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► **To cite this version:**

Coen Suurmond. Information Systems and Sign Systems. 16th International Conference on Informatics and Semiotics in Organisations (ICISO), Mar 2015, Toulouse, France. pp.20-29, 10.1007/978-3-319-16274-4\_3. hal-01324958

**HAL Id: hal-01324958**

**<https://hal.inria.fr/hal-01324958>**

Submitted on 1 Jun 2016

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# Information Systems and Sign Systems

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**Abstract.** The organisational world can be considered as a collective of social sign systems and formal sign systems (computer based information systems). In this paper the issue of the fundamental differences between the two kinds of sign systems will be discussed, and the implications of these fundamental differences for system development.

**Keywords:** Organisational Semiotics, Sign Systems, Business Processes

## 1 Introduction

Semiotics is the study of sign processes. In organisational context it covers the study of the use and the production of signs in the execution of business processes. The information flows within an organisation are inextricably connected to the use of signs. Signs are the tangible or intangible carriers used for the transfer of information, and interpretation of signs generates meaning.

Within an organisation all kinds of different sign systems are used. In the development of information systems, we generally tend to be focused solely on one kind of sign system, namely the highly structured and formalised IT sign system. In analysis, modelling, requirements elicitation, specification, design and building we use partly formalised language in order to construct IT artefacts, rigid and formal computer based sign systems. Yet, in the daily routine of business processes, real people do not use only or even primarily formalised language. People interact through various kinds of social sign systems like natural language, specialised language (jargon), body language, pictorial information, and they use experience and background knowledge in their daily business routines. People interact on the basis of a combination of patterns, conventions, and norms. In the execution of their organisational tasks real people must deal with real world situations and with the expectations of other real people, using IT systems, natural language, sensory information, experience and background knowledge simultaneously in order to interpret the situation, take the correct actions, and inform people and automated processes in subsequent processes.

Much organisational work is routine and can be automated. At the same time, automation itself is a human activity. Both automation projects and working with the results of automated operational processes are human activities and must necessarily be cov-

ered by human responsibilities in the organisation. This implies that formal sign systems (computer systems) will always be embedded in social sign systems.

In the study of the use of information systems in organizational context, we should focus on the role of information in the business processes. The primary question should be: what information is needed in what form to carry out the tasks and responsibilities in business processes, where the tasks and responsibilities must necessarily include the production of information for subsequent processes. A similar focus on information rather than on technology is expressed by Ron Weber when he states that the core of the information systems discipline will lie in theories that account for information systems-related phenomena, and not in theories that account for information technology-related phenomena [1]. However, in much of ISR literature, and also in the statement on the IFIP website of the scope of TC8, the emphasis seems to be on the application of information technology [2].

For the exchange of information between business processes different kinds of sign systems are involved, some formal, some informal. The different sign systems may complement each other, or they may overlap. One can distinguish between the mechanisms of the formal organisation (as specified in the official documents) and ‘shadow’ mechanisms (as evolved through the needs of the processes as perceived by the people involved). This leads to the following questions:

- Which different kinds of sign systems can be distinguished within an organisation, and what are their respective characteristics?
- What are the implications of the differences between sign systems for system development?

To find answers to these questions I will first discuss some basic insights from semiotics, and I will give tentative definitions of the concepts of sign system, formal sign system and social sign system. The paper will continue with a discussion of the economic criteria for the execution of business processes. The core of the paper is in the presentation and discussion of a typical business case and the role of formal and social sign systems in the case. To conclude, I will give provisional answers to the questions asked above, and I will indicate lines for further research.

## 2 Semiotics

Kecheng Liu writes in his work on organisational semiotics about the use of signs in organisations: “that all organised behaviour is effected through the communication and interpretation of signs by people, individually and in groups” [3]. According to a much used definition by Peirce “a sign, or representamen, is something which stands to somebody for something in some respect or capacity” (2.228) [4]. Any individual percept can (must) be interpreted and as such function as a sign. In semiosis, humans are aware of the difference between the sign itself and that which is represented by the sign. This awareness is fundamental for semiosis, as Van Heusden has analysed in his work. He defines: “Semiosis is the relating, by someone, of a form and an icon” [5]. In this definition, the form represents the general, the convention, the stability and the continuity. This allows us to communicate with each other. The icon represents the

specific situation, the individual perception. The awareness of the difference between form and icon is the driving force in the development of meaning. New words and new meanings of words are implicitly learned by ostension (pointing out typical examples) by use, and by generalising from individual instances of use to general conventional meaning [6]. A specific case of the development of general (and binding) meaning by conscious assessment of individual cases against general meaning is the administration of justice. One example from the Dutch High Court: when the maximum amount of nitrate on lettuce is explicitly bound by law, does the same law apply to crinkly lettuce? Is crinkly lettuce a different vegetable, or is it just another kind of lettuce? [7]

