Information
Basis For Action In Human Information Processing
Consequences For Information System Design

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Abstract

Information is available internally as well as all around us. It is possible to identify a number of different levels for information. Internally we can find genetic information that will make us the way we are. It will determine our characteristics as human beings. There is also other internal information that we are unaware of, information that controls automatic processes like heartbeat and breathing. We also have internal information that we are aware of. Such information appears when we are thinking of something or solving problems using our previous knowledge and impressions from the outside world. External information can be obtained from several different information sources. Physical objects may convey information to us when we perceive them. Such information can be obtained through active as well as passive search. Conversation with other people is another information source. Talking to people can also give us information through active as well as passive search. Reference information is found in for example encyclopaedias and reference literature. Such information is usually found through active search, but it may happen that when looking for one concept you get information about another concept and therefore this kind of information can also be gained through passive search. Mass media is another information source that will bring us news information. We are fed with the information that news editors has chosen to deliver to us. Encyclopaedias and mass media can be seen as logical objects. There are also other kinds of logical objects that may convey information to us such as for example books about a certain subject or fiction. I will call this kind of logical objects descriptions. Descriptive information is usually gained through passive search. Regardless of information source, we get information only after we have interpreted the impressions and created a meaning using previous knowledge. Information is thus regarded as an internal concept. We can see that much of the information is a direct base for action. Thoughts are used for decision making, which is we plan actions according to what we think. Information from external sources can also be used as a base for actions since we use information obtained in that way for decision making. An information system should help the user in information processing. Since information is the base for actions it is not enough to look at usability aspects of the information system but actability aspects must also be considered. Actability means that the system should support and encourage the user to perform the actions that the supplied information will imply as well as to support the information behaviour of the user to find the information that he or she needs.

Keywords: information, information system design, actability, levels of information, action, information behaviour

Introduction

Information is readily available all around us. But information also resides inside us. It is possible to identify three levels of internal information. The first level consists of the genetic information that will define our characteristics. This information determines who we are and what we are. It will also determine how we behave and act. Genetic information is thus a basis for actions – the actions that occur in our daily life. Two different individuals with different genetic information will react differently on external impressions and their actions in a given situation will therefore be different. Each person will demonstrate his or her own action pattern.

The second level of internal information is information that controls the automatic processes such as for example heart beat and breathing. This information is necessary for our survival and it triggers impulses that lead to different actions. This level of information is thus also the basis for actions – automatic actions.

We are however not aware of the internal information flow on the first two levels. But there is also conscious internal information. Such information appears when we are thinking of something or solving a problem using previous experiences and impressions from the outer world. Using that information, we make different decisions that lead to actions of various kinds. It could for instance be a decision about walking across the road having considered the traffic flow and compared distances to approaching vehicles with earlier experiences. Or it could be a decision about introducing a new computer system in a company evaluating different alternatives and finding arguments for the choice.

As it seems all internal levels of information are basis for some kind of actions. It would thus be adequate to say that internal information is a basis for action. Let us look at external information to see if it is possible to find similar characteristics for such information.

A computer system also has an internal information flow that may result in automatic actions from the computer system. These actions may be invisible for the user (black box) or they can be possible to observe (white box).

External information can be obtained from several different information sources. Physical objects may convey information to us when we perceive them. Such information can be obtained through active as well as passive search (Wilson, 1999) Active search occurs for example when we examine a map to get information about the best route between two cities. Passive search instead occurs for example when we pass an object with an advertisement about a new product. We did not actively look for that information but received it passively.

There are different levels on which external information can occur (Wurman, 2001). The first level is reference information. Reference information can be obtained from encyclopaedias and reference literature as well as from computerized search systems. Such information is usually found through active search. We are actively looking for

information. It could for example be the location of Fisherman's Wharf in San Francisco as a preparation for going there. But reference information can also be found through passive search. When looking for information about Fisherman's Wharf we may come upon information about Alcatraz that we were not actively looking for. But having gained that information it encourages us to plan a visit to Alcatraz. Reference information can thus be used for planning actions and can thus be seen as a basis for actions.

On the next information level we can find conversation information. Conversations with other people reveal information about different concepts and the process can be seen as active as well as passive search. Sometimes we engage ourselves in conversations in other people to gain information about a certain concept whereas at other occasions we gain information from conversations that we did not consciously look for.

