffer from these defects. Moreover, one can easily map from them to ER-like models [Halpin, 2001], not vice versa. Next, their close connection to natural language, the first and ultimate vehicle for people to express meaning, puts them close to the LAP. Therefore we will take them as the representatives of the conceptual modeling approaches. We will call their perspective on information the *Language/Fact Perspective* (LFP).

As will be shown, the LFP is not able to address the mentioned issues in a satisfying way. As will be shown also, the LAP is able to provide the missing links. The question then is how the LFP and the LAP can be integrated such that they can profit optimally from each other's scientific achievements. We will confine ourselves to information in organizations. This is still a vast domain; it encompasses all societal institutions (enterprises, governments, clubs etc.) as well as all information and communication systems functioning in these organizations, whether or not making use of modern ICT. What we will try to do is to pave the way towards an understanding of the term 'information' that has a lucid and firmly founded definition, and at the same time accommodates every specific use of the term within the said domain. Next to that, the definition should be consistent with the corresponding philosophical concepts as put forward by semiotics, language philosophy and logic. Therefore, a definition of information in the common sense, i.e. a description of the concept in terms of other concepts as one can find in dictionaries, is not sufficient. To emphasize the necessity of having a rich and multi-faceted understanding as well as the necessity of getting a broad consensus, we prefer to speak of an *information paradigm* instead of a definition.

This is the challenge to the LAP community: to develop an information paradigm that has the power to convince the information systems designers and engineers in the world because it explicitly addresses the problems they face. The goal of this paper is to start the spadework for constructing this paradigm. In particular, two issues are addressed that seem to be indispensable components of the paradigm:

*Integrity.* How can one be sure that a received piece of information is a correct answer to one's question? It includes two sub issues: *atomicity* and *validity*.

*Authenticity.* How can one be sure that a piece of information is authentic? It also includes two sub issues: *originality* and *ownership*.

As example methodologies we take ORM [Halpin, 2001] from the LFP and DEMO [Dietz, 2003a], [Dietz, 2003b] from the LAP since the mutual profitability of these two methodologies has already been demonstrated and discussed in [Dietz and Halpin, 2004]. The outline of the paper follows the issues mentioned above. After having provided, in section 2, a summary of the LFP and the LAP, the issue of integrity is discussed in section 3, and the issue of authenticity in section 4. Section 5 contains the discussion and the conclusions.

## 2 Summary of the LFP and the LAP

As explained above, the LFP is the perspective on information that is, more or less implicitly, taken by information modeling approaches. One may say that the LFP has started to exist in the early 1970's. Some well known early researchers are [Codd, 1969], [Chen, 1976], and [Nijssen, 1976], and a more recent one is [Halpin, 2001]. Particularly in the natural language based approaches, quality factors were formulated and strived for, like the 100% principle and the conceptualization principle [Griethuysen, 1982]. A model of the basic understanding of information in the LFP is exhibited in Figure 1: information is something that is put into and got from an information system.

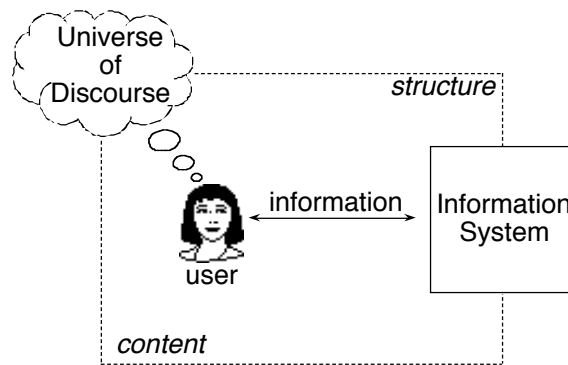


Figure 1. The basic understanding of information in the LFP

Both in the LAP and in the LFP, the concept of information is related to the concept of communication, however in different ways. In the LFP communication is understood as the transfer of information. An instance of communication is the transfer of a particular information item from one agent to another agent (or a number of agents). The term 'agent' is deliberately used here since in the LFP it is not necessary that the communicating parties are human beings, they may as well be machines (cf. Figure 1). So, in the LFP information comes first and communication comes second. Conversely, in the LAP communication is understood as social action. The basic model of a communicative act is shown in Figure 2. A human being or subject (the performer) wants to evoke a particular state of mind in another subject (the addressee). In order to let this happen, the performer has to formulate her thought in a message, i.e. an expression in some language (of which both subjects have a thorough command) and subsequently to utter that expression. The utterance is perceived by the addressee and subsequently interpreted, such that the addressee understands which state of mind the performer wants to evoke in him. The expression is a piece of information. So, in the LAP communication comes first and information comes second. Information is the result of or the means for communication.