In the context of organisational semiotics, Van Heusden and Jorna have analysed how in organisations types of knowledge can be related to the use of signs. In sensory knowledge (the craftsman) the iconicity is predominant, in theoretically concrete knowledge standardised forms (codification) is predominant (classification schemes, conventional signs such as pictograms), and in theoretical knowledge (structures) the relation between abstract forms is predominant [8]. Their semiotic space, an adaptation of the information space of Boisot [9], has thus three axes: degree of sensory detail (global/detailed), degree of codification (weak/strong), and degree of theoretical abstraction (concrete/abstract). The semiotic space indicates the kind of knowledge that is predominant in a specific business process as the relative weight of the three dimensions. In each and every case, however, all three dimensions are present. Pure iconicity cannot be communicated (works of art come close), pure theory would be unconnected to concrete events (mathematics and logic come close).

In our social world we deal mostly with signs in the context of more or less comprehensive sign systems. Natural language is an example (utterances stand for meaning and intentions), it is the sign system in which our culture as a whole is embedded. Morse code is another example, and is a dedicated sign system designed for a specific purpose, both in a narrow sense (the coding of letters in dots and bars) and in a broad sense (the conventions that regulate the communication by means of Morse code). The nautical system of flag signals is another example of a sign system. To elaborate a little on the last examples (and in agreement with the general system theory that says that any coherent set of elements and relations can be considered a system): the system of flag signals, the system of colours and forms of buoys, the convention of nautical radio communication, the use of symbols on water charts can each be considered as separate sign systems, or the sum of all conventions regarding nautical communication together can be considered as a single sign system. Each part of the nautical sign system is governed by explicitly stated rules and conventions, the nautical sign system as a whole is both governed by the underlying rules and conventions, and will probably also show emerging social habits and patterns that are characteristic for certain places or for certain types of sea traffic.

In natural language a lot of different sign systems could be differentiated, and it would be difficult to find good demarcations between them. Lotman has coined the term “semiosphere” for the grand total of all the different and overlapping sign systems that make up the environment a human being lives in [10]. It is certainly not my ambition in this paper to develop a method for distinguishing all kinds of possible

sign systems in human communication. For this paper it suffices to make the essential distinction between formal sign systems (especially as used in computer systems) and social sign systems (as used in human communication). I will start with some tentative definitions of sign system, formal sign system, and social sign system.

A **sign system** is a set of signs, used by a social group in a social context, together with for that group in that context settled practices regarding the application and interpretation of the signs and combinations of signs.

A **formal sign system** is a sign system where the set of signs and the set of rules governing well-formed formulas as valid combinations of signs are formally defined. A good example of a definition of such a system is the proposal for an International Algebraic Language (IAL, precursor of Algol-60) by Backus in his paper at the ACM-Conference in Zürich in 1959 [11]. Backus writes in this paper:

“(1) There must exist a precise description of those sequences of symbols which constitute legal IAL programs. Otherwise it will often be the case that a program which is legal and translatable for one translating program will not be so with respect to another.

(2) For every program there must be a precise description of its “meaning”, the process or transformation which it describes. Otherwise the machine language programs obtained by two translating programs from a single IAL program may behave differently in one or more crucial respects.”

What is stated here, is that given the formal and deterministic nature of translator programs (translating source code into machine code), the rules for the source code must be fully specified. If not, writers of translator programs may make different choices, resulting in different behaviour for the same source code.

A **social sign system** is a sign system where the set of signs and the set of habits governing the application and interpretation of signs are formed by social practices, varying from explicit stated rules via social conventions to evolving patterns). In law, we find explicitly stated rules. In the application of law (police, court) we recognise the normative force of social conventions and social patterns. For example, what counts as “self-defence” is dependent on the societal context and of the interpretation of the actual situation and the societal context. In the case of Oscar Pistorius in South Africa the judge had to decide whether to interpret Pistorius’ killing of his girlfriend as an act of mistaken self-defence, as an act of manslaughter, or an act of murder.