On the third information level we have news. News are delivered to us through mass media. We are fed with the information that news editors have chosen to deliver to us. An actual event is observed by a journalist who writes a story to cover the event. This story then passes a number of gates with different editors as gate-keepers. The editors may change or reject the description and in the end this article compete with other articles from other journalists for space in the media. Depending on the competition the article may occur or not in the media and the position in the media will also depend on the competition. With poor news flow a rather uninteresting event may be reported on the front page of a newspaper. It there are many interesting events, the same event may be rejected or presented further back in the paper. News can be obtained through active or passive search. We may look at a TV-program to gain information about the disaster caused by a certain hurricane. When waiting for this information we are fed with other information that we did not look for.

Encyclopaedias and mass media can be seen as logical objects. There are also other kinds of logical objects that may convey information to us such as for example books about a certain subject or fiction. I will call this kind of logical objects descriptions. Descriptive information is usually gained through passive search.

The highest level of external information is described as cultural information. Such information is present all around us in our culture. Culture is however not something fixed but is changing. We are influenced by cultural information at the same time as we contribute to it. Cultural information will influence our interpretation of information on the other levels.

External information may be used for different actions. News information about a hurricane may cause us to move to a safe area. Reference information about a location may enable us to go there. But external information needs to be internalized, that is perceived, interpreted and compared with previous experiences, to be understood and to create meaning. Only then external information on different levels can be seen as a basis for action. External information that has not yet been internalized can be seen as *potential* information. Information thus has an internal character.

But how is this character met by the information systems that we create? Can the information systems support human actions or do they just deliver information without considering possible user actions? This paper will look further into the characteristics of the interaction between human beings and computer systems that may support user actions. The interaction is also related to different kinds of information and actions that are part of human activity systems that are described below.

Human Activity Systems

Human activity systems are social systems where people perform actions. Information systems are communication systems and as such a part of a human activity system. An information system is a socio-technical system involving human activities as well as information technology. (Benyon-Davies, 2002)

Human activity systems can contain other systems such as for example information systems and production systems. The kind of system that is of interest in this research is the information system that can be characterized as a communicative system but also as a sociotechnical system. (Benyon-Davies, 2002). An information system can be further divided in human systems and technical systems.

A computer information system belongs to the technical part of an information system. The relationships between different kinds of systems are illustrated in the figure below (Lind & Lind, 2004). The arrow between humans and computer systems illustrate the interaction that is focused in this paper.

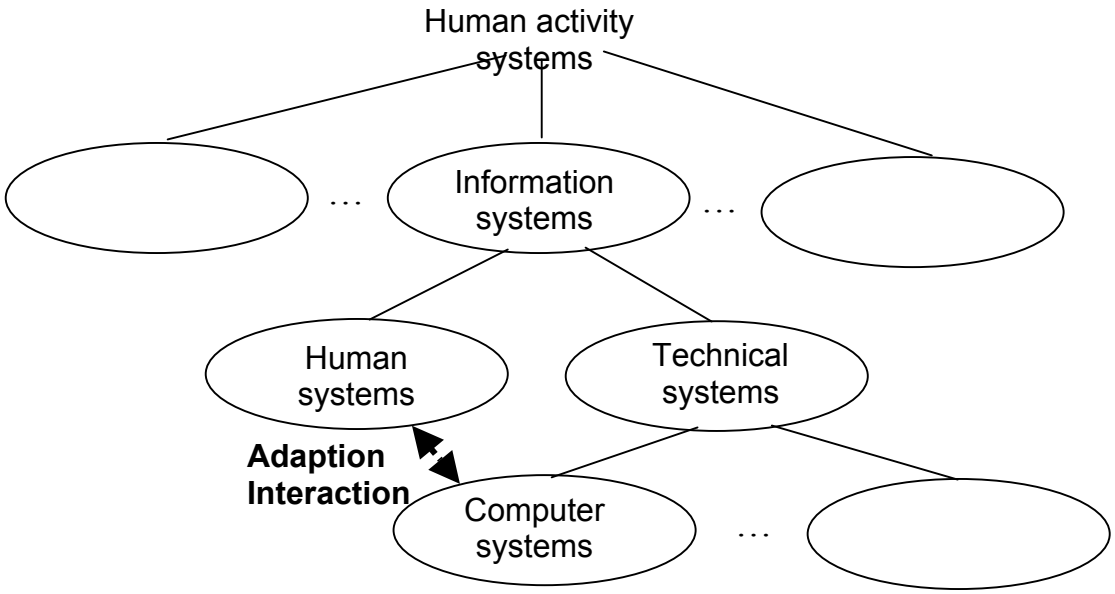

Figure 1: System Relationships

Human activity systems are systems concerned with different kinds of human actions. These systems are possible to observe in the world since a great number of human activities, more or less consciously ordered for some purpose, occur everywhere around us. The human act of design of physical or abstract systems is characteristic for this system class. One extreme example is a system consisting of one man using a hammer and on the other extreme we can find international systems needed for life to be tolerable on earth. (Checkland, 1999)