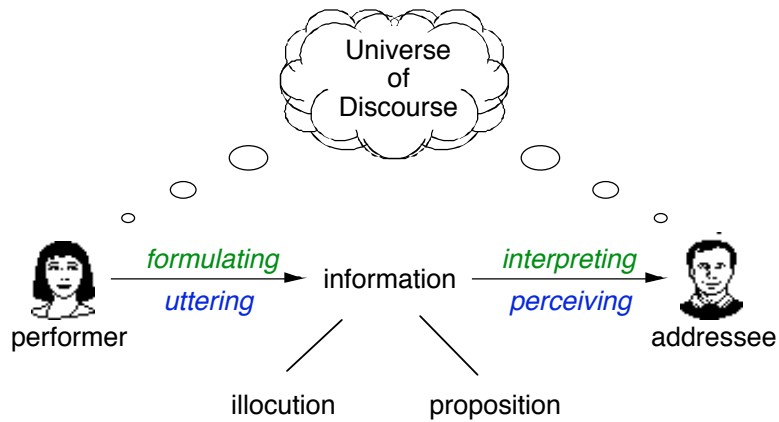


Figure 2. The basic understanding of information in the LAP

More important is that the piece of information contains an illocution and a proposition (Note. This is just another way of saying that performing a communicative act consists of performing a propositional act and an illocutionary act, next to the utterance act [Searle, 1969]). The proposition is some fact or state of affairs in some world. The illocution is what the performer expresses about the proposition, i.e. the intended kind of the state of mind to be evoked in the addressee. Examples of illocutions are question, assertion, request, promise, praise, and apology. Figure 3 shows the explicit notation of an example communicative act in a library. It conveys that John wants to borrow a copy of the book titled “Life of Pi”. Apparently, Mary is the person who is authorized to lend the book to John. In normal language this could be expressed by the sentence “John asks Mary to lend the book “Life of Pi” to him”.

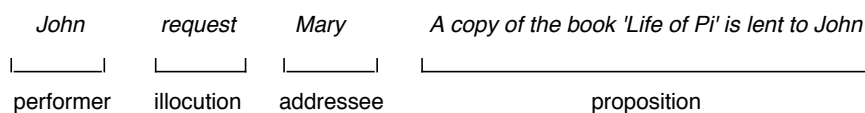


Figure 3 Explicit notation of a communicative act

There is a bunch of literature on the LAP. A selection of relevant recent publications is [Ågerfalk and Eriksson, 2004], [Dietz, 2003a], [Lind and Goldkuhl, 2003], [Schoop e.a., 2003], [Taylor and Every, 2000], [Weigand and De Moor, 2003]. A selection of earlier, and of more seminal work, is [Austin, 1962], [Flores and Ludlow, 1981], [Goldkuhl and Lyytinen, 1982], [Searle, 1969], [Searle, 1995], [Winograd and Flores, 1986]. The work in Organizational Semiotics (cf. e.g. [Liu e.a., 2001]) is also relevant. As accounted for earlier [Dietz and Widdershoven, 1991], to our opinion does Habermas’ Theory of Communicative Action

[Habermas, 1981] explain best the conditions for success and failure of communicative acts. On the basis of the three validity claims and the corresponding three different kinds of worlds, a clear taxonomy of intentions is provided, as exhibited in Figure 4. It is a slightly modified version of the one in [Dietz and Widdershoven, 1991].

	Constativa	Regulativa	Expressiva	
objective world				claim to truth
social world				claim to justice
subjective world				claim to sincerity
	<i>question assertion</i>	<i>request promise</i>	<i>praise apology</i>	

Figure 4. The taxonomy of communicative acts according to Habermas

The *constativa* are the class of acts of which the dominant validity claim is the claim to truth; therefore they are primarily oriented to the objective world. Examples are questions and assertions. The *regulativa* are the class of acts of which the dominant validity claim is the claim to justice; therefore they are primarily oriented to the social world. Examples are requests and promises. The *expressiva* are the class of acts of which the dominant validity claim is the claim to sincerity; therefore they are primarily oriented to the subjective world. Examples are praises and apologies. It is important to recognize, for every communicative act, that the non-dominant claims always also exist and thus that an act is also always oriented to the other two worlds, just less prominently. For example, a request may fail because the addressee thinks it is impossible to bring about the requested fact (e.g. making a perpetuum mobile) or because the addressee has severe doubts about the sincerity of the performer.