## 2.1 Meaning and Sign Systems

Meaning can only be found in the use of social sign systems. A formal sign system by itself is devoid of meaning, although there is often the suggestion that it does have meaning. Backus writes “meaning” between quotation marks when discussing automatic processing or transforming, to indicate there is no real meaning involved here

(my interpretation). I will give an example from daily practice of the meaninglessness of formal sign systems.

Some time ago I needed a new bank card because the old card was pretty damaged. It was still functioning, but it would be broken soon. In order to request a new card via the website of the bank I had to log in first. For this action I needed to use my damaged but functioning card. The request form for the new card asked for the reason (an obligatory choice) for requesting a new bank card: (A) my card is broken; (B) my card was lost; (C) my card was stolen. My reason did not appear in the options. How to answer the question? My line of thought was: if I choose either “lost” or “stolen”, I will probably get a new PIN code. If I choose “broken”, I will retain my PIN code. Therefore, I chose “broken”. Then, I finished the other questions on the form and concluded my dialogue with the website by again using my damaged card and entering the security code connected to that card. The final message of the website was: “You requested a new bank card because your current card does not function any more. The new card will be available after three working days”. So, I had to use my damaged card twice to tell the system the self-same card did not function any more. I was quite happy this formal sign system did not have meaning!

This example shows three different domains of interpretation: (1) natural language as used and interpreted in human communication, here used for the description of the case; (2) the formal operations within the ICT system according to the formally declared variables, their values, and the conditions as specified in the program code; and (3) natural language in the presentation layer of the software. The last domain suggests the use of meaningful terms by the computer, but is nothing more than an alias for some formal variable or value on a variable.

### **3 Economic Norms**

Information systems are resources for business processes, and just like any other kind of resource organisational and economic norms apply for their effective and efficient deployment. Information systems include all kinds of organised exchange of information, both computer based and based on numerous other forms of exchange of information by face to face meeting, email, reporting, and so on. Norms of effectiveness and efficiency are generic economic criteria and are always relevant. These norms apply for the use of sign systems in business processes like they apply for the use of every kind of resource.

Sign systems fulfil a role in the transfer of information within and between internal business processes, as well as in the interaction and transfer of information between the organisation and its customers, suppliers, and any other external stakeholder. Sign system A is better suited than sign system B for a certain task if A consumes less resources than B. Like many other economic issues the generic criterion is straightforward and clear. However, practice is more often than not complex and not straightforward: (1) the criteria for the successful execution of the task are multi-dimensional, (2) the term resources encloses a heterogeneous group of very different kinds of resources, (3) the determination of the price per unit consumed for a resource can be a

highly complex and challenging issue, and (4) the attribution of the amount of resources to specific tasks is often difficult. All these considerations do not take away the fundamental insight that the issues of effectiveness and efficiency always apply in an organisational context. Sometimes effectivity will prevail, sometimes efficiency, but it is always an essential consideration in an organisational context.

Apart from the generic criteria mentioned above specific norms for the particular organisation will apply. Partly, these norms derive from the position of the organisation in its environment (for a company: primarily market relations, in combination with relations with other external stakeholders), and partly the norms derive from the internal organisation (Mintzberg: the way of splitting up the tasks and the supplementary mechanisms for coordination of the tasks) [12].

In the context of this paper for the market relationship (both as seller and as buyer) the difference between classical contracts and relational contracts is very important [13]. Classical contracts are explicit and based on standard terms. These kind of contracts are therefore suited for elementary stand-alone economic transactions between anonymous trading partners, such as can be found on spot markets (buying a paper at the news stand or buying a shipload of crude oil). Relational contracts are not fully specified and are based on a longer lasting trusting relationship between the trading partners. In traditional economic theory, the model of the classical contract prevails with its notion of the individualistic and selfish behaviour of economic actors. In real economic relationships, elements of relational contracts are usually present. The relational aspect of economic relationships of the company with its customers and suppliers is the basis for some of the company's operational norms in business processes. In executing its processes the implicit rules of the economic relationship with the customer must be obeyed (and rules apply for the behaviour of the customer towards the company also). For those who are familiar with the Demo method: in Demo literature the examples are typically examples of transactions in classical contracts, and give therefore a distorted view of business practices [14].