A central part of a human activity system is human information processing that can be described as the process in which a person thinks, acts and modifies subsequent behavior. The self-corrective unit extends far beyond the human body. (ibid) If a computer system is part of the human activity system, it should assist the human being(s) in the system in their information processing activities. The system has an aim to achieve something, to create an added value for somebody who is called the customer.

Checkland (1999) presents a way to describe a human activity system which can be summarized by the acronym CATWOE, where

- C= Customer, who is the person who will benefit from the activity.

  The human activity system must have a Customer since somebody must experience and take advantage of the added value that is created by the system; otherwise the activities would be meaningless and the system would probably cease to exist.

- A = Actors, who are the actors involved in the activity.

  The actors in a human activity system are the users that interact with each other and the computer system.

- T = Transformation, which defines input, output and main processes necessary to describe the system.

  The human activity system will somehow perform a transformation from *input* to *output*; it is this transformation that creates the added value that gives the customer satisfaction.

- W = Weltanschauung (= world perception, the perception of critical concepts related to the activity).

  The perception of the world will influence the processes in the human activity system; for example a technical perspective will focus more on the computer system whereas a human or social perspective will focus more on the interaction between people.

- O = Ownership, that is the organizational body that has the ultimate power and ambition to continue the activity.

It is important to identify "who is in charge", that is who is responsible for the activities and has a possibility to control and change what happens in the system.

- E = Environment, the factors in the surrounding world (context) that could influence the activity.

  Environmental factors of importance are created by stake holders outside the human activity system; an example of such stake holders are people in charge of systems analysis and design.

Usability

In a human activity system, interaction between people and computers is essential. Norman (1988) has presented a model illustrating the interaction between a human system and a computer system. The model shows that the human system first creates an action plan that is executed on the interface of the computer system. The human system then observes the result on the screen to decide successive actions.

One important concept in relation to human computer interaction (HCI) is usability. It is a quality criteria for computer systems (or other interactive artefacts). Determining usability can however be time consuming since it is the interaction between the human and the computer system over a certain period of time that must be studied. Usability is thus not an objective property of the computer system but arises through its use. (Ottersten & Berndtsson, 2002) The context includes the user and the task as well as artefacts and physical environment (Ågerfalk & Cronholm, 2001).

ISO-9241-11 defines the concept as *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use* "(ISO-9241-11, 1998) Using the term "specified user" indicates that ISO wants to stress that different users may have different needs and may understand the artefact differently. (Ågerfalk & Cronholm, 2001)

Even if usability considers the user's situation in a specific context, it does not different kinds of actions that are involved in a human activity systems. Since I have above presented arguments for information as a basis for action it seems reasonable to expand the concept of usability to include an action perspective. A concept that focuses on actions is actability that is described below.

Actability

Human actions can occur in a number of ways. There are internal actions where genetic information, information controlling automatic, unconscious systems, and information processed by cognitive activities will be used.

There are also external human actions where information controls the choice of alternatives. Such actions take place in human activity systems. Above I have also presented a view that brings people and computers together in a human activity system. In such a system with people as well as computers as interacting entities, people perform actions aided by information presented by the computer system. The actions should lead to transformations in the system, transformations that create an added value. These actions expand the area of interest and are thus important for development. The computer system should therefore support human actions in order to facilitate further expansion. That means that we must consider not only what information should be produced, but also how the information should be used.

A further analysis of information system characteristics could take its starting point from different levels: the surrounding physical world, empirical findings, syntax, semantics, pragmatics and the social world. Pragmatics deals with how the human system is influenced by messages from the computer system and the reactions of the human system of such messages. (Lind, 2005) The computer system thus serves as a communication system.

Since the humans and computers have different features, the computer system must adapt to the human information system. It is important that the computer system has such characteristics that it works well in the context in such a way that it can cooperate with the human system and support human actions. An important aspect of computer systems is *actability* (Cronholm & Goldkuhl, 2002), that refers to the computer system's "ability to perform actions and to permit, promote and facilitate users to perform their actions both through the system and based on messages from the system" (Cronholm & Goldkuhl, 2005). The concept is based on theories from the areas Language Action and Usability (Cronholm, et al 1999).