In every organization, it are the *regulativa* that directly serve to coordinate the (production) actions of the members of the organization. Therefore, they are called coordination acts in DEMO [Dietz, 2003a]. The proposition part is a production fact, to be brought about by a production act. These acts appear to occur in generic patterns, called *transactions* [Dietz, 2003b]. A transaction is carried through by two actors, who alternately perform acts. The actor who starts the transaction and eventually completes it, is called the *initiator*. The other one, who actually performs the production act, is called the *executor*. The result of a successful transaction is that the production fact(s) come into existence.

### 3 Integrity

The integrity of a piece of information may be violated or threatened in various ways. Experience with the management of large databases has taught us that a crucial necessary condition for integrity is the *atomicity* of information items in these databases. Another aspect or sub issue of integrity is the *validity* of an information item at a particular point in time. Both issues are discussed hereafter.

#### 3.1 Atomicity

The notion of atomicity regarding information has drawn the attention of researchers already for a long time (e.g. [Wittgenstein, 1922]). It has been renewed in the 1970's within the field of information modeling. The notion of elementary fact is at the core of the LFP. It is defined on the basis of the natural language sentence in which it is expressed. This notion of sentence is identical to what Wittgenstein has called in German 'Satz' [Wittgenstein, 1922]<sup>1</sup>. The next sentence is an elementary sentence and thus expresses an elementary fact:

*John is born on 16 November 1988* (1)

This sentence is called elementary because it is not possible to split it in two or more parts that are (valid) sentences, while at the same time preserving the meaning of the original sentence. The next one however is not elementary:

*John is born on 16 November 1988 and the color of his eyes is blue* (2)

It is quite obvious, because of the connective 'and', that this sentence can be split in the next two sentences:

*John is born on 16 November 1988* (1)

*The color of John's eyes is blue* (3)

The meaning of the original sentence is completely preserved by the set of these two sentences. Unfortunately, there need not be a connective (and, or, but etc.) to have a non-elementary sentence. Consider e.g. the next one:

*John is born on 16 November 1988 in Amsterdam* (4)

On closer look, this sentence appears to be non-elementary; it can be split in the next two sentences, while preserving the complete meaning:

---

<sup>1</sup> In our opinion, the word 'Satz' is incorrectly translated in English by 'proposition'; it should have been translated by 'sentence'.

*John is born on 16 November 1988* (1)  
*John is born in Amsterdam* (5)

To avoid such misleading peculiarities in the grammar of natural languages, the natural language based modeling approaches soon recognized that a fact can be expressed by a number of different sentences. Next to that, an objective criterion was developed for determining whether a fact is elementary or not. It is called the ‘n-1 rule’ and it reads that every applicable unicity rule must cover at least n-1 roles of the n-ary fact type (cf. [Halpin, 2001]). In the graphical representation, this is easily demonstrated, after having expanded a sentence into its complete form. For example, the expansion of sentence 4 yields:

the PERSON  
 with the PERSON NAME ‘John’  
*is born on*  
 the DATE  
 with the DATE NAME ‘16-11-1988’  
*in*  
 the PLACE  
 with the PLACE NAME ‘Amsterdam’

This is an occurrence or instance of a fact type that is modeled in ORM as exhibited in Figure 5. The symbol for a fact type is a concatenation of boxes, each representing the role of the connected object class (represented by an oval) in the fact type. Below this symbol a so-called population is shown: a set of example combinations of objects that may fulfill the respective roles 1, 2 or 3.

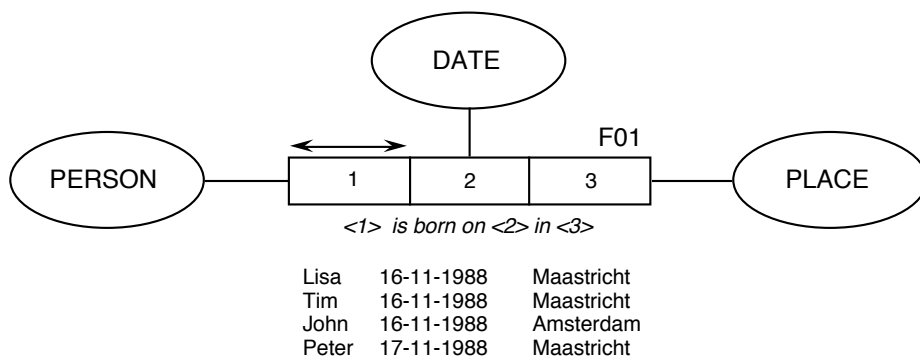


Figure 5. ORM model of the fact type expressed by sentence 4

There is a unicity rule on role 1 only. This means that in any population of the fact type F01, objects in role 1 may only occur once. The example population

provided in the figure illustrates the natural restriction that a person is born at exactly one date and in exactly one place. The unicity rule is not in accordance with the n-1 rule, so the fact type is non-elementary. The corresponding procedure for correcting the mistake is to replace the ternary fact type F01 by two binary ones, the one expressed by sentence 1 and the one expressed by sentence 5, as shown below:

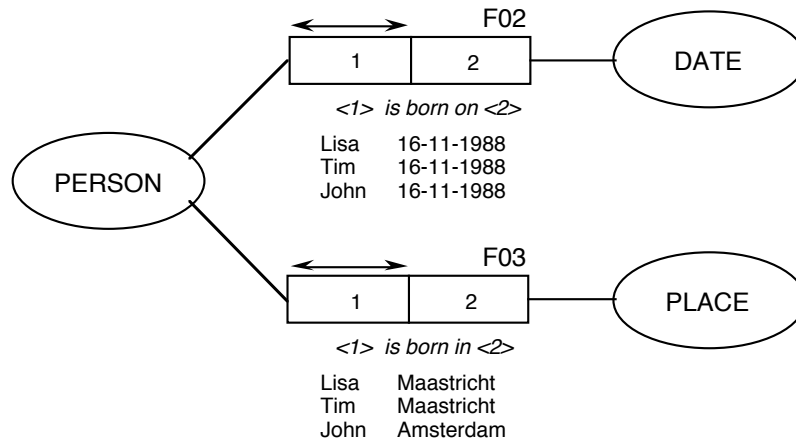


Figure 6. ORM model of the fact types expressed by sentences 1 and 5

The notion of Universe of Discourse (UoD) in the LFP corresponds fully with the notion of world in [Wittgenstein, 1922]. To illustrate this, we cite a few of his propositions (Wittgenstein's numbering between brackets):

- The world is the totality of facts, not of things.* (1.1)
- The world divides into facts.* (1.2)
- What is the case, the fact, is the existence of atomic facts.* (2)
- An atomic fact is a combination of objects.* (2.01)
- The object is simple.* (2.02)
- In the atomic fact objects hang one in another, like the links of a chain.* (2.03)
- The totality of existent atomic facts is the world.* (2.04)

The kind of sentence on which the LFP is founded, is the declarative sentence. Grammatically, these are the sentences that are ended in English (as in most languages) by a full stop (.), contrary to the question mark (?) and the exclamation mark (!). A more precise definition of the declarative sentence can be found in [Dik, 1989]. The inherent problem of the declarative sentence is that it cannot be distinguished from the mere expression of a proposition. For example, if one reads the sentence 'John is born on 16 November 1988', the natural interpretation of it is that the sentence represents a true fact, that John is born on 16 November 1988.

Sometimes however one may just want to model only the proposition, separated from the assertion that is inherent in the declarative sentence. The LAP offers the possibility to do this, as illustrated in Figure 7; it exhibits the conceptual model that corresponds with the example communicative act in Figure 3.

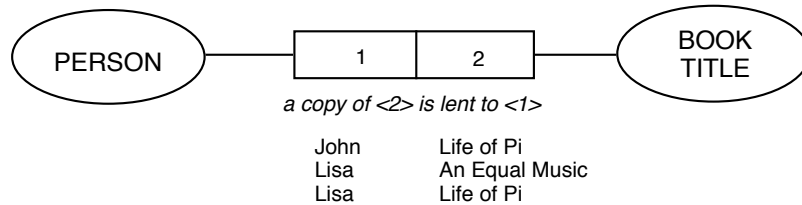


Figure 7. ORM model of the proposition in Figure 3

The fact type in this figure must now be interpreted as a possible fact in the considered UoD. This is the common interpretation in DEMO; the existence of a fact is something that is established as the results of transactions. Figure 8 contains the Transaction Result Table that belongs to the case Library, as discussed in [Dietz and Halpin, 2004]. The effect of a successful transaction is the creation of an event in the production world (P-event). These events are explicitly modeled in the Object Fact Diagram, which specifies the state space of the production world, and which is based on ORM. The relevant part of this model for our discussion is exhibited in Figure 9. For example, in the Library an instance of the object type LOAN may be present as well as instances of the two existentially dependent fact types “the membership of <2> is <1>” (where <2> is a placeholder for a membership and <1> for a loan) and “the book copy of <1> is <2>” (where <1> is a placeholder for a loan and <2> for a book copy). They come into existence when an event of type PE04 is created, thus when a transaction of type T04 is carried through successfully. The object types and fact types that are not created by transactions in the considered part of the Library are colored gray.