## 4 Case Study

The following example shows what the considerations are in choosing the right sign system. Suppose a customer has a long standing relationship with his supplier / producer, and the customer asks: "Could you deliver about 3000 kg trimming in the second half of next week, not too fat?". The supplier answers: "I will take care of it!". What kind of agreement do we have here, as expressed in loose natural language? And how will this agreement be translated into the computer systems of the supplier / producer, from order entry, through production and shipping to delivery and invoicing?

### **Producer / Supplier 1**

Suppose the supplier / producer has a simple and small-scale computer system for sales & invoicing. The internal processes are not supported by this system. In this situation the order will be put into the sales-system with customer-number, delivery date either Thursday or Friday (more or less arbitrarily), the quantity ordered is 3000kg, and the item-number for the product with the description "trimmings 80/20" (trimmings with 80% meat and 20% fat), price. If it is a regular order from a regular

customer, this information will suffice. If this order is in some respect an exception to the regular habits and patterns, some notes will be made to remind the colleagues in production and shipment department what is to be known about this particular order. These notes might be made into the computer system (if some comment fields for free text are available), or in the sales-agenda of the sales-person, or on some paper.

When later on the order is prepared, and it is a regular order from a regular customer, then the information Customer C, Product P, Delivery D, Amount A will be sufficient for the production department to select or produce the trimmings that will satisfy this customer order. Just the variable parameters of the order are communicated to the shop floor. All further information to fulfil this order is known by the employees on the shop floor, including the slack permitted in the product specifications, the delivery date and the amount to be delivered (routine is presupposed). In other words: to know the customer and the product ordered is sufficient for the execution of the order on the work floor, all to specifications and expectations.

Part of the established habits of this particular customer – supplier relationship might be that the supplier informs the customer on Tuesday or Wednesday what will probably be delivered, and when. Or the customer informs the supplier that due to unforeseen demand he has a shortage, so please deliver at the earliest possible moment.

#### **Producer / Supplier 2**

Suppose, by contrast, a supplier / producer who has a highly integrated ERP system. Here also the first step is order entry with the customer-number, product-number, delivery date, quantity, price. The differences are in the subsequent processes. The order data are processed in production planning, as a result production orders will be generated to have exactly the ordered quantity of the ordered product available at the shipping date. Next, production will execute the production orders. The shop floor control module of the ERP system will be monitoring the progress and results of the production processes. Deviations from the production planning are detected and result in corrective actions. If the output from production is less than planned, production will be replanned to produce the lacking quantity. If the output from production is more than planned, the extra output will be added to stock. Is demand for that product-number more than what is available, for example because of late orders from other customers, replanning (or buying) must provide the lacking quantity. All the actions indicated above can be executed automatically in the ERP system.

### **4.1 Analysis of the Sign Systems in the Business Case**

In the examples above we see two different sign systems at work. The first supplier / producer uses a natural language sign system with apparently vague descriptive terms and very loosely formulated and imprecise specifications. The trade partners have a stable relationship and each of the trade partners in this economic relation understands the product, the market, and the partner. In this situation, the margins of the trade are sufficiently clear, the trade partners grant each other some latitude in the interpretation of the agreement, and as a result both the internal and external transaction costs are kept at a minimum level. It is a typical example of a relational contract.

For the financial aspects some very specific formal obligations apply. Financial transactions must be factual, consistent and transparent for external stakeholders (In-

land Revenue, chartered accountants). Therefore, each invoice must have a unique number (with checks on completeness), and each invoice will show the VAT number of seller and buyer, and each invoice must declare the delivered goods (description and quantity). These formal requirements are met in the sales / invoicing system, partly automatically generated (unique successive invoice-number), partly configuration (VAT-rate, own VAT number), partly master data (VAT-number customer, address data of the customer, description of the product), and partly from order / delivery data (product-number, price, possibly discount, quantity delivered).