To promote actability a computer system must consist of certain parts. These include (Cronholm & Goldkuhl, 2002)

- an action potential based on a predefined set of actions
- the ability to perform actions interactively with the user and/or automatically
- action memory that stores earlier actions and prerequisites for actions
- documents, such as action conditions and results
- a structured language that defines frames for actions

Actability is however not a property of the system but will arise when an individual uses the computer system. Actability will influence the efficiency in the human activity system since it has a direct impact on the user's ability to perform actions.

Although actability is not a property of the system it is possible to identify some characteristics that are important in order to reach actability (Cronholm & Goldkuhl, 2005):

- it should be simple to understand what can be done through the system and the operations in the system

- the user should be able to understand the concepts that are used
- it should be simple to navigate in the system
- the user should be able to see that an operation really is performed and get a picture of the result
- the user should be able to under stand the consequences of proposed and performed actions
- the user should be able to say what he wants through the system
- the user should be given good support for his or her actions

These general characteristics can be applied to create requirements for different situations.

From this perspective the computer is not seen as passive but instead an active entity that can perform actions on behalf of a person as well as influence the user's actions. The computer system actions have the characters of speech acts (Searle, 1969) or communicative acts (Habermas, 1984). The computer system is thus used for communicative purposes.

In a human activity system, actions related to the computer system can be of three different kinds (Goldkuhl and Ågerfalk, 2002):

- actions when actually retrieving information from the system (interactive actions)
- actions performed automatically by the system (automatic actions)
- actions based on the retrieved information (consequential actions)

An *interactive situation* occurs when the computer system is used for actions by the user through the system. In an *automatic situation* the computer system perform actions on behalf of a human actor without any human interventions but using instructions specified by a person. A *consequential situation* occurs when a user performs actions based on information from the computer system.

An interactive action can be related to illocution since it focuses on symbol exchange, whereas a consequential action focuses more on the action as a result of symbol transfer and therefore is more related to perlocution (Searle, 1969). The aim for a computer system should be to take part in and support the users' illocutive actions through interactive and automatic actions in a way that enables the users to perform a competent choice (a perlocutive action) (Lind, 2005).

A computer system can be regarded as actable in an interactive situation if it gives support to the user to (ibid)

- choose action
- give a suggestion to an action
- perform communicative actions
- interpret and evaluate an action and its effects

Actability can thus be regarded as a dynamic concept depending on structures in the human activity system. The degree of necessary actability should therefore be related to the specific context in question. This context includes the users' earlier experiences, the situation and the task that should be solved.

A Model of Actability

The picture below shows a model of actability in a human activity system. The *customers* are those who will benefit from the activities. This could be a number of different people with connections to the activity. The *actors* in the system are the computer system and the human systems (people) involved in the transformation process.

The task controls the transformation process where the state of process is compared with the demands of the task. This is a cybernetic loop that continues until the user is satisfied and can produce a result that solves the task.

The interaction in the *transformation* process consists of different kinds of actions where information may be exchanged. The human system and the computer system engage in interactive actions. The computer system also perform automatic actions that may be caused by interactive actions. The outcome of these combined actions is communicated to the human system as potential information. For the computer system to be able to recommend an action, it is necessary to have access to a repertoire of possible actions as well as sometimes also access to external information sources that can give data (reference information) to the computer system. In a similar way the human system can use other sources for reference information as well as communicate with other people (conversation information) to support the transformation process.

When the cybernetic loop has been gone through a sufficient number of times and the user is satisfied, the human system can perform a consequential action that consists of a solution of the task. This can be seen as the result of the transformation process. An actable system should also be able to evaluate the result. This is also shown in the model.

The *world perception* prevalent in the human activity system will have a major impact on the transformation process. It will influence internal as well as external actions and is to a great extent dependent on cultural information. The *owners* of the system is not illustrated in the model. They can consist of any organizational body that can have an ultimate influence over the system. In the *environment* there are external information sources that the computer system and the human system can use to increase available information.