transaction type	resulting P-event type
T01 membership_registration	PE01 membership M has started to exist
T02 membership_fee_payment	PE02 the fee for membership M in year Y has been paid
T03 reduced_fee_approval	PE03 the reduced fee for membership M in year Y has been approved
T04 loan_start	PE04 loan L has started to exist
T05 book_return	PE05 book copy C has been returned
T06 loan_end	PE06 loan L has ended to exist
T07 return_fine_payment	PE07 the late return fine for loan L has been paid
T08 book_shipment	PE08 shipment S has been performed
T09 stock_control	PE09 the stock_control for period P has been done
T10 annual_fee_control	PE10 the annual_fee_control for year Y has been done

Figure 8. Transaction Result Table of the Library

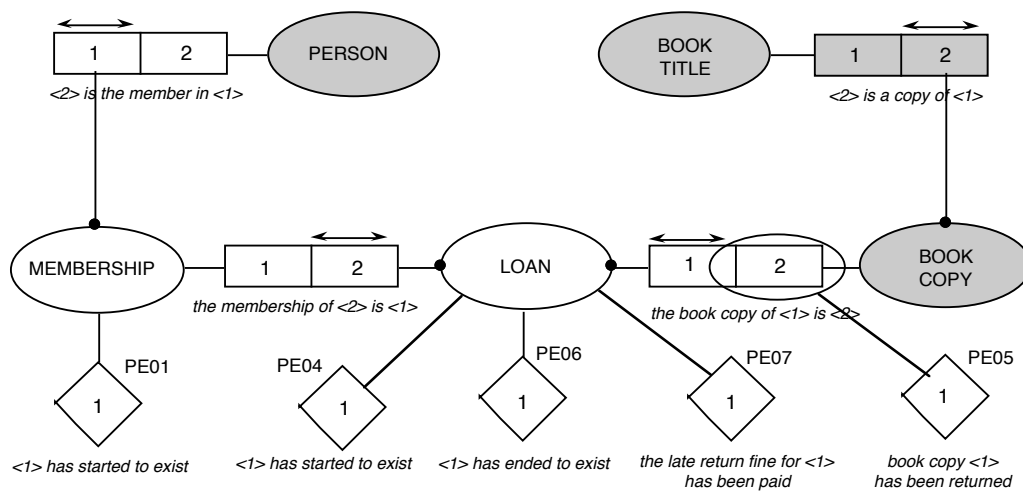


Figure 9. Part of the Object Fact Diagram of the Library

Comparing Figure 7 with Figure 8 and Figure 9 yields that the fact type of Figure 7 does not appear in the model of the Library. Apparently, a refinement of the notion of atomicity is achieved in applying DEMO. The careful modeling of the operations in an organization in terms of transactions and actor roles, leads indeed to a clear articulation of the essential object types and fact types. In the case of the Library, the object types MEMBERSHIP and LOAN appear to be core (essential) concepts. They are uniquely identifiable basic states of affairs. For example, the concept of membership allows for a person to be multiple members (which may be allowed concurrently but at least sequentially), and the concept of loan allows that there are multiple (sequential) occurrences of a person having lent (via one of his memberships) the same copy of a book. So, the fact type in Figure 7 becomes a derived fact type in the model of Figure 9. Its derivation rule is based on the presence of a particular membership and a particular loan. Of course, one could have come up to this model while applying an LFP-based method. But that would be by chance since the LFP lacks appropriate guidelines to achieve this result.

### 3.2 Validity

The next issue to be discussed is the question how to determine whether a fact exists (or is the case) at a particular point in time. Although the issue of validity has got serious attention in the LFP, it is not possible in this perspective to determine it. Fortunately and expectedly, the LAP offers the right means.

As has been explained in [Dietz, 2003b] a production fact comes into existence at the moment at which the coordination act ‘accept’ (which is the last step of a transaction) is performed by the initiator. This holds equally for material and for

immaterial facts. It is by this act that the initiator and the executor reach agreement about the production fact that is actually produced (which might differ from the one that was originally requested). Only if this agreement is reached will the production fact become existent. The moment at which it starts to exist is the very moment of having reached agreement between the two actor roles (to be precise: between the two subjects that actually play the role of initiator and executor respectively). So, the time of acceptance of a production fact is the time at which the production event occurs (cf. Figure 9). For example, a loan comes into existence at the moment of creation (let us say  $t_1$ ) of the corresponding event of type PE04. Its existence ends at the moment of creation (let us say  $t_2$ ) of the corresponding event of type PE06. Before  $t_1$  it was in its ‘prenatal phase’ and after  $t_2$  it is in its ‘post mortem phase’. Figure 10 exhibits the general case of the lifetime of an object or fact.