The second supplier / producer uses a formal sign system which operates by unique ID's for customers, address data, sales items and all other entities involved in the processing of information. The Bill of Material specifies precisely which resources in which quantities are required to produce one unit of a sales unit, sometimes in combination with a specification of setup times for production, sometime with a specification of setup times dependent on the preceding product on the production line. The ordering process (commerce), the production planning process (coordination), and the production and distribution processes (material handling) are (dis)connected by the ERP system

At the beginning of the trade process, at order entry, there is no difference between the two suppliers / producers. Basically, they record the same information in the same way. At the end of the trade process, after establishing the delivery data, the subsequent processes of preparing the delivery documents (either on paper or electronically), and invoicing are the same. The latter processes are bound by financial rules and commercial law. But in between, in all processes involved in order fulfilment, important differences can be found. In the case of the first supplier / producer, the order entry data are made available for the internal processes, and all interpretation is done by knowledgeable employees. In the case of the second supplier, the order entry data of this particular order is automatically processed together with a bunch of other customer orders. Formally derived information is made available for specific processes. The two essential differences between the cases are: (1) the kind of interpretation / processing of information, and (2) the kind of information that is available at different points in the order fulfilment processes. Both differences have a strong connection with the predominant sign system used for the internal processes in the organisation: a social sign system in the first case (common natural language, professional language, organisational terminology), formal sign systems in the second case (computer systems).

## **5 Sign Systems and Business Processes**

From the example case it will be clear that formal and social sign systems differ in their characteristics to a considerable extent. A general problem in developing computer based information systems is a lack of awareness of these differences. Taken collectively, the user community tends to neglect the differences and ascribe meaning and a capacity of understanding to machines and automata, while the system developer community tends to neglect the differences and blame users for not making clear what they are doing and what they want. Under the hypothetical assumption that in a

concrete project both user community and developer community (1) are well aware of the differences between formal sign systems and social sign systems, and (2) are well aware of the double embeddedness of formal sign systems in social sign systems (both in the development of formal sign systems and in the operational application of formal sign systems), the question is what the practical implications are of the differences in the development of an information system.

The same economic norms apply for information systems as for all other kind of resources; the information systems should be effective and efficient. Towards external stakeholders, effectiveness means satisfying their justified requirements and expectations (the expectations being an essential component of relational contracts). For the internal business processes, the effectiveness of the information systems means satisfying the maxims of Grice for a conversation: give all relevant information for the task at hand, avoid all irrelevant information, be accurate, brief, clear and orderly [15]. To meet these Gricean maxims, some information is best provided by computer systems, and some by human communication. Situational factors like the kinds of relationship with the outside world and the internal company's culture are codetermining for what the best mix between formal and social sign systems would be.

John Kay writes: "The firm is defined by its contracts and relationships. Added value is created by its success in putting these contracts and relationships together, so it is the quality and distinctiveness of these contracts that promote added value" [16]. To sustain the distinctive capabilities of a company with relational contracts, social sign systems matter most.

Also important is the human accountability for actions in an organisational context. Tasks and decisions may be delegated to computer systems, but people are responsible for the execution of the automated tasks. Firstly, this implies that in the configuring of a computer system the responsible people in the organisation must determine the categorisations and the business rules, and must be able to observe and approve the behaviour of the system before operational application of the system. This makes high demands on the translation of the organisational practices into formalised models, and vice versa. Secondly, in operational use people must be able to translate their operational situation into meaningful categories in the computer system (N.B.: this means meaningful for the employee!). Thirdly, in operational use people must be able to translate output of the computer into meaningful information for their task at hand.

## **6 Conclusions**

In the sections above the fundamental differences between social sign systems and formal sign systems were discussed and illustrated with some business examples. When practitioners in both the user community and the developer community are more aware of these differences, much would be gained already. Subsequent research is necessary to further conceptualise sign systems and its properties, and to analyse business processes in relation to the properties of sign systems.

Apart from the essential distinction between social sign systems and formal sign systems, many subtypes in both social and formal sign systems can be differentiated.

However, there is the risk of uncontrolled proliferation in such differentiation when a clear goal is lacking. In Information Systems Research, the goal would be to gain a better understanding of the fit of computer based information systems to the business processes. In this perspective, both social sign systems, formal sign systems and business processes should be analysed and categorised in relation to each other. Several kinds of problems are to be solved: (1) the practical problem of the translation of information between formal sign systems and social sign systems; (2) the practical problem of the translation of information between different formal sign systems (in a heterogeneous landscape of different computer systems, also EDI issues); (3) the practical problem of translation between different social sign systems (a classical organisational issue); and last but not least (4) the fitness of a specific sign system for specific business processes.

To conclude, insight in the nature and characteristics of different kinds of sign systems is highly relevant for information system development, and will gain both economic results (effectiveness and efficiency, competitiveness) and organisational results (better definition of tasks, less erosion of responsibilities).

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