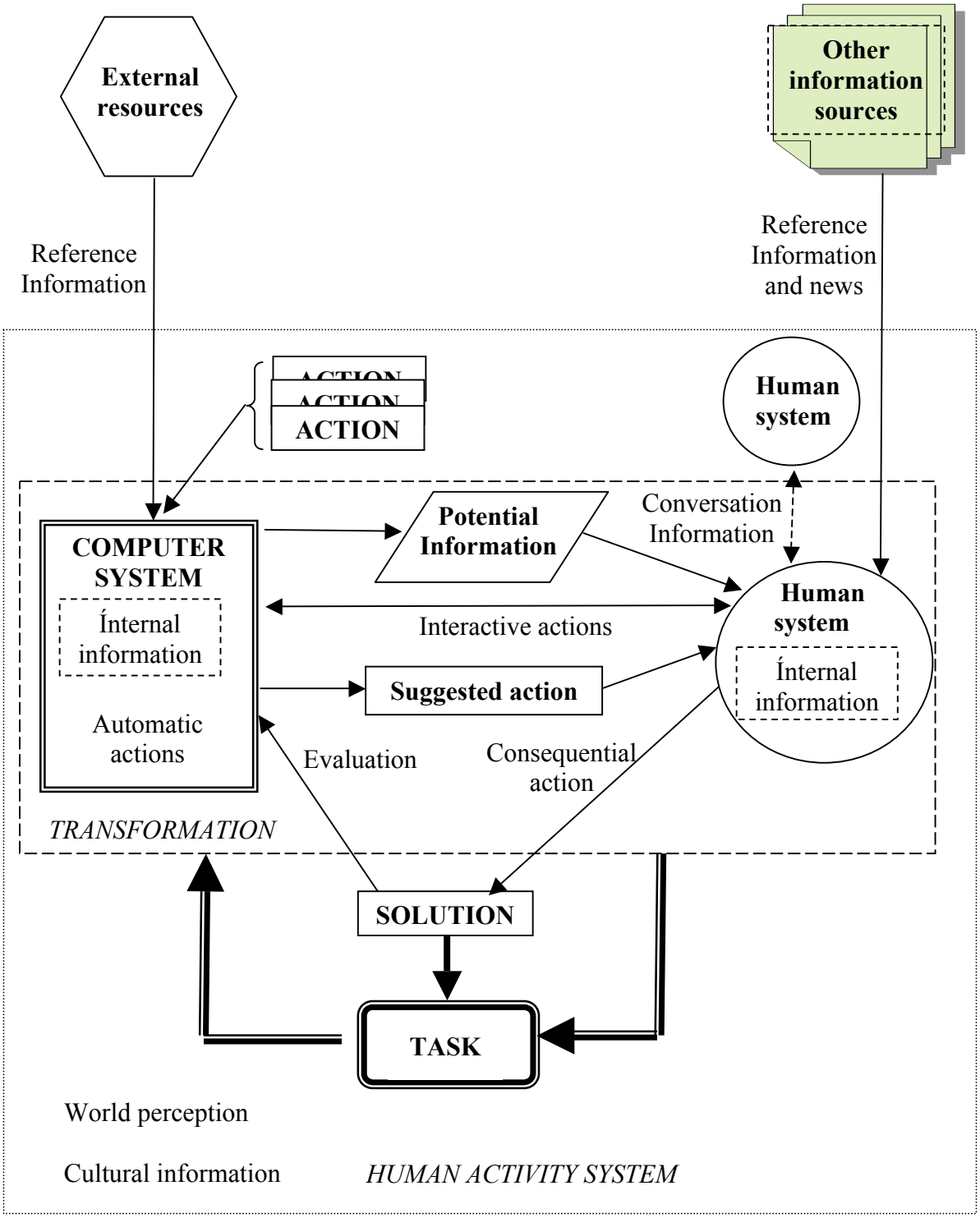

Figure 2: A Model of Actability

Conclusions

In this paper different kinds of actions have been identified. Different levels of information have also been discussed and it has been argued that different levels of information control different kinds of actions. In fact, all kinds of actions are based on some type of information.

Since computer systems are information processing and information distribution artifacts it is important to consider different kinds of actions when designing computer systems. In relation to computer systems three different kinds of actions have been identified: automatic actions, interactive actions and consequential actions. A computer system must have characteristics that can deal with or support all these action types. Such a computer system is said to support actability in an interactive situation.

To facilitate the understanding of the process of human – computer interaction from an actability perspective, a model has been presented. The model shows that the computer system must have access to a "library" of possible actions to choose from. The choice is presented to the user. The model also illuminates different kinds of actions and what kind of information that is a base for a specific type of action.

The model can be used to create a basic understanding for human computer interaction that is valuable for designing interactive systems.

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