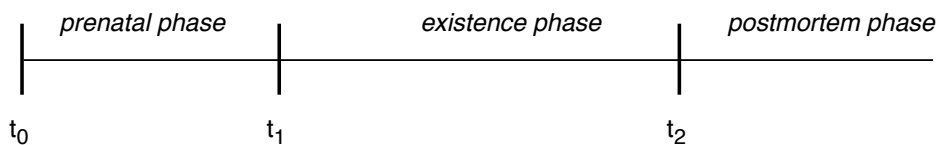


Figure 10 The three lifetime phases of an object or fact

By  $t_0$  is meant the time at which a fact is conceived in the organization. Therefore a fact is said to be *present* from  $t_0$  on and to *exist* at any point between  $t_1$  and  $t_2$ . The prenatal phase and the postmortem phase do not only make the whole theoretically complete, they have also practical relevance. The relevance of the prenatal phase of an object type, e.g. MEMBERSHIP, is that one can e.g. already speak about a membership of the library (and have it stored in a database) while the transaction that makes it existent is still going on. The relevance of the postmortem phase is that one can speak of the membership and still find related facts after it has been resigned.

## 4 Authenticity

Two kinds of authenticity can be distinguished. One of them concerns the authenticity of the person or the institution with which one is communicating. It regards the question whether this person or institution is really the one he/it says to be. The other kind of authenticity concerns the authenticity of the information itself. It regards the question whether the provided information is the real original one as well as the question whether the person or institution that is providing the information is the actual owner of it. We will only discuss hereafter the second kind since the first one does not regard the information itself. It can only be assured by protocol measurements. The discussion is divided in two sub sections.

#### 4.1 Originality

Within the LFP a distinction is made between base facts and derived facts. By base facts is meant the facts that are put into a database by the users of the database. Derived facts are facts that are logically or computationally derived from base facts. The derived facts may, for the sake of efficiency, also be stored in the database but that does not make them base facts. Information modeling approaches in the LFP include derived fact types in information models (conceptual schema's), where they are marked in some way as being derived. Next to that a formal derivation rule is provided. Figure 11 exhibits an example of a derived fact type (F04). The corresponding derivation rule is:

$$\text{age}(P) = (\text{current\_year} - \text{year\_of\_birth}(P) - 1) + \text{current\_day\_of\_year} \text{ div } \text{day\_of\_year\_of\_birth}(P)$$

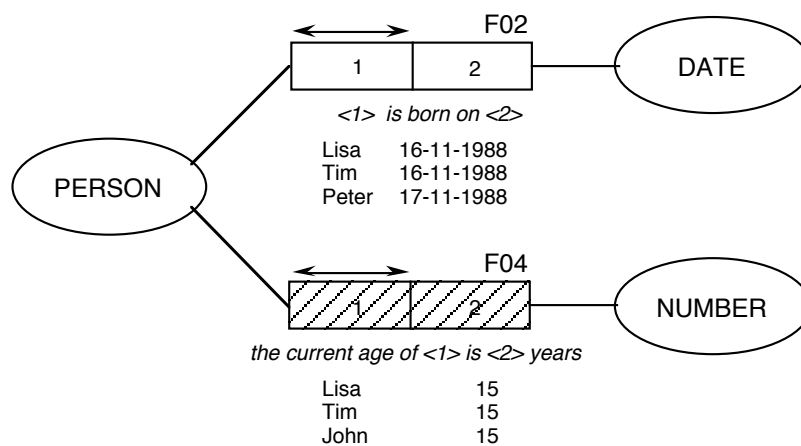


Figure 11 Example of the modeling of a derived fact type

Obviously, the distinction between base facts and derived facts is relative to the particular database (or information model) one is dealing with. For example, it is quite common to input in an accounting information system figures that are themselves results of computation (like the daily number of items sold). In the LFP, it is not possible to have an absolute distinction between genuine, original, facts and derived facts. The LAP however offers a clear yardstick: every fact that is established as the result of an essential business transaction [Dietz, 2003b] is an original fact; all other facts are by definition derived. Regarding the storage of information in databases, it suffices to store only original facts. Every other information can be derived from these facts.

## **4.2 Ownership**

The second sub issue of authenticity is the ownership of information. Let us take, for the sake of the argumentation, once more sentence 1 from section 3:

*John is born on 16 November 1988* (1)

This is a fact that is brought about in a transaction of which the registrar or county clerk of the municipality where John is born is the executor. One may argue about who actually fulfills the role of initiator. In our opinion it is John himself, be it through ‘delegation’ of his authority to someone else, e.g. his father. However, one may also contend that it is the father. We will not elaborate this question here. In any case, it is the registrar or county clerk who performs the production act and it is John or a legal representative who accepts the fact. We postulate that, by default, the executor is the *owner* of the production fact. So, this actor role is the original source for this information. Thus, if one wants to be fully sure about the authenticity of a piece of information, one better addresses oneself to the source. Concretely, if one wants to know someone’s birth date one has to address oneself to the registrar or county clerk of the municipality where this person is born. In real important cases, this is indeed what is actually done. Usually, one is asked to produce this fact by heart, and often it is checked at the source whether one has told the truth. On closer look, this is a rather odd way of doing.

## **5 Discussion and conclusions**

It has been postulated that the concept of information has to be reconsidered in the context of the information era that we are supposed to enter or have entered already. This reconsideration should not just yield an appropriate definition of information but an *information paradigm*, a multi-faceted mental tool for addressing the problems that people face in dealing with information. It holds both for ICT professionals and for all (casual) information users. Two major facets have been identified and discussed in the paper: the integrity and the authenticity of information. They have been investigated from both the Language/Fact Perspective (LFP) and the Language/Action Perspective (LAP). The methodologies ORM and DEMO were chosen as representatives of the LFP and the LAP respectively because their mutual profitability has already been demonstrated.

We are well aware that the proposed (and partly conducted) research is not new in a general sense. Many more people have investigated the essence of information, whether for practical purposes or out of sheer scientific interest. We mentioned in the introduction already the field of semiotics. Peirce [Peirce, 1958] and, more recently, e.g. Nauta [Nauta Jr., 1972] have carefully investigated the

usage of signs in nature, not only by human beings. The modern branch of organizational semiotics (cf. e.g. [Liu e.a., 2001]) is the most close to the LAP. However, as was also already said in the introduction, the purpose of this paper is not to provide a survey of all the work that could be considered relevant. Instead the purpose was to see how the LAP could be reconciled with the LFP in such a way that some serious problems that ICT professionals and information workers all over the world are facing today can be solved. As an important side effect, the LAP community could profit from the primacy of the LFP community.

A publication that reports about research in much the same line as ours is the so-called FRISCO-report [Falkenberg, 1998]. One could say that our work is an attempt to proceed that work in finding a more concrete connection between (organizational) semiotics and conceptual information modeling. Within the LAP community, the work that is reported in [Ågerfalk and Eriksson, 2004] is pretty close to ours. Unfortunately, the authors do not seem to be well acquainted with DEMO, judging by their dismissal of DEMO as a methodology that ‘... does not see the important coupling between the propositional content and the illocutionary component ...’. It would be better to abstain from unjustified judgments. Anyhow, we think that the conclusions drawn below are original findings that contribute to the constitution of a LAP-based information paradigm.

Regarding the issue of *integrity*, it was postulated that a necessary condition for the integrity of a piece of information is it's being atomic. This guarantees consistency and, if the information is original, it also guarantees non-redundancy. The LFP provides a useful criterion for determining the *atomicity* of facts, namely the n-1 rule. However, in the LFP the designers of information systems lack guidelines for effectively dealing with the design freedom they face. The LAP appears to be able to offer effective help in identifying (or creating) those atomic object or entity types that are essential from the business point of view. Moreover, these entity types and their accompanying fact types appear to be highly generic. Regarding the sub issue of *validity*, the LFP appeared not to be able to provide any contribution at all, only the LAP does. Based on the notion of events, the existence phase of a fact or an entity is precisely defined. Moreover, it has been shown that the preceding prenatal phase and the succeeding postmortem phase are relevant notions for the integer usage of information. Presence has been clearly distinguished from existence.

Regarding the issue of *authenticity*, two sub issues were distinguished: originality and ownership. Concerning the *originality* of information, the conclusion is that the LFP is not able to make a definite, absolute distinction between original facts and derived facts, although the importance of this distinction is widely recognized (see also the previous paragraph). The key to the solution of the problem by the LAP is the combination of the concept of transaction and the concept of the essential level of abstraction. The production facts at the essential level are the only and definite original facts in an

organization. Regarding the sub issue of *ownership*, the LFP can only cause confusion by taking the inserter of information in an information system as the ‘owner’. Again, the LAP is able to solve the problem definitely and correctly by taking the executor of a transaction as the owner of the resulting production fact(s).

## References

- [Ågerfalk and Eriksson, 2004] P.J. Ågerfalk, O. Eriksson, Action-oriented conceptual modeling, *European Journal of Information Systems*, 13:80-92, 2004
- [Austin, 1962] J.L. Austin, *How to do things with words*, Harvard University Press, Cambridge MA, 1962
- [Chen, 1976] P.P. Chen, The Entity-Relationship Model – Toward a Unified View of Data, *ACM Transactions on Database Systems*, 1(1):9-36, 1976
- [Codd, 1969] E.F. Codd, Derivability, Redundancy and Consistency of relations stored in Large Data Banks, IBM Research Report, San Jose, California RJ599, 1969
- [De Bono, 1978] E. De Bono, *Practical Thinking*, Penguin, London, 1978
- [Dietz and Widdershoven, 1991], J.L.G. Dietz, G.A.M. Widdershoven, Speech Acts or Communicative Action? *Proc. 2nd European Conf. on CSCW*, Kluwer Academic Publishers, Boston, 1991
- [Dietz, 2003a] J.L.G. Dietz, The Atoms, Molecules and Fibers of Organizations, *Data and Knowledge Engineering*, 47(3):301-325, 2003
- [Dietz, 2003b] J.L.G. Dietz, Generic recurrent patterns in business processes. In: W. van der Aalst, A. ter Hofstede, M. Weske, (Eds.), *Business Process Management*, LNCS 2678, Springer-Verlag, 2003.
- [Dietz, 2004] J.L.G. Dietz, T.A. Halpin, Using DEMO and ORM in Concert – a Case Study, in: K. Siau (ed.) *Advanced Topics in Database Research*, vol. 3:218-236, Idea Group Inc., 2004
- [Dik, 1989] S.C. Dik, *The Theory of Functional Grammar – Part I: The Structure of the Clause*, Foris Publications, Dordrecht, 1989
- [Falkenberg, 1998] E.D. Falkenberg, (ed.), *A Framework for Information Systems Concepts*, IFIP, 1998 ([www.wi.leidenuniv.nl/~verrynst/frisco.html](http://www.wi.leidenuniv.nl/~verrynst/frisco.html))
- [Flores and Ludlow, 1981] F. Flores, J.J. Ludlow, Doing and Speaking in the Office. In: G. Fick, H. Sprague Jr. (Eds.). *Decision Support Systems: Issues and Challenges*, Pergamon Press, New York, 95-118, 1981.
- [Goldkuhl and Lyytinen, 1982] G. Goldkuhl, K. Lyytinen, A language action view of information systems, In M. Ginzberg, C.A. Ross, (Eds.), *Proceedings of the 3<sup>rd</sup> international conference on information systems*, TIMS/SMIS/ACM, 1982
- [Griethuysen, 1982] J.J. van Griethuysen (ed.), Concepts and Terminology for the Conceptual Schema and the Information Base, ISO TC97/SC5/WG3, N695, 1982.

- [Habermas, 1981] J. Habermas, *Theorie des Kommunikatives Handelns*, Erster Band, Suhrkamp Verlag, Frankfurt am Main, 1981
- [Halpin, 2001] T.A. Halpin, *Information Modeling and Relational Databases*. San Francisco: Morgan Kaufmann, 2001
- [Lind and Goldkuhl, 2003] M. Lind, G. Goldkuhl, The constituents of business interactions – generic layered patterns, *Data and Knowledge Engineering*, 47(3): 327-348, 2003
- [Liu e.a., 2001] K. Liu, R.J. Clarke, P.B. Andersen, R.K. Stamper, (eds.), *Information, Organisation and Technology – Studies in Organisational Semiotics*, Kluwer Ac. Publ. 2001
- [Nauta Jr., 1972] D. Nauta Jr., *The Meaning of Information*, Mouton & Co, The Netherlands, 1972
- [Nijssen, 1976] G. M. Nijssen, A Gross Architecture for the Next Generation Database Management System. *IFIP Working Conference on Modelling in Data Base Management Systems*, 1-24, 1976
- [Peirce, 1958] C. Peirce, *Collected Papers of Charles Sanders Peirce*, Cambridge Mass., 1958
- [Searle, 1969] J.R. Searle, *Speech Acts, an Essay in the Philosophy of Language*, Cambridge University Press, Cambridge MA, 1969
- [Searle, 1995] J.R. Searle, *The Construction of Social Reality*, Allen Lane, The Penguin Press, London, 1995
- [Schoop e.a., 2003] M. Schoop, A. Jertila, T. List, Negoisst: a negotiation support system for electronic business-to-business negotiations in e-commerce, *Data and Knowledge Engineering*, 47(3):371-401, 2003
- [Taylor and Every, 2000] J.R. Taylor, E.J. van Every, *The emergent organization – Communication as Its Site and Surface*, Lawrence Erlbaum Associates, 2000
- [Weigand and De Moor, 2003] H. Weigand, A. de Moor, workflow analysis with communication norms, *Data and Knowledge Engineering*, 47(3):349-369, 2003
- [Winograd and Flores, 1986] T. Winograd, F. Flores, *Understanding Computers and Cognition: A New Foundation for Design*. Ablex, Norwood NJ., 1986
- [Wittgenstein, 1922] L. Wittgenstein, *Tractatus logico-philosophicus* (German text with an English translation by C.K. Ogden), Routledge & Kegan Paul Ltd, London, 1922